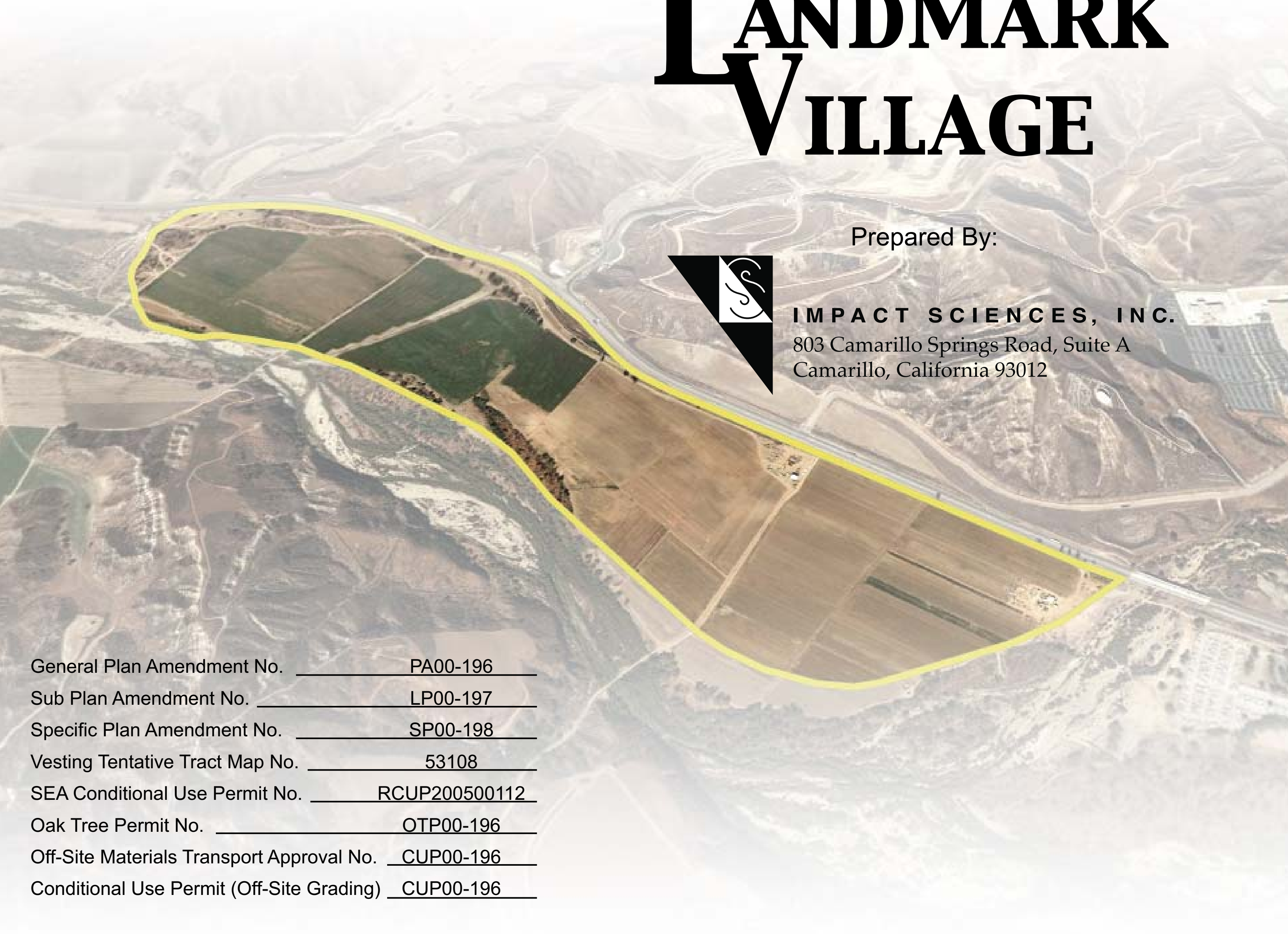
County of Los Angeles

Draft Environmental Impact Report
SCH No. 2004021002

Volume VI — Appendices
Appendix 4.10 (Continued)

LANDMARK VILLAGE



Prepared By:

IMPACT SCIENCES, INC.
803 Camarillo Springs Road, Suite A
Camarillo, California 93012

General Plan Amendment No.	PA00-196
Sub Plan Amendment No.	LP00-197
Specific Plan Amendment No.	SP00-198
Vesting Tentative Tract Map No.	53108
SEA Conditional Use Permit No.	RCUP200500112
Oak Tree Permit No.	OTP00-196
Off-Site Materials Transport Approval No.	CUP00-196
Conditional Use Permit (Off-Site Grading)	CUP00-196

NEWHALL RANCH
Newhall Ranch Company

NOVEMBER 2006

DRAFT
ENVIRONMENTAL IMPACT REPORT
for
LANDMARK VILLAGE

SCH No. 2004021002

Volume VI - Appendices
Appendix 4.10 (Continued)

Prepared for:

Los Angeles County
Department of Regional Planning
320 West Temple Street
Los Angeles, California 90012

Prepared by:

Impact Sciences, Inc.
803 Camarillo Springs Road, Suite A
Camarillo, California 93012
Phone: (805) 437-1900

November 2006

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Water Service

Nickel Water Contract Documentation

NICKEL FAMILY LLC

15701 Highway 178 • P.O. Box 60679 • Bakersfield, CA 93386-0679
(661) 872-5050 • Fax: (661) 872-7141

August 16, 2002

RECEIVED
AUG 2 1 2002
By

Mr. Robert DiPrimio, President
Valencia Water Company
24631 Avenue Rockefeller
Valencia CA 91355

Dear Mr. DiPrimio:

Enclosed please find the following documents:

1. Contract for Purchase and Sale of Kern River Water and Storage Rights dated 3/18/81.
2. Resolution of Nickel Family LLC Class A and Class B giving approval to sign Contract.
3. Resolution of Nickel Family LLC Management Committee giving approval to sign Contract.
4. Resolution of Bravo Management Company Board of Directors giving approval to sign Contract.
5. Resolution of Olcese Water District giving approval to sign Contract.
6. Resolution of Kern County Water Agency Board of Directors giving approval to sign Contract.
7. Resolution of Kern County Water Agency re: 10,000 acre feet use out of County.
8. Kronick, Moskovitz, Tiedemann & Girard Opinion Letter of Counsel re; Water Rights.
9. Letter from Gene R. McMurtrey, Attorney for Olcese Water District, representing that the representations and warranties given by Olcese in Article 7.1(k) are true and correct.

If I can be of further assistant, please call.

Sincerely,

Rita

Rita J. Rowland
Administrative Assistant

Encs.
File: 220-F-17

053837

1981 MAY 26 AM 11:35

RECORD[illegible]
RAY [illegible]
KERN [illegible] RECORDER

OLCESE WATER DISTRICT
Suite 307
1415-18th Street
Bakersfield, Calif. 93301

CONTRACT FOR PURCHASE AND SALE OF KERN RIVER WATER AND STORAGE RIGHTS

28962 B 05/26/81

1:35

OR

MD

THIS AGREEMENT, dated March 18, 1981, is between OLCESE WATER DISTRICT, a California water district, hereinafter "Olcese", and LA HACIENDA, INC., a California corporation, GEORGE W. NICKEL, JR., and ADELE R. NICKEL, husband and wife, hereinafter collectively referred to as "La Hacienda."

RECITALS

1. La Hacienda owns, administers and/or represents certain water rights in the Kern River and storage entitlement in Isabella Reservoir. Such water and storage rights which are collectively hereinafter generally referred to as the "Hacienda Water Rights," are dealt with in various previously executed contracts, including the following:

   (a) Kern River Water Rights and Storage Agreement, dated December 31, 1962, among and between certain districts identified as the "Upstream Group" and Hacienda Water District and Tulare Lake Basin Water Storage District, identified as the "Downstream Group";

   (b) Contract dated October 23, 1964, by and among the United States of America and North Kern Water Storage District, Buena Vista Water Storage District, Tulare Lake Basin Water Storage District and Hacienda Water District;

   (c) Kern River Water Settlement Agreement dated January 1, 1963, by and between the Tulare Lake Basin Water Storage District and the Hacienda Water District;

(d) Supplement to Kern River Water Settlement Agreement dated August 8, 1974, by and between Tulare Lake Water Storage District and Hacidena Water District;

(e) Water Substitution Agreement dated November 14, 1972, by and between Buena Vista Water Storage District and Hacienda Water District, and any amendments or supplements thereto;

(f) Agreement for Establishment and Maintenance of Minimum Recreation Pool of 30,000 Acre Feet In Isabella Reservoir dated November 8, 1963, by and between Buena Vista Water Storage District, North Kern Water Storage District, Tulare Lake Basin Water Storage District, Hacienda Water District and the County of Kern;

(g) Agreement of Sale and the Kern River Water Storage and Reservation Agreement which is incorporated therein, both of which are dated October 16, 1978, and are by and between George W. Nickel, Jr., Adele R. Nickel, La Hacienda, Inc., and Tulare Lake Representatives, a joint venture, and

(h) Kern River Water Right and Storage Allocation Agreement dated March 10, 1961, by and between Hacienda Water District, Kern River Delta Farms, as first parties, and Robert Burhans, Jr., Gertrude B. Burhans, his wife, and Burhans & Trew, Inc., as second parties. The interests of the second parties (Burhans) established by this agreement were subsequently assigned to Miller & Lux, Incorporated on March 10, 1961, thence to J. G. Boswell Company on January 11, 1974, and thence to George W. Nickel, Jr., on October 4, 1974.

It is the understanding and intent of the parties that the Hacienda Water Rights include 100% of the "Downstream Group's" rights as described in the 1962 agreement referred to in (a) above.

2. Olcese and the City of Bakersfield (hereinafter the "City") have entered into two agreements which are referred to

respectively as "Agreement No. 77-07 W.B.", dated November 9, 1977, and "Agreement No. 78-12 W.B.", dated June 27, 1978, which permit Olcese to use the City's 2800-acre spreading grounds west of the City for spreading and recovery of water under certain circumstances. These 2800 acres are hereinafter referred to as the "City's Kern River spreading area."

3. On August 1, 1979, and February 11, 1980, Olcese and La Hacienda entered into two Agreements for Sale and Purchase of Stored Water (Kern River Fan) providing for the sale and transfer of a portion of the Hacienda Water Rights to Olcese. Olcese and La Hacienda now desire to supplant those agreements with this contract providing for the purchase and sale of all of the Hacienda Water Rights upon the terms and conditions provided for herein.

4. Olcese is a California water district duly organized and existing under and by virtue of the laws of the State of California with full and lawful power and authority to enter into this agreement and to perform all covenants and obligations on its part to be performed hereunder.

5. La Hacienda, Inc., is a California corporation and George W. Nickel, Jr., and Adele R. Nickel, his wife, own a majority of the stock of La Hacienda, Inc. La Hacienda, Inc., is lawfully empowered and authorized to enter into this agreement and perform all covenants and obligations on its part to be performed hereunder.

NOW, THEREFORE, IT IS AGREED between the parties as follows:

Section 1. Sale and Transfer of Hacienda Water Rights and Substitution of Olcese as Attorney-In-Fact.

La Hacienda hereby sells, transfers, assigns and sets over to Olcese all of its rights, title and interest in the Hacienda Water Rights. La Hacienda also hereby substitutes Olcese in place of La Hacienda, Inc., as Hacienda Water District's Attorney-In-Fact under that special power of attorney granted to La Hacienda, Inc., by Hacienda Water District on September 2, 1980, which is recorded in Book 1184, at Page 120, Official Records of Kings County and in Book 5315, at Page 1253, Official Records of Kern County.

Section 2. Further Assurances.

The parties agree to make, execute and deliver such documents and undertake such other and further acts as may be reasonably necessary or convenient to carry out the intent of the parties to this contract. In this regard, La Hacienda shall use its best efforts to obtain from the Hacienda Water District, Tulare Lake Basin Water Storage District and Tulare Lake Representatives any documents or actions that may be reasonably necessary or convenient to evidence the transfer of the Hacienda Water Rights to Olcese.

Section 3. Place and Manner of Use.

(a) Except for water made available to La Hacienda under the provisions of Sections 6, 7 and 8 below or as provided for in Paragraph (b) of this section, no Hacienda Water Rights water sold to Olcese under this contract shall be sold or otherwise made available for use outside the boundaries of Olcese as they now exist without the prior written consent of La Hacienda; provided, however, the written consent of La Hacienda shall not be required for the service of Hacienda Water Rights water to all or any portion of the City's Rio Bravo Annexation which, as of the date of this contract, is being considered by LAFCO for annexation to Olcese, if it is annexed to Olcese.

(b) The parties recognize that the Hacienda Water Rights are rights to high flows in the Kern River which need regulation in order to be put to maximum beneficial use. For this reason, Olcese has entered into the two agreements with the City referred to in Recital No. 2 above, and 76,932 acre feet of Hacienda Water Rights water were spread, prior to January 1, 1981, all of which is now in storage in the City's Kern River spreading area for the benefit of Olcese pursuant to those agreements. In order to continue to conserve and maximize the use of Hacienda Water Rights water, Olcese shall spread water on the City's Kern River spreading area pursuant to said agreements when it is available for such purpose, so that this water will be available for recovery at later times for use either by Olcese directly or through exchanges or by La Hacienda pursuant to the provisions of Sections 7 and 8 below. In addition to using this water through such spreading and recovery operations, Olcese may use such water by direct diversion from the Kern River within Olcese boundaries when such water is available; provided, however, that, except as provided in Section 6 hereof, Olcese shall not use water stored in Isabella Reservoir for either direct diversion or spreading.

Section 4. Price.

(a) Throughout the term of this contract, Olcese shall pay La Hacienda for each acre foot of Hacienda Water Rights water put to use by Olcese an amount equal to the price per acre foot then being paid to the State of California by the Kern County Water Agency for California Water Project entitlement water made available for use in the Agency's Improvement District No. 4 at the Tupman Turnout (Reach 12E) of the California Water Project Aqueduct; provided, that if and when the price per acre foot of such water exceeds $55.00 the price thereafter shall be $55.00 an acre foot.

(b) Although title to Hacienda Water Rights water is by this contract conveyed to Olcese, Olcese will have no requirement to pay La Hacienda for any such water until it is used by Olcese by exchange or otherwise. For payment purposes Hacienda Water Rights water shall not be deemed to have been used by Olcese until either water theretofore spread in City's Kern River spreading area is extracted for Olcese's use or Hacienda Water Rights water has been directly diverted from the Kern River for use within Olcese.

Section 5. Time and Manner of Payment.

Olcese shall meter the amount of Hacienda Water Rights water it uses each year in a manner acceptable to La Hacienda.

The quantities used each month shall be reported to La Hacienda no later than the 15th day of the subsequent month. The payments for each month's use required by Section 4 above shall be made on or before 90 days following the end of the month in which the water is used.

Section 6. Use of Isabella Reservoir Storage and River Flows and Payment of Obligations and Charges Associated with Hacienda Water Rights.

(a) Any Hacienda Water Rights water stored in Isabella Reservoir not needed by Olcese for spreading to meet Olcese's thirteen year requirement referred to in Section 8 below, all Hacienda Water Rights water not needed by Olcese for direct diversion from the Kern River, and any such water not usable by Olcese for spreading may be used and disposed of by La Hacienda at any time, in any manner, at any place outside the boundaries of Olcese, and for any purpose La Hacienda thinks proper without any payments to Olcese for such water except as provided in (b) below. Any such water which becomes available for La Hacienda's use pursuant to the preceding sentence may be kept in storage in Isabella Reservoir for use in subsequent years by La Hacienda and shall not be available for use by Olcese.

(b) A portion of La Hacienda's Hacienda Water Rights were obtained subject to the following obligations: (1) obligations owed to Tulare Lake Basin Water Storage District (Tulare Lake BWSD), (2) Isabella Reservoir storage charges, and (3) charges for Kern River Watermaster costs. These obligations are set forth in the agreements referred to in Recital No. 1 above. La Hacienda shall meet these obligations, subject to being reimbursed by Olcese for that portion of the Isabella Reservoir storage charges attributable to water stored therein for use by Olcese pursuant to (a) above, to and including the year in which Olcese's annual use of Hacienda Water Rights water for consumption within Olcese Water District first reaches 5,000 acre feet. Thereafter, Olcese shall be responsible for paying these obligations, subject to being reimbursed by La Hacienda for that portion of these obligations attributable to water stored in Isabella Reservoir for La Hacienda's use pursuant to (a) above. The reimbursement payments to be made by one party to the other for Isabella Reservoir storage shall be made 90 days following notice.

Section 7. Option to Purchase Excess Water.

The parties realize that for many years the quantity of water available to Olcese from the City's Kern River spreading area should be substantially in excess of Olcese's needs for water within its boundaries. As part of the consideration for the sale of the Hacienda Water Rights to Olcese, La Hacienda shall have each year during the term of this contract a right to purchase all of Olcese's water in the City's Kern River spreading area that is excess to Olcese's needs, determined as hereinafter provided in Section 8 (a), which water is referred to herein as "option water." As between Olcese and La Hacienda, but subject to the limitations in Agreement 78-12 W.B., or any amendment or extension thereof, any such option water extracted and delivered by Olcese to La Hacienda may be used and disposed of by La Hacienda in any manner, at any place outside the boundaries of Olcese, and for any purpose La Haciendda thinks proper, either during the year the option is exercised or, subject to the provisions of Section 10, any time thereafter, at La Hacienda's discretion.

Section 8. Procedure for Determining Availability and Purchase of Option Water.

(a) The following procedure shall be used to determine how much water in the City's Kern River spreading area Olcese has each year in excess of its needs available for purchase by La Hacienda pursuant to Section 7 above. A consulting engineering firm designated and paid by Olcese, in conjunction with the City as provided in Agreement No. 78-12 W.B., and after consultation with La Hacienda shall annually on or before August 1st of each year determine what Olcese's requirements for Hacienda Water Rights water will be for the following thirteen years. This water requirement shall be compared to the amount of water that Olcese then has in storage in the City's Kern River spreading area, and the amount of water then in storage that is over 5,000 acre feet greater than the thirteen year requirement shall be deemed to be excess water available for option by La Hacienda pursuant to Section 7 above and Olcese shall give La Hacienda written notice of this amount by August 1 of each year.

(b) At the request of La Hacienda, option water may either be delivered immediately or kept in storage in the underground for La Hacienda's later use. Any option water left in storage for later use by La Hacienda shall not be considered as water that Olcese has in storage in determining the availability of option water in subsequent years.

Section 9. Amount of Option Water Available for Purchase by La Hacienda.

It has been determined that for the thirteen year period commencing January 1, 1981, Olcese's requirements are 68,150 acre feet and all water Olcese had in storage in the City's Kern River spreading area on January 1, 1981, in excess of 73,150 acre feet is hereby deemed option water under the provisions of this contract.

Section 10. Price for Option Water.

For each acre foot of option water purchased by La Hacienda pursuant to Section 7 above, La Hacienda shall pay Olcese $10.00 plus all costs of such water to Olcese, including but not limited to a proration of operation and maintenance and capital costs. The price should be escalated based on changes from the July 1, 1980, price under "all commodities" classification of the wholesale price indices for Major Commodity Group published by the U.S. Bureau of Labor Statistics. Adjustment shall be made in January of each year. If the reference index is discontinued, the parties shall agree upon an appropriate substitute basis to reflect the effects of inflation. Olcese shall meter the option water delivered by Olcese to La Hacienda as it is extracted and report the quantities to La Hacienda no later than the 15th day of each month. La Hacienda shall pay for each month's water no later than 90 days following the end of the month in which the water is delivered; provided that any option water not delivered within three years shall be paid for by the end of such three years or shall revert back to Olcese as water available to it.

Section 11. Use of Proceeds From Sale of Option Water.

The net receipts of Olcese resulting from La Hacienda's purchase of the water provided for in Section 7 above, over and above all costs to Olcese for water so purchased by La Hacienda, shall, to the extent necessary, be used by Olcese in the performance of its obligations under Article I of its Agreement No. 77-07 W.B. with the City, as amended. If these net receipts are not sufficient to enable Olcese to meet its obligations under Agreement No. 77-07 W. B., La Hacienda shall advance to Olcese sufficient funds for this purpose, and Olcese shall repay such advances, with interest at the maximum interest rate permitted by law at the time of the advance, as Olcese is able to do so from future net revenues from the sale of water extracted from the City's Kern River spreading area.

Section 12. Use of Hacienda Water Rights.

All rights to store, sell, transfer or substitute Hacienda Water Rights water which are transferred to Olcese hereunder and which are not needed by Olcese to make Hacienda Water Rights water available for use within Olcese, shall be made available to La Hacienda for its use and Olcese shall cooperate with La Hacienda to enable La Hacienda to make use of such rights.

Section 13. Term of Contract.

This contract shall be in perpetuity.

Section 14. Termination of August 1, 1979, and February 11, 1980, Agreements.

This contract shall supersede the Agreements for Sale and Purchase of Stored Water (Kern River Fan) dated August 1, 1979, and February 11, 1980, between Olcese and La Hacienda, Inc., and upon execution of this contract those agreements shall have no further force or effect.

Section 15. La Hacienda's Separate Water.

Heretofore, La Hacienda has delivered to the Kern County Water Agency 32,163 acre feet of Kern River water for use in the Agency's Improvement District No. 4 treatment plant. This water was delivered pursuant to an exchange agreement with the Agency wherein the Agency agreed to deliver to La Hacienda at some future date an equal amount of Improvement District No. 4's allocation of State Project Water. This right to receive such water from the Agency belongs to La Hacienda and is not in any way being transferred, assigned or conveyed to Olcese by this contract.

Section 16. Representations.

La Hacienda hereby agrees to hold Olcese harmless from and against any and all loss, liability and expense which Olcese may sustain by reason of the breach of any of the representations set forth in Recitals Nos. 1, 3 and 5 of this contract.

Section 17. Notices.

Any notices required or convenient to be given under this contract shall be in writing, and unless in fact otherwise timely received, shall be considered effectively given only upon personal delivery or upon mailing by registered mail, return receipt requested, postage prepaid. Notices shall be addressed to the parties at the following indicated addresses, or at such other addresses as may be later indicated to the other party:

Olcese Water District
1415-18th Street, Room 302
Bakersfield, CA 93301

La Hacienda, Inc.
c/o Nickel Enterprises
Star Route 4, Box 801
Bakersfield, CA 93306

Section 18. Successors, Heirs and Assigns.

The provisions of this contract shall inure to the benefit of and shall be binding upon the heirs, successors and assigns of the parties hereto, and each party may assign its interests in this contract without the written consent of the other party.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first written above.

OLCESE WATER DISTRICT

By Melvin L. McColloch
Melvin L. McColloch, President

ATTEST:

By
Owen F. Goodman, Secretary

GEORGE W. NICKEL, JR.

Adele R. Nickel
ADELE R. NICKEL

LA HACIENDA, INC.

By
George W. Nickel, Jr., President

By Frank K. Stamboolian Jr.
Frank K. Stamboolian, Jr., Secretary

STATE OF CALIFORNIA)
)ss.
County of Kern)

On March 18, 1981, before me, the undersigned, a Notary Public in and for said State, personally appeared Melvin L. McColloch, known to me to be the President, and Owen F. Goodman, known to me to be the Secretary of the district that executed the within instrument, known to me to be the persons who executed the within instrument on behalf of the district therein named, and acknowledged to me that such district executed the within instrument pursuant to an order of its Board of Directors.

WITNESS my hand and official seal.

RITA JANE PETER
NOTARY PUBLIC - CALIFORNIA
BOND FILED IN
KERN COUNTY
MY COMMISSION EXPIRES APRIL 1, 1983

Rita Jane Peter
Notary Public

STATE OF CALIFORNIA)
)ss.
County of Kern)

On March 18, 1981, before me, the undersigned, a Notary Public in and for said State, personally appeared GEORGE W NICKEL, JR., known to me to be the __________ President, and FRANK K. STAMBOOLIAN, JR., known to me to be __________ Secretary of the corporation that executed the within instrument, known to me to be the persons who executed the within instrument on behalf of the corporation therein named, and acknowledged to me that such corporation executed the within instrument pursuant to its by-laws or a resolution of its board of directors.

WITNESS my hand and official seal.

RITA JANE PETER
NOTARY PUBLIC - CALIFORNIA
BOND FILED IN
KERN COUNTY
MY COMMISSION EXPIRES APRIL 1, 1983

Rita Jane Peter
Notary Public

STATE OF CALIFORNIA)
)ss.
County of Kern)

On March 18, 1981, before me, the undersigned, a Notary Public in and for said State, personally appeared George W. Nickel, Jr., and Adele R. Nickel, known to me to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same.

WITNESS my hand and official seal.

Rita Jane Peter
Notary Public

RITA JANE PETER
NOTARY PUBLIC - CALIFORNIA
BOND FILED IN
KERN COUNTY
MY COMMISSION EXPIRES APRIL 1, 1983

CERTIFICATE OF ACCEPTANCE
(27281)

This is to certify that the interest in real property conveyed by the foregoing Contract for Purchase and Sale of Kern River Water and Storage Rights dated ________________, 1981, from La Hacienda, Inc., a California corporation, George W. Nickel, Jr., and Adele R. Nickel, husband and wife, hereinafter collectively referred to as "La Hacienda," to Olcese Water District was accepted by order of the Board of Directors of Olcese Water District made January 9, 1981, and Olcese Water District consents to the recording thereof.

____
Owen F. Goodman, Secretary
Olcese Water District

RESOLUTION

WHEREAS, Nickel Family LLC has negotiated a "Contract to Transfer Lower River Water Rights on the Kern River" by and between Nickel, Olcese Water District, and Kern County Water Agency; and,

WHEREAS, the Contract provides substantial benefits to Nickel and, therefore, its execution is in the best interests of Nickel.

Now and therefore, the Class A and Class B Members of Nickel Family LLC do hereby approve the "Contract to Transfer Lower River Water Rights on the Kern River" and hereby authorizes and directs its President to enter into said contract.

Executed as of the 2nd day of December, 2000.

Nickel Family LLC

Class A Members

George W. Nickel, Jr.

Adele R Nickel

Adele R. Nickel

James L. Nickel

Class B Members

Sally N. Zanze

Sally N. Zanze

KSMurphy

Kinzie S. Murphy

Susan N. DuVall

Susan N. DuVall

James L. Nickel

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

Geo W. Nickel

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Trustee

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge
Cynthia B. Selfridge

John S Selfridge
John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel
Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

John S Selfridge for Sam Selfridge

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

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John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

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Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Trustee

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

D. Marskey

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge
Cynthia B. Selfridge

John S Selfridge
John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi Michael
Heidi N. Michael

Kara N. Lucas

Cynthia B. Selfridge

Cynthia B. Selfridge

John S Selfridge

John S. Selfridge

Nancy N. Resor

George Wilmarth Nickel, III

Kathleen D. Nickel, General Partner of
the Miller Nickel Family Partnership

Sam Selfridge

Christine M. Warburton

Deborah Marskey

Eric DuVall

Miller DuVall

Erin D. Nickel, Special Needs Trust

Heidi Michael

Heidi N. Michael

Kara N. Lucas

Kara N. Lucas

James C. Nickel

Brian Murphy

Sarah Murphy

Turner Resor

Miller Resor

LOST HILLS FARMING COMPANY

By:

James L. Nickel, General Manager

James C. Nickel

Brian Murphy

Sarah Murphy

Turner Resor

Miller Resor

LOST HILLS FARMING COMPANY

By:

James L. Nickel, General Manager

James C. Nickel

Brian Murphy

Sarah Murphy

Turner Resor

Miller Resor

LOST HILLS FARMING COMPANY

By:
James L. Nickel, General Manager

James C. Nickel

Brian Murphy

Sarah R. Murphy

Sarah Murphy

Turner Resor

Miller Resor

LOST HILLS FARMING COMPANY

By:

James L. Nickel, General Manager

James C. Nickel

Brian Murphy

Sarah Murphy

TURNER RESOR BY Nancy N. Resor
(Mother)
Turner Resor

Miller RESOR BY Nancy N. Resor
(Mother)
Miller Resor

LOST HILLS FARMING COMPANY

By:
James L. Nickel, General Manager

RESOLUTION

WHEREAS, Nickel Family LLC has negotiated a "Contract to Transfer Lower River Water Rights on the Kern River" by and between Nickel, Olcese Water District, and Kern County Water Agency; and,

WHEREAS, the Contract provides substantial benefits to Nickel and, therefore, its execution is in the best interests of Nickel.

Now and therefore, the Management Committee of Nickel Family LLC does hereby approve the "Contract to Transfer Lower River Water Rights on the Kern River" and hereby authorizes and directs its President to enter into said contact.

Executed as of the 2nd day of December, 2000.

Management Committee
Nickel Family LLC

By:____________________
George W. Nickel, Jr.

By: Adele R Nickel
Adele R Nickel

By:____________________
James L. Nickel

RESOLUTION

WHEREAS, Bravo Management Company entered into a Management Agreement by and between Bravo Management Company (Bravo) and Nickel Family LLC (Nickel) dated December 14, 1996 in which Bravo was hired to manage the assets of Nickel; and,

WHEREAS, Nickel proposes to enter into a "Contract to Transfer Lower River Water Rights on the Kern River" with Kern County Water Agency and Olcese Water District; and,

WHEREAS, the Bravo Board of Directors has determined that entering into the proposed Contract is in the best interest of Nickel;

Now and therefore, the Board of Directors of Bravo Management Company hereby authorizes James L. Nickel, President of both Nickel Family LLC and Bravo Management Company, to enter into the proposed contract.

Executed this 2nd day of December, 2000.

BRAVO MANAGEMENT COMPANY

By:
George W. Nickel, Jr.

By: Sally N. Zanze
Sally N. Zanze

By: Susan N. DuVall
Susan N. DuVall

By: Jock Selfridge
Jock S. Selfridge

By: Adele R Nickel
Adele R. Nickel

By: Kinzie S Murphy
Kinzie S. Murphy

By: Cynthia B. Selfridge
Cynthia B. Selfridge

BEFORE THE BOARD OF DIRECTORS OF THE OLCESE WATER DISTRICT

RESOLUTION NO. 395

IN THE MATTER OF:)
)
LOWER RIVER RIGHT SALE)
)
)

WHEREAS, a contract has been negotiated between Nickel Family LLC, a California limited liability company, the Olcese Water District, and the Kern County Water Agency regarding transfer of the Lower River water rights on the Kern River from the Nickel Family LLC and Olcese Water District to the Kern County Water Agency; and

WHEREAS, this District will receive valuable consideration for the transfer of its interest in the Lower River water right to the Kern County Water Agency; and

WHEREAS, the Board of Directors of this District has reviewed the Agreement and has determined that said Agreement, and the transfer contemplated therein, is in the best interests of the District and its landowners;

NOW, THEREFORE, BE IT RESOLVED AND ORDERED:

1. All the foregoing is true and correct.
2. The transfer of the Lower River water rights to the Kern County Water Agency as provided in the Agreement previously presented to this Board of Directors be, and it hereby is, approved.
3. The President and Secretary of the District be, and they hereby are, authorized and directed to execute, on behalf of the District, the final form of said Agreement when it is available for signature in substantially the form heretofore presented to the Board of Directors.
4. The Secretary of the District be, and hereby is, authorized and directed to distribute this Resolution as necessary or proper to confirm the action taken this date.

All the foregoing being on the motion of Director McNeill, seconded by Director Gregory, and authorized by the following vote, namely:

AYES:	McNeill, Gregory, Davis.
NOES:	None.
ABSENT:	None.
ABSTAIN:	Teagarden, Nickel.

I HEREBY CERTIFY that the foregoing Resolution is the Resolution of the Olcese Water District as duly passed and adopted by said Board of Directors at a legally convened meeting held on the 27th day of November, 2000.

WITNESS my hand this 23 day of January, 2001.

President of the Board of Directors
OLCESE WATER DISTRICT

ATTESTED TO:

Secretary of the Board of Directors
OLCESE WATER DIST.

BEFORE THE BOARD OF DIRECTORS

OF THE

KERN COUNTY WATER AGENCY

In the matter of:

APPROVAL OF PROPOSED AGREEMENT
FOR AGENCY ACQUISITION OF LOWER
KERN RIVER WATER RIGHTS AND OTHER
ASSOCIATED RIGHTS FROM THE NICKEL
FAMILY LLP AND OLCESE WATER DISTRICT
AND AUTHORIZATION OF THE EXECUTION
OF SAME BY THE GENERAL MANAGER

I, **PAM BOSWORTH**, Secretary of the Board of Directors of the Kern County Water Agency, of the County of Kern, State of California, do hereby certify that the following resolution proposed by Director Radon and seconded by Director Garnett, was duly passed and adopted by said Board of Directors at an official meeting hereof this 15th day of December, 2000 by the following vote to-wit:

Ayes: Garnett, Frick, Radon, Lundquist, Rogers, Mathews & Starrh

Noes: None

Absent: None

Pam Bosworth
Secretary of the Board of Directors
of the Kern County Water Agency

Resolution No. 88-00

WHEREAS, the Kern County Water Agency ("Agency") has previously entered into a long term water supply contract with the State of California for more than 1,000,000 AF of water per year on a firm annual basis, but due to regulatory restrictions the State of California is currently unable, and for the mid-term future will apparently be unable, to meet the obligations of that contract;

WHEREAS, the Agency currently has an opportunity to acquire and manage certain water rights and associated rights on the Lower Kern River currently held by the Nickel Family LLP and Olcese Water District due to funding provided by the State of California as directed by Governor Davis to help alleviate the shortages to the Agency which are anticipated;

WHEREAS, the General Manager has entered into negotiations with the Nickel Family LLP and Olcese Water District to reach agreement on a transaction which would provide for voluntary acquisition of such rights by the Agency;

WHEREAS, the General Manager has reached tentative agreement with the Nickel Family LLP and Olcese Water District on an agreement for such transaction which is attached hereto as Exhibit A and incorporated herein by reference;

WHEREAS, the Agency by virtue of its powers granted by the legislature in the Kern County Water Agency Act is empowered to acquire such rights by agreement; and

WHEREAS, the transaction is part of the Kern River Program previously approved by the Agency Board of Directors, including the analysis of environmental impacts associated therewith and the documentation of the Agency's review and decision regarding the analysis of environmental impacts.

NOW THEREFORE BE IT RESOLVED by the Board of Directors of the Kern County Water Agency that:

1. The foregoing recitals are found to be true and correct, and incorporated herein.
2. The agreement attached hereto as Exhibit A for transfer of the lower river rights of the Kern River, as defined therein is approved.
3. The General Manager is authorized to execute the agreement with the substantive provisions contained therein, subject to approval of the General Manager and General Counsel as to form.

Draft Redline Version dated
12/13/00

CONTRACT TO TRANSFER

LOWER RIVER WATER RIGHTS ON THE KERN RIVER

This Contract is made as of the 21st day of December 2000, by and between Nickel Family, LLC ("Nickel"), a California limited liability company; the Olcese Water District ("Olcese") and the Kern County Water Agency ("Agency"), both of which are public agencies in the State of California, duly organized, existing and acting pursuant to the laws thereof.

RECITALS

WHEREAS, the Governor's Budget Act for 2000, Chapter 52, Statutes of 2000, appropriated to the Department of Water Resources local assistance grant funds in the amount of $161,544,000 by budget item 3860-01-6027, payable from the interim Reliable Water Supply and Water Quality Infrastructure and Management Subaccount, and the Kern County Water Agency's Kern River Restoration Project has been selected for funding in the amount of $23,000,000 from that subaccount; and

WHEREAS, the Agency intends to use money from that appropriation for development of local water supplies and banking programs within Kern County; and

BEFORE THE BOARD OF DIRECTORS

OF THE

KERN COUNTY WATER AGENCY

Post-it® Fax Note 7671	Date 8-16-02 # of pages ▸ 3
To Rita	From Holly Melton
Co./Dept.	Co. KCWA
Phone #	Phone # 634-1467
Fax #	Fax # 634-1428

In the matter of:

CONSIDERATION OF PROPOSED AGREEMENT FOR AGENCY ACQUISITION OF LOWER KERN RIVER WATER RIGHTS AND OTHER ASSOCIATED RIGHTS FROM THE NICKEL FAMILY LLP AND OLCESE WATER DISTRICT AND FINDING THAT THE WATER PROPOSED FOR UTILIZATION THEREIN IS SURPLUS TO AGENCY NEEDS PURSUANT TO AGENCY ACT SECTIONS 5 AND WATER CODE SECTION 382

I, PAM BOSWORTH, Secretary of the Board of Directors of the Kern County Water Agency, of the County of Kern, State of California, do hereby certify that the following resolution proposed by Director Radon and seconded by Director Garnett, was duly passed and adopted by said Board of Directors at an official meeting hereof this 15th day of December, 2000 by the following vote to-wit:

Ayes: Garnett, Frick, Radon, Lundquist, Rogers, Mathews & Starrh

Noes: None

Absent: None

Secretary of the Board of Directors
of the Kern County Water Agency

Resolution No. 90-00

WHEREAS, the Kern County Water Agency ("Agency") has previously entered into a long term water supply contract with the State of California for more than 1,000,000 AF of water per year on a firm annual basis, but due to regulatory restrictions the State of California is currently unable, and for the mid-term future will apparently be unable, to meet the obligations of that contract;

WHEREAS, the Agency currently has an opportunity to acquire and manage certain water rights and associated rights on the Lower Kern River currently held by the Nickel Family LLP and Olcese Water District with an average historical yield of 50,000 AF/year of which approximately 40,000 AF/year is subject to capture in the opinion of the Agency General Manager and engineering staff;

WHEREAS, the General Manager has developed a proposed agreement which would provide for voluntary acquisition of such rights by the Agency to be approved by other resolution;

WHEREAS, the Agency by virtue of its powers granted by the legislature in the Kern County Water Agency Act is empowered to acquire such rights by agreement;

WHEREAS, the transaction is part of the Kern River Program previously approved by the Agency Board of Directors, including the analysis of environmental impacts associated therewith and the documentation of the Agency's review and decision regarding the analysis of environmental impacts; and

WHEREAS, this Board has considered the acquisition of such rights which contemplates the utilization of 10,000 AF/year of existing Agency supplies to exchange as part consideration for the transaction which will acquire 50,000 AF/year of water on average of which 40,000 AF/year average is capturable in the expert opinion of the Agency General Manager, who is thoroughly familiar with the rights, and the Agency engineering staff, who are experts in utilization of groundwater recharge and are thoroughly familiar with Agency existing facilities and planning for additional facilities; and

WHEREAS, no opponents to the plan have offered equivalent consideration for the exchange of such water, and there is no substantial evidence to show that the net effect of the transaction will be to enhance Agency supplies by an average of 30,000 AF/year to 40,000 AF/year over the long term.

NOW THEREFORE BE IT RESOLVED by the Board of Directors of the Kern County Water Agency that:

1. The foregoing recitals are found to be true and correct, are incorporated herein, are supported by substantial evidence, and are sufficient basis for the additional findings herein.
2. The agreement approved by Resolution No.88-00 provides for the transfer by the Agency to Nickel Family LLP of 10,000 AF/year of Agency water to obtain water rights which historically have yielded far in excess of that amount.
3. The Agency is capable and will be capable of capturing sufficient amount of such water to provide a substantial net benefit to the Agency in terms of water supply, both quality and quantity.
4. No other entities have offered equivalent consideration for such water.
5. Under the terms of the proposed agreement which provide a significant net benefit to the water supply of the Agency, the water to be offered in exchange is surplus to Agency needs, and to be provided by voluntary conservation efforts, pursuant to the meaning of Agency Act Section 5 and Water Code Section 382.

KRONICK
MOSKOVITZ
TIEDEMANN
& GIRARD
A PROFESSIONAL CORPORATION

STANLEY W. KRONICK
EDWARD J. TIEDEMANN
FREDERICK G. GIRARD
LLOYD HINKELMAN
CLIFFORD W. SCHULZ
BERT E. MURPHY
BERT S. SHELBURNE
ES M. BOYD, JR.
ANET K. GOLDSMITH
ROBIN LESLIE STEWART
WILLIAM A. KERSHAW
ROBERT A. RUNDSTROM
RUTHANN G. ZIEGLER
PAUL W. TOZER
DONALD W. FITZGERALD
THOMAS C. HUGHES, III
MICHAEL A. GROB
P. ADDISON COVERT

JAN K. DAMESYN
ANN M. MURRAY
PHILIP A. WRIGHT
DOROTHY S. LANDSBERG
ANN M. SIPRELLE
JAMES P. WIEZEL
JONATHAN P. CRISTY
MICHAEL F. DEAN
EMILY E. VASQUEZ
LYLE W. COOK
BRUCE A. SCHEIDT

ANTHONY B. MANZANETTI
WILLIAM T. CHISUM
JEFFREY A. MITCHELL

DONNA M. MATTIES
SUSAN R. DENIOUS
THOMAS W. BARTH
JAMES J. BANKS

STACY L. SAETTA
MARILYN L. JACOBS
CYNTHIA L. KNIGHTON
GREGORY T. LYALL
SCOTT A. MORRIS
STEPHEN J. GREENE, JR.
SHELLY L. RENNER
CATHY S. HOLMES
JONATHAN P. HOBBS
AMELIA T. MINABERRIGARAI
JESS PORT TELLES, IV

STEPHEN CHILCOTT
KAREN NATAL
HOWARD F. WILKINS, III
LOUIS E. GREENWALD
ANDREW P. PUGNO

OF COUNSEL
DANIEL J. O'HANLON
MARK A. WASSER
CHARLES A. BARRETT
LEONARD M. FRIEDMAN (RETIRED)

ADOLPH MOSKOVITZ (1923-1996)
E. KENDELL DAVIS (1908-1967)
DEBORAH J. FRICK (1955-1995)

February 22, 2001

Mr. Thomas N. Clark
General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, California 93302

Re: Purchase of the Kern River Lower River Water Rights

Dear Mr. Clark:

We serve as attorneys to Nickel Family, LLC ("Nickel"). On January 23, 2001, Nickel, the Kern County Water Agency ("Agency") and Olcese Water District ("Olcese") entered into a contract entitled "Contract to Transfer the Kern River Lower River Water Rights", hereinafter referred to as "the Contract". Article 8.1(d) of the Contract, which is one of the conditions precedent to the close of the escrow provided for in the Contract states:

> (d) Opinion Letter of Counsel: Nickel shall deposit into escrow an opinion letter of counsel, satisfactory to the Agency, providing that the conveyances, transfers and assignments provided in this Contract are sufficient to transfer all right, title and interest of Nickel and Olcese to the rights described herein, except those specifically retained by or quitclaimed to Nickel and/or Olcese.

This letter, which is that opinion, traces the ownership of the rights transferred to the Agency by Nickel and Olcese from the Miller-Haggin Agreement of July 28, 1888 to Nickel and Olcese.

The Miller-Haggin Agreement

The Miller-Haggin Agreement of July 28, 1888, was executed by numerous parties, but the principal party representing the Kern River downstream interests was Henry

ATTORNEYS AT LAW
400 CAPITOL MALL, 27TH FLOOR SACRAMENTO, CALIFORNIA 95814-4416 TELEPHONE (916) 321-4500 FAX (916) 321-4555

Miller and the principal party representing the Kern River upstream interests was James B. Haggin. The agreement was entered into after the California Supreme Court issued its decision in *Lux v. Haggin* (1886) 69 Cal.255, holding, among other things, that the riparian rights of downstream owners on the Kern River were not extinguished by the use of upstream appropriators. The parties to the agreement claimed riparian, appropriative and other rights to the waters of the Kern River, Buena Vista Slough, Kern Lake, Buena Vista Lake, and the slough connecting those lakes, and the purpose of the agreement was to compromise and settle all claims among the parties. The Miller-Haggin Agreement, including the November 30, 1889 Supplemental Agreement, is item 1 in Exhibit A accompanying this letter. ("Exhibit A")

The Miller-Haggin Agreement established two points of measurement on the Kern River which were designated and have been known since then as "First Point of Measurement" and "Second Point of Measurement." The water was divided between the parties in two ways. During the months of March through August of each year, the first 300 cubic feet per second (cfs) of water flowing at First Point were given to the Kern Island Irrigating Canal Company and any flows over 300 cfs during that period were divided one-third to the so-called "first parties," which were Henry Miller and the other downstream owners, and the remaining two-thirds was given to the so-called "second parties," which were James B. Haggin and the other upstream users. The agreement further provided that the first parties were entitled to receive their one-third at the Second Point "without diminution by reason of percolation or seepage or any interference whatsoever of or by parties of the second part."

With regard to the flows during the months of September, October, November, December, January and February, the Miller-Haggin Agreement specified that all water flowing in the Kern River above the Second Point of measurement belonged to the second parties who could divert it and use it as they desire. Any water which the second parties did not divert before it reached the Second Point, became the property of the first parties, to be used when and where they desired.

The Miller-Haggin Agreement states that the water given to the various parties may be used and disposed of by them in any manner, at any place, and for any purpose they may think proper, or that they may arrange or agree upon among themselves. The agreement also specifies that if anyone not a party to the contract shall at any time divert water from the Kern River between the first and second points, the loss occasioned to the parties to the contract will be borne one-third by the parties of the first part (Miller, et al.) and two-thirds by the parties of the second part (Haggin, et al.). It also states that if anyone not a party diverts water between those two points, the parties will unite in such suits or proceedings as may be necessary to prevent such diversions and that the costs of such litigation will be borne one-half to the parties of the first part and one-half to the parties of the second part.

The Miller-Haggin Agreement states it is perpetual and is to be construed as a covenant running with all of the land owned and claimed by all of the parties situated in the various townships described in the agreement. The townships described in the agreement include virtually all of those in the San Joaquin Valley portion of Kern County between the State Aqueduct on the west, the Southern Pacific Railroad on the east, and the north boundary of the Wheeler Ridge-Maricopa Water Storage District on the south. The Miller-Haggin Agreement was recorded in Volume 2 of Contracts and Agreements at page 40 in the Kern County Recorder's Office.

The Miller-Haggin Agreement has been amended and supplemented from time to time, including the September 14, 1955, agreement between the North Kern Water Storage District ("North Kern WSD") and various canal companies, all of which are collectively referred to in that agreement as the "First Point Group," and Buena Vista Water Storage District ("Buena Vista WSD") and such other parties as wish to join in the agreement, which are collectively referred to as the "Second Point Group". In this agreement the First Point Group stated that it owns substantially all the waters apportioned to the second parties to the Miller-Haggin Agreement (Haggin, et al.) and Buena Vista WSD stated that it owned or controlled the major portion of the waters apportioned to the first parties in the Miller-Haggin Agreement (Miller, et al.). This 1955 agreement changed the allocations under the Miller-Haggin Agreement to provide the first parties (the Second Point Group) with a somewhat greater share of the water during the March through August period when the flows at First Point exceed 2,000 cfs, and to give the first parties one-third of the flows over 1,500 cfs during the months of September through February. The agreement states that waters apportioned to any party may be stored in Isabella Reservoir or elsewhere in any surface or underground reservoir and may be taken out, used and disposed of by such party in any manner, at any place and for any useful purpose as the parties may determine from time to time. The September 14, 1955 agreement is item 2 in Exhibit A.

The Miller-Haggin Agreement pertained to land only in Kern County and did not allocate water to the Hacienda Ranch, which is located in Kings County. It was, however, the forerunner of subsequent Kern River water agreements which do involve water rights which are the subject of the Contract.

Kern River Water Rights and Storage Agreement of December 31, 1962

On December 31, 1962, Buena Vista WSD, North Kern WSD, Tulare Lake Basin Water Storage District ("Tulare Lake BWSD"), and Hacienda Water District ("Hacienda WD") entered into a contract entitled "Kern River Water Rights and Storage Agreement" ("the 1962 Agreement"). Buena Vista WSD stated that it executed the 1962 Agreement for and on behalf of itself, Buena Vista Associates, Incorporated, and all the parties of the first part (Miller, et al.), or their successors in interest, to the Miller-Haggin Agreement, who may wish to share in the benefits and obligations of the 1962 Agreement. North Kern WSD stated that it executed the 1962 Agreement for and on behalf of all the parties of the second part (Haggin, et al.), or their successors in interest, to the Miller-Haggin Agreement whose rights on the Kern River were adjudicated among themselves in the so-called "Shaw Decree"[1] who wish to share in the benefits and obligations of the 1962 agreement. Tulare Lake BWSD and Hacienda WD executed the 1962 Agreement on behalf of themselves and all others who establish rights to the waters of the Kern River for use on lands north of Wasco Road who wish to share in the benefits and obligations of the 1962 Agreement. Throughout the 1962 Agreement, Tulare Lake BWSD and Hacienda WD are collectively referred to as the "Downstream Group" and Buena Vista WSD and North Kern WSD are collectively referred to as the "Upstream Group". The 1962 Agreement is item 3 in Exhibit A.

The 1962 Agreement apportions the waters of the Kern River between the Upstream and Downstream Groups. The division between the two groups is set forth in Paragraph 1 of the 1962 Agreement. The 1962 Agreement also apportions the conservation storage space in Isabella Reservoir, with 32% allocated to Buena Vista WSD and the other 68% to North Kern WSD. The Downstream Group was given an option to purchase 20/68th of North Kern's space, which was equal to 20% of the entire space. This is referred to as the "Downstream Space." In addition to this option, which was never exercised, the Downstream Group was given a "perpetual right to rent the Downstream Space in whole or in part from North Kern for the storage of Kern River water allocated to Downstream Group in this contract." This is the method employed by Nickel and Olcese and their predecessors to store Kern River Water in Isabella Reservoir.

Other provisions of the 1962 Agreement which relate to the Downstream Group Rights are contained in Paragraphs 4, 12, and 14. Paragraph 4 states:

> 4. <u>Covenant Against Claims.</u>
>
> Each party hereby accepts the water apportionment provisions hereof as a final and permanent settlement of all of its rights and claims in and to the waters of Kern River, and each party hereby covenants and agrees with the others that it will never make or assert against any other party or parties hereto any claim to any of

---

[1] This is a 1900 Kern County Superior Court decree in which the rights of the second parties (Haggin, et al.) to the Miller-Haggin Agreement were adjudicated among themselves by Judge Lucien Shaw in <u>Farmers Canal Company, et al. v. J.R. Simmons, et al.</u>, Action No. 1901.

> the waters of Kern River except the waters herein expressly apportioned to it. Each party agrees that all waters of the Kern River to which it may become entitled under any application now pending or hereafter filed before the State Water Rights Board, or under any permit or license issued pursuant to any such application, shall serve and be used only to feed and support the respective rights and allocations of the parties hereto in accordance with the provisions of this contract.

Paragraph 12 of the 1962 Agreement required the Kern River Delta Farms (predecessors to Nickel), the then owner of the Hacienda Ranch (which owned substantially all the land in Hacienda WD), to dismiss with prejudice two actions it had brought pertaining to Kern River water. The first was an action in the Kings County superior court and the other was in the United States Court of Claims.

Paragraph 14 provides that the Downstream Group shall have a priority position on any contracts to exchange Kern River water. It states that the Downstream Group may at any time sell Kern River water to which it is entitled under the 1962 Agreement or exchange it for water owned or obtained by other parties from other sources. It then states that North Kern WSD and Buena Vista WSD may independently or together exchange Kern River water to which they are entitled for waters owned or obtained by others from other sources, subject to the right of the Downstream Group to substitute, upon the same terms and conditions, up to the quantity of Kern River entitlement that the Downstream Group then has available, its Kern River water for all or a portion of the North Kern WSD or Buena Vista WSD water that other parties agree to accept. It also provides that the water to be returned by other parties for Kern River water shall first be offered to the Downstream Group to the extent that such group is willing to accept such water and to the extent that the Downstream Group has a credit balance of Kern River water. The Downstream Group is given the right to specify the points of delivery of such exchange water. North Kern WSD and Buena Vista WSD are also required, in any exchanges with third parties, to inform them of these provisions and require the third parties to agree to them.

Downstream Group Agreements

On January 1, 1963, one day after execution of the 1962 Agreement, the Downstream Group (consisting of Hacienda WD and Tulare Lake BWSD) entered into an agreement dividing among themselves their Downstream Group allocation (the "Downstream Group Agreement"). The two districts agreed to a 50/50 split of both the Kern River water and the Isabella Reservoir storage rights apportioned to the Downstream Group. The Downstream Group Agreement also provides that Hacienda WD shall have the right to use Tulare Lake BWSD's share of Kern River water and storage in Isabella Reservoir in return for Hacienda WD either paying Tulare Lake BWSD cash for such water or by making State Water Project water available to Tulare Lake BWSD in exchange for such Kern River water. The Downstream Group Agreement did not prohibit or restrict transfers of the right of use by Hacienda WD or require the consent of Tulare Lake BWSD to any such transfer.

This 1963 agreement between Hacienda WD and Tulare Lake BWSD was amended and supplemented on August 8, 1974 to revise the payment an exchange provisions. The agreement as it now stands provides for the establishment of an Exchange Water Account. With regard to Tulare's water in that account, it states:

> The amount of Tulare's water that shall be credited to Tulare in such Exchange Water Account in any one year shall be the amount of water which is divided and apportioned to Tulare under the following formula:
>
> | Aggregate Kern River Flow in Thousands of acre-feet | Credit to Tulare |
> |---|---|
> | January – March | |
> | First 250 | None |
> | All over 250 | 10% |
> | April – July | |
> | First 550 | None |
> | Next 50 (from 550 to 600) | 10%* |
> | Next 50 (from 600 to 650) | 10% |
> | Next 400 (from 650 to 1050) | 13-1/3% |
> | All over 1050 | 18-1/3% |
> | August – December | |
>
> * Only in certain years, namely, each year immediately following a year in which the April - July flow equals or exceeds 600,000 acre-feet.
>
> The maximum credit to the bank account of Tulare in any one calendar year will be 75,000 acre-feet. Any water that the foregoing formula yields to Tulare in any calendar [year] in excess

> of 75,000 acre-feet may be used by Hacienda free of any charge therefor by Tulare and without obligation to return to Tulare under the exchange formula

In return for this water, Hacienda WD can either deliver State Project Water or make dollar payments. The amount of water to be delivered to Tulare Lake BWSD in each year is either 10,000 acre feet or the quantity in Tulare's Exchange Water Account, whichever is less. if Hacienda WD elects to pay cash in lieu of water deliveries, the payments were set at $5.00 per acre foot, with the amount to be adjusted as necessary on January 1, 1980 and each 5 years thereafter based upon changes in the Consumer Price Index.

Thus, in any year when Tulare's Exchange Water Account has a balance of 10,000 acre feet or more, Hacienda WD must deliver 10,000 acre feet of State Project water or pay an amount in excess of $50,000 (10,000 AF times $5.00 times the change in the Consumer Price Index).

The Downstream Group Agreement and the 1974 amendment are items 4 and 5 in Exhibit A.

The Minimum Pool Agreement

On November 8, 1963, the four parties to the 1962 Agreement entered into an agreement with the County of Kern to provide for a minimum pool of 30,000 acre-feet in Isabella Reservoir for recreational purposes (the "Minimum Pool Agreement"). The Minimum Pool Agreement provides that when the volume in the reservoir is 30,000 acre-feet or less, the parties would not release or withdraw any of their water from Isabella Reservoir for irrigation purposes at any time. The parties also agreed to allocate all seepage and evaporation losses and flood control releases attributable to the 30,000 acre-foot recreational pool as follows: 25% to Buena Vista WSD and 75% to North Kern WSD. The Minimum Pool Agreement is item 6 in Exhibit A.

Federal Contract for Isabella Storage

On October 23, 1964, the four parties to the 1962 Agreement entered into a contract with the United States of America pertaining to storage of Kern River water at Isabella Dam and Reservoir. The four parties stated that they executed the contract for the same respective parties for whom they executed the 1962 Agreement and the 1962 Agreement is attached to and incorporated into this contract with the United States.

The U.S. contract apportions all of the irrigation storage capacity in Isabella Reservoir, which is set at 535,000 acre feet, in the same manner as the 1962 Agreement, -- *i.e.*, -- 32% to Buena Vista WSD and 68% to North Kern WSD. It also apportions the reimbursable costs and operation and maintenance charges for this storage capacity in the same manner.

In the contract, the United States expressly recognizes the Kern River water rights of the four districts under the Miller-Haggin Agreement, the Shaw Decree, the 1962 Agreement and the Minimum Pool Agreement, and the contract contemplates the use of 100% of the irrigation storage space of Isabella Reservoir by the four districts. However, if parties other than the four districts, and those on whose behalf they executed the contract, establish rights to Kern River water, such other parties will have the right to contract with the United States for the use of a proportionate part of such storage space under the same terms and conditions as the four districts. In such event, there would be a reapportionment of the costs to reflect these new storage rights. The federal contract for Isabella Storage is item 7 in Exhibit A.

Hacienda Ranch Sale Agreements

On October 6, 1978, George W. Nickel and Adele R. Nickel conveyed the Hacienda Ranch to La Hacienda, Inc., together with all water rights appurtenant to the property. This conveyance is item 8 in Exhibit A. On October 16, 1978, La Hacienda, Inc. and George and Adele Nickel sold the Hacienda Ranch to a joint venture group known as "Tulare Lake Representatives" ("TLR"). The sale was consummated by several agreements in which La Hacienda, Inc. and the Nickels are collectively referred to as "Nickel." One of the agreements was designated "Kern River Water and Storage Reservation Agreement." (the "Reservation Agreement.") The Reservation Agreement recited that the Hacienda WD owned and administered or represented certain Kern River water rights and Isabella Reservoir storage entitlements and stated that such water and storage rights were dealt with in various contracts, including some of those referred to in this letter. The agreements with TLR provide that all of the Kern River water rights and Isabella Reservoir storage entitlement owned, administered or represented by Hacienda WD, were reserved to, transferred, or conveyed to "Nickel", subject to the obligations owed to Tulare Lake BWSD or other Tulare Lake Basin interests. The rights reserved or transferred to "Nickel" were also limited to those attributable to the Hacienda Ranch property sold to TLR and such other Kern River water and storage rights then held by Hacienda WD. The Reservation Agreement is item 9 in Exhibit A.

The Reservation Agreement, in Recital 9, recognized that fulfillment of the parties' intentions was subject to various legal and practical contingencies. To better protect the Kern River water reserved to "Nickel" from third-party challenges, the Reservation Agreement further provided that TLR would appoint "Nickel" as its agent in fact for the limited purpose of contracting for, selling, exchanging, transferring, conveying, or otherwise dealing in those water rights and that TLR would also, subject to certain fiduciary obligations, cause the Hacienda WD to appoint "Nickel" as agent in fact for these same limited purposes.

Hacienda WD, on or about February 6, 1979, appointed La Hacienda, Inc., as its attorney-in-fact for the limited purpose of contracting for, selling, exchanging, transferring, conveying or otherwise dealing with the Kern River water and storage rights reserved to "Nickel" under the Reservation Agreement. On February 8, 1979, TLR appointed La Hacienda, Inc., as its attorney-in-fact for the limited purpose of contracting for, selling, exchanging, transferring, conveying or otherwise dealing with the Kern River rights reserved to "Nickel" under the Reservation Agreement. At that point in time, La Hacienda, Inc., held the right to contract to sell, exchange, transfer, or convey, or to otherwise deal with, the Downstream Group's water rights under the 1962 Agreement.

Transfers to Olcese

In 1980, Hacienda WD and Tulare Lake BWSD, by formal agreement, consented to La Hacienda, Inc., selling, transferring, assigning and setting over to Olcese all of La Hacienda, Inc.'s rights, title and interest in and to the Kern River water and storage rights allocated to the "Downstream Group" in the 1962 Agreement which were reserved, transferred, or to be transferred to "Nickel" pursuant to the Reservation Agreement. This agreement also provided that, to the extent Hacienda WD and Tulare Lake BWSD held or administered any right, title or interest in such rights, those districts transferred, assigned and set such rights over to Olcese. In addition, Hacienda WD and Tulare Lake BWSD consented to the substitution of Olcese in place of La Hacienda, Inc., as their attorney-in-fact under the special powers of attorney referenced above. Copies of these consents are item 10 in Exhibit A.

By agreement dated March 18, 1981, (the "1981 Agreement"), La Hacienda, Inc. and the Nickels, et al., sold, transferred, assigned and set over to Olcese all of their right, title and interest in all of the Kern River water rights and storage entitlement in Isabella Reservoir referred to in that agreement.. They also substituted Olcese in place of La Hacienda, Inc., as the attorney-in-fact under the special power of attorney granted to La Hacienda, Inc., by Hacienda WD regarding the subject Kern River water and storage rights. In this 1981 Agreement, La Hacienda, Inc. and the Nickels reserved to themselves in their own capacities, and not as agents, the use of all the Kern River water and storage rights transferred to Olcese that is in excess of the needs of Olcese. They retained the right both (a) to use any water that Olcese could not use or spread in any year and (b) to purchase all water that Olcese spread in the City of Bakersfield's Kern River spreading area which is in excess of Olcese's needs as determined by the 1981 Agreement. This excess spread water was referred to as "option water" and was defined as the amount of water in storage in the City of Bakersfield's spreading area in excess of the sum of 5,000 acre-feet and Olcese's requirements for such water for the next 13 years. The agreement also provided for payment provisions for the purchase of the "option water." Olcese is obligated, pursuant to this agreement, to cooperate with La Hacienda, Inc. and the Nickels, to enable them to make use of their retained water. The 1981 Agreement is item 11 in Exhibit A.

By agreement entered into on November 9, 1977, Olcese obtained from the City of Bakersfield the right to spread water on the City's 2800-acre spreading area, subject to the City's first priority right (the "City Agreement"). The City Agreement also provides for the sharing of costs between the City and Olcese associated with spreading water and the costs that Olcese must pay the City for water it pumps from the spreading area. On April 15, 1981, the City Agreement was amended to allow Olcese to sell water for non-irrigation use outside Olcese according to terms mutually agreeable to Olcese and the City. This amendment also modified the City's priority right for spreading and recovery of water in return for Olcese's commitment to construct some additional wells and water conveyance facilities. The April 15, 1981 amendment, however, did not modify the provisions of the March 18, 1981 Agreement pursuant to which Olcese is prohibited from selling or otherwise using Downstream Group water outside the boundaries of Olcese and certain property known as the "Rio Bravo Annexation" without the consent of the Hacienda Parties. The City Agreement and the 1981 amendment, along with Buena Vista WSD's April 15, 1981 letter attached, are items 12 and 13 of Exhibit A.

La Hacienda, Inc. – KCWA Agreement

On May 6, 1987, La Hacienda, Inc., entered into an agreement with the Agency entitled "Agreement on Use, Storage & Extraction of Hacienda Kern River Water" ("KCWA Agreement"). The KCWA Agreement provided that the parties would share on an equal basis all "Hacienda Water" diverted into a spreading area to be developed by the Agency for percolation and storage within the Kern River Basin. The KCWA Agreement was contingent upon the Agency acquiring and developing a spreading area consisting of 3,000 acres, or more, for such purpose. The Agency did not acquire and make available the spreading acreage required by the KCWA Agreement, and on September 13, 1994, La hacienda, Inc. sent a letter to the Agency terminating the KCWA Agreement.

Transfers to Garces and the Trust

In an agreement dated March 29, 1988 (the "Transfer Agreement"), George W. Nickel, Adele R. Nickel, Nickel Enterprises, Rio Bravo Resorts, Inc., La Hacienda, Inc., Kern River Development Company and Lekcin Management Company, Inc. collectively referred to as "Transferrors" transferred (a) to Garces Water Company, Inc. ("Garces") an undivided fifteen percent (15%) of the Transferrors' interest in certain Kern River water and storage rights referred to in that agreement as "Water Assets," which included the "Lower River Water Rights" described in the Contract, and (b) to the McNear-Driver Trust (the "Trust") the other undivided eighty-five percent (85%) in those assets. At the time of those transfers, Garces and the Trust appointed George W. Nickel and Adele Nickel and La Hacienda, Inc. as its attorney-in-fact to obtain, store, transfer, exchange, market, or sell various water and water rights, including the water which is the subject of the Transfer Agreement. The transfers to the Trust and Garces were subject to a security interest held by Wells Fargo Bank. Olcese concurred in these transfers to Garces and the Trust, including the right of Garces and the Trust to exercise the special powers of attorney granted to La Hacienda, Inc., and the Nickels. This power of attorney and the Wells Fargo security interests referred to in this paragraph were terminated in 1994. The Transfer Agreement is item 14 in Exhibit A.

Other Transfers

In 1990, La Hacienda, Inc., as the attorney-in-fact for Garces and the Trust, sold 98,005 acre-feet of Downstream Group water to the Agency for the benefit of the State of California. The Department of Water Resources (DWR) performed a detailed legal analysis of La Hacienda, Inc.'s rights and was apparently satisfied that La Hacienda, Inc., had legal ability to pass title to the water in issue. This sale and resulting transfer of the water to the DWR occurred without any legal challenge. Also, we have been informed that the DWR has pumped and used a portion of this water without challenge.

On or about November 30, 1992, Judgment was entered in Kern County Superior Court No. 181265 settling litigation commenced by Kern Property Corporation against La Hacienda, Inc., and others. As part of the settlement, La Hacienda, Inc., is contractually obligated to provide up to 3,300 acre-feet of banked groundwater per year to supplement a base supply of 3,300 acre-feet per year of drain water made available by Buena Vista WSD to Kern Property Corporation for use on its lands located north of Wasco Road.

Transfer from Trust to Nickel Family LLC

On April 4, 1997, the Trust transferred its undivided eighty-five percent interest in the "Water Assets" to the Nickel Family LLC. This 1997 transfer agreement without exhibits is item 15 in Exhibit A. Exhibit A to that agreement dealt with so-called "Hydro Assets", not a part of this Contract. Exhibit B was the "Water Assets" which are described in the March 29, 1988 "Transfer Agreement" referred to above (item 14).

On September 1, 2000, the Agency purchased Garces' fifteen percent interest in the "Water Assets". On the close of escrow provided for in the Contract, the Agency will own all of the Lower River Water Rights provided for in the Contract.

Warranties by Nickel and Olcese

In Article 7.1 of the Contract, Nickel and Olcese have given the Agency various warranties. Among those warranties they have warranted that they have the "full power, authority and legal right to execute, deliver and perform the Contract" and that they now possess "the unrestricted right and power to own, use and sell their respective interests in the Lower River Water Rights as set forth in Exhibit A" of the Contract.

Conclusions

Based on our review of the documents discussed in this letter and other information which has been provided to us:

1. It is our opinion that Nickel and Olcese hold such rights and have such obligations with respect to the Lower River Water Rights as are created by the reviewed documents and can transfer those portions of those rights to the Agency as provided for in the Contract. We are not aware of any other documents of any kind or nature or any other facts that would render the description of those rights and obligations set forth in this letter false or misleading, but do not, by this letter, offer an opinion with respect to the nature or extent of those rights and obligations.

These rights are subject to the following obligations, as well as the laws of California governing water rights and the laws of the United States governing the use of Federal facilities:

a. The California constitutional limitation that the water must be put to reasonable beneficial use.

b. The limitation imposed by the Minimum Pool Agreement that you not release or withdraw any of your stored water when the volume in the reservoir is 30,000 acre-feet or less.

c. The obligation to pay Tulare Lake BWSD for any credits it has in its Exchange Water Account, or deliver water to Tulare Lake BWSD pursuant to the Downstream agreement.

d. The obligation to provide water to the Kern Property Corporation pursuant to the November 30, 1992 judgment.

e. The obligation to pay fees for storage in Isabella Reservoir.

f. The possible obligation to share storage capacity in Isabella Reservoir pursuant to the 1964 federal contract.

g. Any obligations that may be owing to the City of Bakersfield as a result of the City Agreement and amendments thereto referred to above and in items 12 and 13 of Exhibit A.

h. Any other obligations that Nickel and Garces may have had regarding the use of Lower River Water Rights and Isabella storage at the time of the transfer of those rights to the Agency not heretofore disclosed to us.

2. We are not aware of any current or threatened litigation challenging the Nickel's or Olcese's rights to the Lower River Water Rights which are the subject of the Contract. However, litigation exists in the United States District Court which may affect the amount of water you can store in Isabella Reservoir: *Southwest Center for Biological Diversity v. Colonel Dorothy Klasse*, Case CIV S-97-1969 GEB JFM.

3. Assuming the parties to the various agreements described above are bound thereby, there are only two types of persons or entities who theoretically might be able to challenge these water rights. The first type is appropriators and the second is riparians.

a. We are not aware of any existing appropriators not a party to the existing agreements for the Kern River. We are aware of some small diversions from Lake Isabella, but believe these are illegal diversions rather than being pursuant to established rights. The only permits and licenses that have been issued by the State on the Kern River are those given for non-consumptive power generation use. Any other appropriators would have had to have begun their appropriations prior to 1914 and their use would have had to have been continuous since then or their right would be subject to loss for non-use. We have not carried out any independent investigation to determine if there are any existing appropriative rights of which we are not aware.

b. As to potential new appropriators, in 1964, in its Decision D. 1196 denying various applications to appropriate Kern River water, the State Water Rights Board found there was no unappropriated water in the River. In that decision, the Board found that: "The natural flow of Kern River reaching the floor of the San Joaquin Valley has been apportioned among the various users for many years by court decisions and agreements." It then referred specifically to the Supreme Court decision in *Lux v. Haggin*, supra, the Miller-Haggin Agreement and amendments thereto, the Shaw Decree, the Minimum Pool Agreement, and the 1962 Agreement.

c. Again, on November 16, 1989, the State Water Resources Control Board ("State Board"), acting pursuant to Water Code Sections 1205 through 1207, adopted Board Order WR-89-25, entitled "Order Adopting Declaration of Fully Appropriated Stream Systems and Specifying Conditions for Acceptance of Applications and Registration." Exhibit A to the Declaration indicates that the Kern River in Kern County is a fully appropriated stream and that there is no unappropriated water on this system. In 1994, the State Board adopted Order WR-94-1 denying Lost Hills Water District's request to modify Board Order WR-89-25, i.e. that the Kern River is a fully appropriated stream. More recently, the State Board's Division of Water Rights has received four petitions requesting modification of the fully appropriated stream determination for the Kern River and applications for appropriation. The petitions and applications were based on a determination by the Superior Court of Tulare County in *North Kern Water Storage District v. Kern Delta Water District, et al*,. Case 96-172919, that 87,000 acre-feet per year of water held by Kern Delta Water District under a pre-1914 appropriative water right had been forfeited by non-use. The State Board has deferred action on these petitions and applications until completion of the on-going litigation, which is currently on appeal.

d. As for non-party riparians, there are some apparently riparian lands upstream from First Point of measurement. However, we have been informed that their potential use is not considered material. If there are any such users along the river below First Point who were not parties to the above-mentioned agreements or successors in interest to any of the parties, they might be able to assert their riparian rights. However, we are informed that there are very few parcels along the river that meet this test and that none of them are of significant size. We have not independently investigated the extent of riparian lands along the Kern River.

4. Nickel, the Trust and La Hacienda, Inc., as attorneys-in-fact have made several sales and exchanges of Kern River water with various public entities and individuals, such as the sale to the Agency/State of California referenced above. Additional transactions have involved the Agency and its Improvement District #4, County of Kern, North Kern Water Storage District, Buena Vista Water Storage District, Lost Hills Water District, the Kern National Wildlife Refuge, Shell Oil Co., Union Oil Co., Chevron Oil Co. and Paramount Farming Company. These transactions have been accomplished without successful challenge.

The factual matters discussed in this letter are made to the best of our current actual knowledge. We have used due diligence in accumulating and reviewing this material so that the opinion accurately reflects the state of the record as reasonably determinable as of the date of this opinion. In the course of preparing this letter, no information that would give us current actual knowledge of the inaccuracy of such factual statements has come to our attention. We have made no other factual investigations beyond the documents provided.

This letter should not be construed as a representation that all of the facts necessary to reach any particular conclusion are contained herein. Rather, we represent only that this letter contains those facts within our current actual knowledge that we would deem material in connection with due diligence investigations of transactions of this sort. You should review the documents in their entirety. We are not currently aware of any other agreements, water rights, documents or circumstances that would impair Nickel's or Olcese's ability to carry out their obligations under the Contract, or that would impair the ability of the Contract to function in the manner contemplated by the parties.

We disclaim the use of this letter as warranting title to the water and water rights in issue. We have provided and/or offered to the Agency copies of all of the agreements, assignments, and powers of attorney in our possession which we believe to be relevant to the Kern River Lower River Water Rights which are the subject of the Contract. You have informed us that you have made a thorough independent examination into this matter and have completed your own due diligence review to confirm the information in this letter.

We disclaim any obligation to update this letter for events occurring after the date hereof.

This letter is furnished by us as counsel to Nickel Family, LLC. No attorney-client relationship has existed or exists between our firm and Olcese or Garces in connection with the Contract or by virtue of this letter. This letter is intended solely for the use of the Agency in connection with the Contract, and may not be used, circulated, quoted or otherwise referred to or relied upon for any other purpose or by any other person without our prior written consent.

Respectfully,

KRONICK, MOSKOVITZ, TIEDEMANN & GIRARD
A Professional Corporation

cc: Mr. James L. Nickel

642630.2

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February 22, 2001

Via Hand Delivery (Bakersfield)

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Nickel, LLC
P. O. Box 60679
Bakersfield, CA 93386-0679

Scott A. Morris, Esq.
Kronick, Moskovitz, Tiedemann & Girard
400 Capitol Mall, 27th Floor
Sacramento, CA 95814-4416

Re: Purchase of the Lower Kern River Water Rights
(Our File No.: OWD-8.1.2)

Gentlemen:

As you are aware, on January 23, 2001 Nickel Family, LLC ("Nickel"), a California limited liability company; the Olcese Water District ("Olcese") and the Kern County Water Agency("KCWA"), both of which are public agencies in the State of California, executed the Contract to Transfer the Kern River Lower River Water Rights (hereinafter referred to as the "Contract"). Article 8.1(d) of the Contract states:

> (d) Opinion Letter of Counsel: Nickel shall deposit into escrow an opinion letter of counsel, satisfactory to the Agency, providing that the conveyances, transfers and assignments provided in this Contract are sufficient to transfer all right, title and interest of Nickel and Olcese to the rights described herein, except those specifically retained by or quitclaimed to Nickel and/or Olcese.

In order to satisfy Article 8.1(d), I hereby represent that the representations and warranties given by Olcese in Article 7.1(k) are true and correct.

Very truly yours,

Gene R. McMurtrey
Attorney for Olcese Water District

GRM:gg
[illegible]

CONTRACT TO TRANSFER THE KERN RIVER LOWER RIVER WATER RIGHTS

This Contract is made as of the 23rd day of January 2001, by and between Nickel Family, LLC ("Nickel"), a California limited liability company; the Olcese Water District ("Olcese") and the Kern County Water Agency ("Agency"), both of which are public agencies in the State of California, duly organized, existing and acting pursuant to the laws thereof.

RECITALS

WHEREAS, the Governor's Budget Act for 2000, Chapter 52, Statutes of 2000, appropriated to the Department of Water Resources local assistance grant funds in the amount of $161,544,000 by budget item 3860-01-6027, payable from the interim Reliable Water Supply and Water Quality Infrastructure and Management Subaccount, and the Kern County Water Agency's Kern River Restoration Project has been selected for funding in the amount of $23,000,000 from that subaccount; and

WHEREAS, the Agency intends to use money from that appropriation for development of local water supplies, water quality, conveyance and banking programs within Kern County; and

WHEREAS, the Agency has identified the acquisition of the Lower River Water Rights as a source suitable for such programs; and

WHEREAS, the Lower River Water Rights are Kern River rights that historically have yielded on average 50,000 acre-feet per Year; and

WHEREAS, the Agency has purchased the undivided interest in the Lower River Water Rights, and other water rights and inventories, previously owned by Garces Water Company; and

WHEREAS, Olcese owns the remaining interest in the Lower River Water Rights subject to Nickel's right to use any portion of that water that is excess to Olcese's needs in accordance with the March 18, 1981 contract between Olcese and Nickel; and

WHEREAS, the Agency desires to purchase the remaining interest in the Lower River Water Rights and other interests described herein from Olcese and Nickel on the terms provided for in this Contract; and

WHEREAS, pursuant to the Detachment and Water Sale Contract No. 99-150, dated June 30, 1999, between Olcese, the City of Bakersfield and the California Water Service Company, the City of Bakersfield will provide water to meet the future municipal and industrial needs of lands within Olcese that are within the boundaries of the City of Bakersfield, provided those lands are detached from Olcese; and, WHEREAS, while there is no current demand from the landowners in Olcese for agricultural water supplies, if there should be a demand for water for agricultural use within Olcese over and above the amount that can be supplied to such lands from riparian rights, Olcese will receive sufficient compensation from the sale of its Lower River Water Rights to enable it to meet those demands from sources other than the Lower River Water Rights; and

WHEREAS, the Olcese Board of Directors has determined that the transfer of the Lower River Water Rights to the Agency as provided for in this Contract is in the best interest of its landowners; and

WHEREAS, the Agency, as the lead agency, and Olcese as a responsible agency, have completed all requirements under the California Environmental Quality Act for all actions provided for in this Contract.

NOW, THEREFORE, Nickel, Olcese and the Agency agree as follows:

ARTICLE 1. DEFINITIONS

When used in this contract, the following terms have the meanings hereinafter set forth:

1.1 "Agency's Return on Investment Rate" means the County of Kern's Treasury Pool investment rate.

1.2 "Agency SWP Entitlement Water" and "SWP Entitlement Water" mean the SWP water provided for in Table A of the Agency's Water Supply Contract.

1.3 "Agency's Water Supply Contract" means the November 15, 1963 Water Supply Contract between the State of California Department of Water Resources and Kern County Water Agency, as amended.

1.4 "Carmel Rights" means those rights and interests described in Exhibit C.

1.5 "Castro Ditch Rights" means those water rights and interests described in Exhibit B.

1.6 "CEQA" means the California Environmental Quality Act, California Public Resources Code sections 21000, *et seq.*

1.7 "Close of Escrow" or "Closing Date" means the day on which all applicable conditions precedent to this Contract are completed to Nickel's, Olcese's and the Agency's satisfaction or waived by the party that benefits from the condition precedent as set forth in Articles 8.1, 9.1 and the assignments provision of Article 10.1.

1.8 "DWR" means the Department of Water Resources of the State of California.

1.9 "Escrow Agent" means Chicago National Title Company in its Bakersfield, California office.

1.10 "Agency Transfer Water" means 10,000 acre-feet of water annually, to be provided by the Agency to Nickel for delivery and sale to third parties from the California Aqueduct.

1.11 "Johnson Ditch Rights" means those water rights described in Exhibit B.

1.12 "Lower River Water Rights" means those water rights described in Exhibit A.

1.13 "Rio Bravo Ranch" means that property described as the southern half of the northeast quarter and that portion of the southern half north of the Kern River of Section 33, the southern half of the southern half of Section 34, the southern half of the northern half and the southern half of Section 35, the southern half of the northern half and the southern half of Section 36, Township 28 South Range 29 East Mount Diablo Base and Meridian; Section 1, Section 2, the portion of Section 3 lying east of the Kern River, the northeast quarter of Section 10, Section 11, Section 12, the western half of the northeast quarter and the northwest quarter of the southeast quarter of Section 13, the northeast quarter of Section 24, Township 29 South, Range 29 East Mount Diablo Base and Meridian; the southern half of Section 5, Section 6 and Section 8, Township 29 South, Range 30 East Mount Diablo Base and Meridian, as depicted on Exhibit F.

1.14 "State" means the State of California.

1.15 "State Funds" means the funds made available to the Agency by the State from appropriations of funds authorized by Chapter 52, Statutes of 2000.

1.16 "SWP" means the State Water Project.

1.17 "Tupman" means the point of delivery on the California Aqueduct more particularly described as milepoint 238.04 located within Reach 12E of the California Aqueduct.

1.18 "Year" means the twelve (12) month period from January 1st through December 31st, both dates inclusive.

ARTICLE 2. GENERAL PROVISIONS

2.1 The Agency is purchasing and Nickel and Olcese are selling to the Agency their Lower River Water Rights and other rights as described and provided for herein. The Agency shall pay Nickel and Olcese for these rights the various considerations provided for in this Contract, including, but not limited to, providing Nickel with 10,000 acre-feet of Agency Transfer Water annually at Tupman which Nickel intends to sell both within and outside of Kern County. The Agency shall assume all the rights, duties and obligations associated with the Lower River Water Rights and other rights being transferred to it. Nickel, the Agency, and Olcese shall cooperate with each other in the performance of their respective obligations and in the exercise of their respective rights under this Contract.

ARTICLE 3. TERM OF CONTRACT

3.1 This Contract shall continue in perpetuity. However, if Escrow does not close by the date specified in Article 11.1, this Contract shall terminate on that date.

ARTICLE 4. PURCHASE AND PAYMENT TERMS

4.1 Purchase and Sale: Nickel hereby sells to the Agency and the Agency hereby purchases from Nickel all of Nickel's rights, title and interest to the Lower River Water Rights, including, but not limited to, Nickel's right to store, exchange, substitute and regulate the Lower River water as set forth in Exhibit A. Nickel also quitclaims to the Agency the Castro Ditch Rights and the Johnson Ditch Rights as set forth in Exhibit B. Olcese hereby sells to the Agency and the Agency hereby purchases from Olcese all of Olcese's rights, title and interest to the Lower River Water Rights, including, but not limited to, Olcese's right to store, exchange, substitute and regulate the Lower River Water as set forth in Exhibit A. Nickel and Olcese also hereby substitute the Agency as attorney-in-fact for any powers of attorney they may presently have relating to the Lower River Water Rights sold to the Agency. The purchase and sale of all of these rights shall be consummated through the escrow opened with the Escrow Agent. Any escrow instructions given the Escrow Agent by Nickel, Olcese or the Agency shall be consistent with the terms of this Contract unless otherwise agreed to by all parties in writing.

4.2 Cash Payments: By the Close of Escrow, Agency shall pay to Olcese one million dollars ($1,000,000) for the purchase of Olcese's Lower River Water Rights. By the Close of Escrow, Agency shall pay to Nickel six million four hundred twenty-two thousand dollars ($6,422,000) as partial consideration for the purchase of all rights and assets acquired by the Agency from Nickel under this Contract. The Agency shall pay Nickel and Olcese interest at the Agency's Return on Investment Rate on the above sums from the date on which the Agency receives not less than $10,000,000 of State Funds until the Close of Escrow. This interest shall be payable within five days of the Agency's receipt of the County of Kern's calculation of the first quarter of the Year 2001 quarterly interest rate , provided that the escrow closes, to Nickel and Olcese in proportion to the purchase payments to be paid to them respectively as provided for above.

4.3 Internal Revenue Code Section 1031 Exchange: Agency agrees to cooperate with Nickel in completing an exchange qualifying for nonrecognition of gain under Internal Revenue Code section 1031 and the applicable provisions of the California Revenue and Taxation Code. Nickel reserves the right to convert this transaction to an exchange at any time before the Close of Escrow. Nickel and the Agency agree, however, that consummation of the transaction contemplated by this Contract is not conditioned on completion of such an exchange. Nickel shall have the right to transfer and assign to an intermediary all of Nickel's rights and obligations under this Contract in order to complete the exchange. The Agency shall incur no additional liabilities, expenses or costs as a result of or connected with the exchange.

4.4 Water Exchange: Beginning in 2001 the Agency shall deliver to Nickel, annually during the term of this Contract, ten thousand (10,000) acre-feet of the Agency Transfer Water at Tupman as partial consideration for Nickel's interest in the Lower River Water Rights. The Agency shall provide the Agency Transfer Water at Tupman at no cost to Nickel other than the cost set forth in Article 4.5. The Agency shall use its best efforts to obtain and maintain approvals from the DWR for delivery of any Agency Transfer Water into the California Aqueduct, and if such approvals are not obtained after reasonable efforts the parties shall, in good faith, negotiate alternative mechanisms for delivery of Agency Transfer Water.

4.5 Power Charges: In any Year in which the Agency's allocation of SWP Entitlement Water on May 1st is seventy-five percent (75%) or less than its entitlement for that Year, Nickel shall pay the Agency the following power charge within thirty days after the Agency submits an invoice to Nickel, which invoice shall be submitted on or shortly after May 1. The power charge set forth in the invoice shall be an amount determined by the Agency by multiplying 10,000 acre-feet by the Agency's estimated per acre-foot power costs for pumping water from the Agency's Pioneer Project and delivering it to Tupman. The Agency shall estimate this per acre-foot cost using the method set forth in Exhibit D. There shall be no power charge to Nickel in any Year in which the Agency's allocation of SWP Entitlement Water on May 1 is greater than 75% of its SWP entitlement for that Year.

4.6 Treatment Costs: If the Agency is prevented from delivering non-SWP water into the California Aqueduct to meet the ten thousand (10,000) acre-foot obligation to Nickel required by Article 4.4 due to water quality restrictions unless it is treated, the Agency shall pay the cost of treating that water to the level acceptable for delivery into the California Aqueduct.

4.7 California Aqueduct Capacity: The ten thousand (10,000) acre-feet of Agency Transfer Water provided to Nickel shall be transported within the California Aqueduct to the full extent of the Agency's rights to use Aqueduct.

4.8 Scheduling of Agency Transfer Water: The Agency, in consultation with Nickel, shall schedule all Agency Transfer Water deliveries with the DWR at the same time and in the same manner as the Agency schedules deliveries of SWP Entitlement Water to the Agency's Member Units, as set forth in the Agency's contracts with its Member Units as they presently exist or may be changed from time to time.

4.9 Agency Transfer Water Sales: Any sale of the Agency Transfer Water shall be at the sole discretion and direction of Nickel. Nickel may request Agency's assistance, involvement and expertise in negotiating and consummating any sale. The Agency shall cooperate and assist Nickel, as requested, subject to the Agency's legal powers and duties and the direction of the Agency's Board of Directors. The Agency's involvement may include efforts to market Nickel's Agency Transfer water on behalf of Nickel, entering into contracts for the sale of the Agency Transfer Water and efforts to obtain the approval, cooperation and assistance of DWR and the State Water Contractors in obtaining any necessary approvals from regulatory agencies to effect such sales or transfers.

4.10 Proceeds of Agency Transfer Water Sales: All net proceeds of Agency Transfer Water sales shall be distributed as follows: Ninety percent (90%) to Nickel, ten percent (10%) to the Agency. "Net proceeds of Agency Transfer Water sales" shall mean the amount remaining from the proceeds of a sale after deducting any payments to third parties or other costs incurred by Nickel or the Agency that are necessary in order to complete a sale, such as costs for CEQA compliance, regulatory fees and charges, wheeling charges, power charges for transportation beyond Tupman or pursuant to Article 4.5, etc. Neither Nickel's nor the Agency's administrative costs in affecting an Agency Transfer Water sale shall be deemed to be payments to third parties necessary to complete a sale. All costs shall conform with standard industry practice, and are subject to audit at the requesting parties expense. After incurring such costs, Nickel or the Agency may invoice the other party for its respective share of such costs (Nickel 90%, Agency 10%) and payment thereon shall be made within thirty days of mailing.

4.11 Riparian or Carmel Rights: The Agency shall not challenge or contest directly or indirectly any of the Kern River riparian rights, as defined in the March 18, 1981 "Agency Agreement for Riparian Lands – Olcese Water District", of Nickel or Rio Bravo Ranch. The Agency shall not challenge or contest directly or indirectly any of the Carmel Rights of Olcese, Nickel or Rio Bravo Ranch.

4.12 Discharge of Well Water: The Agency shall not challenge or support any challenge to Olcese's or Rio Bravo Ranch's discharge of well water into the Kern River to meet the demands of the Rio Bravo Ranch or Olcese; provided, that the pumping of such well water does not substantially degrade the Kern River water quality to the injury of the Agency. The Agency acknowledges that Nickel has provided the Agency with an April 2000 study by Kenneth D. Schmidt and Associates regarding the origin of the groundwater pumped by Rio Bravo Ranch and Olcese.

4.13 Additional Consideration: At the Close of Escrow:

(a) The Agency shall convey to Nickel all of the Agency's rights, title and interest in the water inventories, more particularly described in Exhibit E.

(b) Olcese shall convey to the Agency all of Olcese's rights, title and interest in the City of Bakersfield's 2,800 acre recharge facility and to any water banked therein, subject to the City of Bakersfield's agreement to release Olcese from the thirteen (13) year supply requirement to meet the demands within Olcese set forth in Agreement 77-07, as amended by Agreement 78-12, Agreement 81-76, and Agreement 90-05.

(c) The Agency shall quitclaim all its rights, title and interest in the Carmel Rights to Olcese.

(d) Garces Deed: The Agency shall quitclaim to Nickel the rights and property identified in Exhibit G which were included in the rights and property granted to the Agency by the Garces Water Company, Inc. in the September1, 2000 grant deed from Garces Water Company, Inc. to the Agency.

(e) Nickel and Olcese shall deliver to the Agency all documents, files, legal files, historical records, communications and correspondence related to the Lower River Water Rights and the Johnson and Castro Ditch rights. Nickel and Olcese may, at their cost, make copies of such records. The Agency shall provide Nickel and Olcese access to any documents relating to the Lower River Water Rights in its possession upon request.

(f) Miller and Lux Facilities: Nickel and its related entities, and Olcese, agree to transfer, assign and convey any water or water related rights acquired from Miller & Lux, and its successors in interests, related to the Kern River within Kern County north of Highway 46. These rights may include, but are not limited to, transportation, spreading, storage and water rights.

ARTICLE 5. WATER PIPELINE EASEMENT

5.1 Nickel shall grant the Agency, for fifty thousand dollars ($50,000), an easement through Nickel's Rio Bravo Ranch for a water pipeline, beginning at the Rio Bravo Hydroelectric Project power plant forebay and roughly paralleling Highway 178. The size, use, location and terms for this easement shall be mutually agreed upon by Nickel and the Agency. If the use of this easement by the Agency causes any damage of facilities, improvements or orchards in the Rio Bravo Ranch, the Agency shall either, at Nickel's election, replace the damaged facilities or compensate Nickel for the fair market value of the damages. Agency's use of the power canal shall be consistent with the Condemnation Settlement Agreement of May 20, 1985. If any Agency facilities in the easement interfere with Nickel's current or future use of the Nickel's property, the Agency, at Nickel's request, shall relocate its facilities at Nickel's expense. Nickel is not obligated to obtain subordination from existing deeds of trust on its property. For the granting of the easement provided for herein, the Agency shall pay all costs to survey and record the easement. Nickel and the Agency shall use their best efforts to record the easement prior to the Close of Escrow; however, if the easement is not recorded within one year from the date of execution of this Contract the Agency's right to the easement will expire, and the $50,000 payment will be retained by Nickel unless failure to record has been caused by Nickel's failure to cooperate or unreasonable disapproval of proposed alignments. The Agency hereby grants Nickel (a) the right to convey water in the Agency's future water pipeline at the Agency's incremental cost to the extent there is capacity in the water pipeline not being used by the Agency and (b) the right to increase the capacity of the Agency's future water pipeline at the incremental cost.

ARTICLE 6. HYDROPOWER

6.1 Hydropower Interests: Nickel's conveyance of its Lower River Water Rights, and the other described rights to the Agency provided for in this Contract does not include Nickel's rights in the Rio Bravo Hydroelectric Project. The parties agree that Nickel retains its eighty-five percent (85%) interest in the Rio Bravo Hydroelectric Project Agreement dated April 29, 1985 between Catalyst Energy Development Corporation, Catalyst Rio Bravo Corporation and Olcese and the Condemnation Settlement Agreement dated May 20, 1985 between Nickel Enterprises and Olcese.

6.2 Right to Take: Nickel and Olcese shall grant to the Agency the right to take water from the Rio Bravo Hydroelectric Project to serve the Agency's proposed water pipeline referred to in Article 5.1. The Agency's right to take such water shall be subordinate at all times to the extent of Nickel's and Olcese's rights for the Rio Bravo Ranch's current or future irrigation demands.

ARTICLE 7. REPRESENTATIONS AND WARRANTIES

7.1 Nickel and Olcese hereby acknowledge, represent and warrant to the Agency that, as of the date of this Agreement and the Close of Escrow:

(a) Recitals and Exhibits: The Recitals and Exhibits to this Contract are true and correct.

(b) Organization: Nickel and Olcese are duly organized and validly exist in good standing under the laws of the State of California. Nickel and Olcese have full power, authority and legal right to execute, deliver and perform this Contract. To the best of Nickel's and Olcese's knowledge (after due diligent investigation and due inquiry), Nickel and Olcese have the unrestricted right and power to own, use and sell their respective interests in the Lower River Water Rights, as set forth in Exhibit A, as provided in and required by this Contract, have complied with all applicable laws and regulations of governmental agencies, officials or authorities, have obtained all necessary permits, licenses and approvals necessary and appropriate to proceed with the conduct of their business in accordance with the requirements of this Contract and have followed all necessary, proper and appropriate procedures in procuring such permits, licenses and approvals.

(c) Authorization: The execution and delivery by Nickel and Olcese of this Contract, and any other agreements or instruments required by this Contract and the performance by Nickel and Olcese of their obligations in connection with this Contract: (1) have been each duly authorized by all necessary boards of directors; and (2) to the best of Nickel's and Olcese's knowledge, after diligent investigation and due inquiry, require no registrations with or approvals of any person not heretofore obtained.

(d) Litigation: To the best of Nickel's and Olcese's knowledge (after diligent investigation and due inquiry), there is no action, suit, claim, cause of action, or proceeding at law or in equity (or by or before any governmental agency, official or authority of any local, State or Federal government) now pending, contemplated by Nickel or Olcese or threatened in writing against or affecting any Lower River Water Rights other than as expressly stated in a writing delivered to Agency at or prior to the Close of Escrow.

(e) No Oral Understandings: In executing this Contract, neither Nickel nor Olcese is relying upon any representation, communication, understanding or expectation (whether express or implied) that is not clearly and expressly stated in this Contract.

(f) Receipt of Information: Nickel and Olcese have received any and all information from the Agency which they desire or expect in connection with the transaction evidenced by this Contract, or any other document related to or required by this Contract. Nickel and Olcese are not relying upon the Agency directly or indirectly to disclose (or to evaluate any other person's disclosure of) any such matters, and Nickel and Olcese excuse and release the Agency from any duty whatsoever to make such disclosures.

(g) No Continuing Obligations: Nickel and Olcese understand and agree that, after the Close of Escrow, the Agency shall have no direct or indirect obligations whatsoever to them except as expressly stated in or required by this Contract.

(h) Separate Obligations: Nickel and Olcese shall be bound by and perform this Contract and each of the other documents related to or required by this Contract to which they are a party, separately and independently from the obligations of any other person or entity and regardless of whether or not any other person or entity performs this Contract or any other documents related to or required by this Contract.

(i) Violations of Applicable Laws: To the best of their knowledge, neither Nickel nor Olcese is in violation of any law, statute, regulation, ordinance or other governmental provisions with respect to any of the Lower River Water Rights to be conveyed to the Agency pursuant to this Contract.

(j) Violations of Other Agreements: The entry into this Contract does not create or result in a breach of any agreements with respect to any of the Lower River Water Rights to which Nickel or Olcese is a party or to which either of them is otherwise subject or bound.

(k) Ownership of Lower River Water Rights: Nickel and Olcese (a) collectively are the sole owners of the remaining of the Lower River Water Rights, as set forth in Exhibit A, being conveyed herein exclusive of any other owner or claimant and (b) have no knowledge and are not aware of any notice or other information concerning any other claims of any kind which would effect Nickel's or Olcese's title or claim to the Lower River Water Rights. The Lower River Water Rights described in Exhibit A constitute a complete description of all water, water storage, exchange entitlements and drainage contracts and other miscellaneous rights of any kind or description relating thereto owned or claimed by Nickel and Olcese. Nickel and Olcese have heretofore supplied the Agency with all documents known to Nickel and Olcese which constitute evidence of any Lower River Water Rights and title and claim thereto by Nickel and Olcese.

(l) Taxes: To the best of Nickel and Olcese's knowledge (after diligent investigation and due inquiry), Nickel and Olcese have paid (or caused to be paid) all property and other taxes required to be paid (and all assessments of which they have notice or acknowledged) with respect to the Lower River Water Rights to the extent such taxes (or assessments) have become due and payable. If there are any unpaid taxes or assessments as of the Close of Escrow, Nickel and Olcese shall be liable for their payment.

7.2 Agency hereby acknowledges, represents and warrants to Nickel and Olcese that, as of the date of this Contract and the Close of Escrow:

(a) Recitals and Exhibits: The Recitals and Exhibits to this Contract are true and correct.

(b) Organization: The Agency is duly organized and validly exists in good standing under the laws of the State of California. The Agency has full power, authority and legal right to execute, deliver and perform this Contract. To the best of the Agency's knowledge (after due diligent investigation and due inquiry) the Agency has complied with all applicable laws and regulations of governmental agencies, officials or authorities, have obtained all necessary permits, licenses and approvals necessary and appropriate to proceed with the conduct of its business in accordance with the requirements of this Contract and has followed all necessary, proper and appropriate procedures in procuring such permits, licenses and approvals, provided, however, that the approvals which are the subject of Article 4.4 shall be governed by that Article.

(c) Authorization: The execution and delivery by the Agency of this Contract, the consummation of the transactions and contracts required or contemplated by it and the performance by the Agency of its obligations in connection with this Contract: (1) have been each duly authorized by the Agency's board of directors; and (2) to the best of the Agency's knowledge, after diligent investigation and due inquiry, require no registrations with or approvals of any person not heretofore obtained.

(d) No Oral Understandings: In executing this Agreement, the Agency is not relying upon any representation, communication, understanding or expectation (whether express or implied) that is not clearly and expressly stated in this Contract.

(e) Receipt of Information: The Agency has received any and all information from Nickel and Olcese which it desires or expects in connection with the transaction evidenced by this Contract, or any other document related to or required by this Contract. The Agency is not relying upon Nickel or Olcese directly or indirectly to disclose (or to evaluate any other person's disclosure of) any such matters, and the Agency excuses and releases Nickel and Olcese from any duty whatsoever to make such disclosures.

(f) No Continuing Obligations: The Agency understands and agrees that, after the Close of Escrow, neither Nickel nor Olcese shall have any direct or indirect obligations whatsoever to the Agency except as expressly stated in or required by this Contract.

(g) Violations of Applicable Laws: To the best of the Agency's knowledge, the Agency is not in violation of any law, statute, regulation, ordinance or other governmental provisions with respect to any of the funds and the Agency Transfer Water to be conveyed to Nickel pursuant to this Contract.

(h) Violations of Other Agreements: The entry into this Contract does not create or result in the breach of any other agreement to which the Agency is a party or to which the Agency is otherwise subject or bound.

(i) Agency Transfer Water: The Agency has a legal right to the Agency Transfer Water to be provided to Nickel pursuant to this Contract whether from Agency SWP Entitlement Water or other sources, with full authority to exchange such water as provided for herein; and that such water is held free and clear of any liens, encumbrances or rights of any other party, other than the obligation of the Agency to make the payments to the State and other obligations, as required by the Agency's Water Supply Contract, and that the Agency shall maintain such water free and clear of any such claims during the term of this Contract.

(j) Kern River Water: The Agency understands the hydrology of the Kern River and the historical yield of the Lower River Water Rights, which has been on average, approximately fifty thousand (50,000) acre-feet per year. The Agency shall not hold Nickel or Olcese liable for any reduction in the yield of the Lower River Water Rights below this average.

(k) Obligations of the Lower River Water Rights: The Agency understands, agrees and assumes all of the Lower River Water Rights obligations, including, but not limited to, the Tulare Lake Basin Water Storage District annual ten thousand (10,000) acre-foot fee, the Lake Isabella storage costs, the Kern River Watermaster charges and legal fees, and the City of Bakersfield accounting fees and the Kern Property Corporation settlement. The Agency shall assume such obligations at the Close of Escrow, at which time all expenses for such obligations shall be prorated as per Article 9.1.

(l) Litigation: To the best of the Agency's knowledge (after diligent investigation and due inquiry), there is no action, suit, claim, cause of action, or proceeding at law or inequity (or by or before any governmental agency, official or authority of any local, State or Federal government) now pending, contemplated by the Agency or threatened in writing against or affecting any funds the Agency shall receive from the State of California pursuant to the Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act or wherein an unfavorable decision, ruling or finding would (i) affect the creation, organization, existence or powers of the Agency or the titles and powers of its Board members and officers to their respective offices; (ii) enjoin or restrain the approval and/or execution of this Contract, or (iii) in any way question or affect any of the rights, powers, duties or obligations of the Agency with respect to implementation of this Contract, other than as expressly stated in a writing delivered to Nickel and Olcese at or prior to the Close of Escrow.

ARTICLE 8. CONDITIONS PRECEDENT

8.1 The obligations of Nickel and Olcese to sell the water rights set forth in Exhibits A and B and the resulting obligation of the Agency to pay and provide additional consideration are conditioned upon the satisfaction or waiver of the following conditions precedent prior to the Close of Escrow:

(a) State Funds: The Agency's receipt of State Funds sufficient to make the payments required of the Agency.

(b) Agency Resolution: The Agency shall provide Nickel a resolution adopted by the Agency's Board of Directors, meeting the requirement of Section 5 of the Kern County Water Agency Act (California Statutes of 1961, Chapter 1003, as amended), containing a finding by the Board that the Agency Transfer Water to be provided to Nickel pursuant to this Contract will not be needed for use within the Agency.

(c) Authorizing Resolutions: Nickel, the Agency and Olcese shall each provide the other parties to this Contract resolutions from their respective Boards of Directors authorizing the execution of this Contract.

(d) Opinion Letter of Counsel: Nickel shall deposit into escrow an opinion letter of counsel, satisfactory to the Agency, providing that the conveyances, transfers and assignments provided in this Contract are sufficient to transfer all right, title and interest of Nickel and Olcese to the rights described herein, except those specifically retained by or quitclaimed to Nickel and/or Olcese.

ARTICLE 9. CLOSE OF ESCROW

9.1 Close of Escrow: Agency shall deposit the sum of $7,472,000 into Escrow, and Close of Escrow shall occur when (1) the Agency delivers to the Escrow Agent $7,472,000 as required by Articles 4.2 and 5.1; (2) the Agency delivers to the Escrow Agent its prorated portion of the annual expenses incurred by the Lower River Water Rights; (3) the Agency, Nickel and Olcese have deposited all requisite documents for the transfer of the Lower River Water Rights, and other described rights to be transferred pursuant to this Contract, duly executed, authorized , acknowledged and approved by the parties' respective counsel as sufficient to transfer all purchased rights; and (4) all conditions precedent have occurred. If assignments are not approved, Nickel and Olcese shall in good faith negotiate with the Agency to provide for an operation agreement which will provide the Agency with equivalent rights (in the Agency's judgment) to the failed assignment. All expenses associated with the Lower River Water Rights shall be prorated as of January 1, 2001. The Agency, Nickel and Olcese shall notify by written notice to all parties and the Escrow Agent of the intended date for the Close of Escrow. All closing costs and fees, including without limitation, any transfer taxes, escrow fees, drafting and notary charges and recording fees shall be apportioned equally between the Agency, Olcese and Nickel. Each party shall be responsible for fees and costs of its own counsel.

ARTICLE 10. CONDITIONS SUBSEQUENT

10.1 Completion of All Required Assignments of Rights and/or Obligations: Prior to the Close of Escrow, the parties shall cooperate to achieve all necessary approvals of assignments and transfers of the rights and obligations to the Agency described herein and such approvals shall be deposited into Escrow prior to the Close of Escrow. If such assignments are not approved prior to the Close of Escrow, the parties shall negotiate a mutually satisfactory amendment, pursuant to Article 12.9, making such approvals a condition subsequent.

ARTICLE 11. ESCROW AGENT'S EXCULPATORY PROVISIONS

11.1 Close of Escrow: Escrow shall be closed as soon as possible, but no later than February 22, 2001 provided that the Escrow may extend beyond February 22, 2001 for six months by written agreement of the parties.

11.2 Neglect, Misconduct: The Escrow Agent will not be liable for any of its acts or omissions unless the same constitutes negligence or willful misconduct.

11.3 Information: The Escrow Agent will have no obligation to inform any party of any other transaction or of facts within the Escrow Agent's knowledge, even though the same concerns water entitlements, provided such matters do not prevent the Escrow Agent's compliance with this Contract.

11.4 Form, Validity, and Authority: The Escrow Agent will not be responsible for (1) the sufficiency or correctness as to form or the validity of any document deposited with the Escrow Agent, (2) the manner of execution of any such deposited document, unless such execution occurs in the Escrow Agent's premises and under its supervision, or (3) the identity, authority, or rights of any person executing any document deposited with the Escrow Agent.

11.5 Conflicting Instructions: Upon receipt of any conflicting instructions, the Escrow Agent shall immediately notify all parties that there is an apparent conflict in the instructions. The Escrow Agent will have the right to take no further action until otherwise directed, either by the parties' mutual written instructions or a final order or judgment of a court of competent jurisdiction.

11.6 Interpleader: The Escrow Agent will have the absolute right, at its election, to file an action in interpleader requiring the parties to answer and litigate their several claims and rights among themselves, and the Escrow Agent is authorized to deposit with the clerk of the court all documents and funds held in Escrow. If such action is filed, the parties will jointly and severally pay the Escrow Agent's termination charges and costs and reasonable attorney's fees that the Escrow Agent is required to expend or incur in the interpleader action, the amount thereof to be fixed and judgment therefor to be rendered by the court. Upon the filing of such action, the Escrow Agent will be and become fully released and discharged from all obligations to further perform any obligations imposed by this Contract.

ARTICLE 12. MISCELLANEOUS

12.1 Reference: The parties to this Contract agree to waive and give up the right to a jury trial and to submit all disputes, controversies, differences, claims or demands, whether of fact or of law or both, relating to or arising out of this Contract, to be resolved at the request of any party, by a trial on Order of Reference conducted pursuant to the provisions of Code of Civil Procedure section 638 *et seq.* or any amendment, addition or successor section thereto to hear the case and report a statement of decision thereon. The parties intend this general reference agreement to be specifically enforceable in accordance with said provisions. If the parties are unable to agree upon a referee, one shall be appointed by the Presiding Judge of the Kern County Superior Court. The parties shall share equally, by paying their proportionate amount of the estimated fees and costs of the initial reference.

12.2 Indemnity: Each party shall jointly and severally indemnify the other parties hereto against, and hold each other harmless from, any loss, cost, damage (whether general, compensatory, or otherwise), liability, indebtedness, claim, cause of action, judgment, court costs, and legal or other out-of-pocket expense (including attorneys' fees) which any party may suffer or incur as a direct or indirect consequence of (a) any breach by another party of any representation or warranty made in connection with this Contract; (b) any failure of any party to perform any obligation under this Contract which may affect another party.

12.3 Notices: All Notices given hereunder shall be transmitted in writing to the addresses below or to such other address in the State of California as a party may designate by written notice to the other parties:

If to Nickel:

Mr. James Nickel, President
Nickel Family, LLC
P.O. Box 60679
Bakersfield, California 93386-0679
Facsimile: (661) 872-7141

If to Olcese:

Board of Directors
Olcese Water District
P.O. Box 651
Bakersfield, California 93302
Facsimile: (661) 872-9956

If to Agency:

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, California 93302
Facsimile: (661) 634-1428

All such notices shall be deemed to have been given at the first to occur of time of actual delivery, or, if mailed, forty-eight (48) hours after deposited in certified or registered United States mail, postage prepaid. In case of notice transmitted by an overnight delivery service (which obtains a written receipt upon delivery), notice shall be deemed to be given when delivered by any such service, charges prepaid and the receipt is signed. If any party transmits information to any other party orally or by a means not authorized herein, the party receiving such information shall be entitled to assume that the party giving such information will nevertheless comply with its written notice obligations, and no notice shall be deemed to have been given until the party receiving the information receives written notice as required herein.

12.4 Cumulative Remedies: Except as otherwise expressly provided herein, all rights and remedies provided for in this Contract are cumulative and shall be in addition to any and all other rights, powers, privileges and remedies provided by law.

12.5 No Third Parties Benefited: This Contract is made and entered into for the sole protection and benefit of the parties hereto, their successors and assigns, and no other person shall be a direct or indirect beneficiary of, or have any direct or indirect cause of action or claim in connection with, this Contract.

12.6 Time: Time is of the essence in this Contract.

12.7 Governing Law: This Contract shall be governed by and be construed according to the law of the State of California.

12.8 Counterparts: This Contract may be executed in any number of counterparts, each of which shall be deemed an original, but all such counterparts together shall constitute but one and the same instrument.

12.9 Amendments: This Contract contains the entire and exclusive agreement of the parties hereto. This Contract may only be modified or amended by a written contract executed by Nickel and the Agency. This Contract supersedes all prior drafts and communications with respect thereto. Neither such principles of interpretation nor the express language herein shall be impaired or adversely affected by the language of any prior discussion form or draft of this Contract or any other documents. Furthermore, this Contract has been the subject of negotiations by the parties, and this Contract shall not be construed against any party merely because of that party's involvement in their preparation.

12.10 Force Majeure: If the performance by any party to this Contract of any of its obligations or undertakings under this Contract is interrupted or delayed by any occurrence not occasioned by the conduct of any party to this Contract, whether that occurrence is an act of God or public enemy, or whether that occurrence is caused by war, riot, storm, earthquake, or other natural forces, or by the acts of anyone not party to this Contract, then that party shall be excused from any further performance for whatever period of time after the occurrence is reasonably necessary to remedy the effects of that occurrence.

12.11 Post-Escrow Cooperation: Following Close of Escrow, Nickel, Olcese, and Agency shall in good faith cooperate to ensure the complete transfer of all assets as specified in this Contract including, but not limited to, the execution and delivery of documents, deeds, assignments, and other instruments required to achieve the asset transfers specified in this Contract. The parties currently believe George W. Nickel Jr., Adele R. Nickel, and La Hacienda, Inc. do not possess an independent interest in the assets specified in the Contract, but if such interest is discovered they will cooperate to achieve the asset transfers specified in this Contract.

12.12 List of Exhibits: The following shall constitute all of the Exhibits to this Contract and by this reference are fully incorporated herein:

Exhibit A	Lower River Water Rights
Exhibit B	Johnson Ditch Rights and Castro Ditch Rights
Exhibit C	Carmel Water Rights
Exhibit D	Power Charges for Agency Transfer Water
Exhibit E	Water Inventories
Exhibit F	Map of Rio Bravo Ranch
Exhibit G	Garces Property Description

Dated: January 23, 2001

Kern County Water Agency

By ____________________
General Manager

Attested:

By ____________________
Secretary, Kern County Water Agency

Dated: January 23, 2001

Olcese Water District

By ____________________
President, Board of Directors

Attested:

By ____________________
Secretary, Olcese Water District

Dated: January 23, 2001

Nickel Family, LLC

By ________________________
President, Board of Directors

Dated: January 23, 2001

George W. Nickel, Jr.

George W Nickel Jr

Dated: January 23, 2001

Adele R. Nickel

Adele R Nickel

Dated: January 23, 2001

La Hacienda, Inc.

By George W. Nickel Jr
President

Recording Requested By:
CHICAGO TITLE COMPANY
ESCROW NO. 673298-MM

When Recorded Mail to:
KERN COUNTY WATER AGENCY
Attention: JOHN STOVALL
P.O. BOX 58
BAKERSFIELD, CA 93302-0058

GRANT DEED

DOCUMENTARY TRANSFER TAX $ -0-
( ) COMPUTED ON FULL VALUE OF PROPERTY CONVEYED, OR ( ) COMPUTED ON FULL VALUE LESS LIENS AND ENCUMBRANCES REMAINING THEREON AT TIME OF SALE.

____
Signature of declarant or agent determining tax – Firm Name

( ) Unincorporated Area ( ) City of ______________

Assessor's Parcel No.: ______________

NICKEL FAMILY, LLC, a California limited liability company and OLCESE WATER DISTRICT, a California public agency, for valuable consideration, receipt of which is hereby acknowledged, DO HEREBY GRANT TO KERN COUNTY WATER AGENCY, a California public agency, the real property in the county of Kern, State of California, described on Exhibit A attached hereto and incorporated herein by this reference, together with all improvements thereon and all easements, rights of way, and other rights appurtenant thereto, subject, however, to the lien of non-delinquent real property taxes and assessments and covenants, conditions, restrictions, easements, rights-of-way and servitudes of record.

DATE: ______________, 2001

SELLERS:

Nickel Family, LLC

By: ______________________
Title: ______________________

Olcese Water District

By: ______________________
Title: ______________________

(ALL SIGNATURES MUST BE ACKNOWLEDGED)
MAIL TAX STATEMENTS TO GRANTEE AT ADDRESS ABOVE

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

STATE OF CALIFORNIA)
) ss.
COUNTY OF KERN)

On ______________________, before me, ____,
Date — Name and Title of Officer (e.g. "Jane Doe, Notary Public")

personally appeared ____,
Name of Signers

☐ personally known to me – **OR** – ☐ proved to me on the basis of satisfactory evidence to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same in their authorized capacities, and that by their signatures on the instrument the persons, or the entity upon behalf of which the persons acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary Public

OPTIONAL

Though the data below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent reattachment of this form.

CAPACITY(IES) CLAIMED BY SIGNER(S)

☐ Individual
☐ Corporate Officer

____
Titles

☐ Partners ☐ Limited ☐ General
☐ Attorney-In-Fact
☐ Trustees
☐ Guardian/Conservator
☐ Other: ______________________

Signer is Representing:
Name of Persons or Entity(ies)

____

____

DESCRIPTION OF ATTACHED DOCUMENT

____
Title or Type of Document

____
Number of Pages

____
Date of Document

____
Signers Other Than Named Above

EXHIBIT A

TO GRANT DEED FROM NICKEL FAMILY, LLC AND OLCESE WATER DISTRICT TO THE KERN COUNTY WATER AGENCY

The real property transferred pursuant to this Grant Deed consists of the undivided interests held by Grantors, Nickel Family, LLC and Olcese Water District in and to the real property described in EXHIBIT A-1 attached hereto.

EXHIBIT A-1

The property referred to in this Contract is set forth below. For the purposes of this Water Asset Description, the term "Sellers" shall refer collectively to the following:

> Nickel Family, LLC, a California limited liability company (sometimes herein called "Nickel") and the Olcese Water District, a California public agency (sometimes herein called "Olcese"), George W. Nickel, Jr., Adele R. Nickel, and La Hacienda, Inc..

A. LOWER RIVER WATER RIGHTS. Any and all of Sellers' right, title and interest now owned in any right or title to divert that certain present and future allocation of the natural flow of the Kern River, including, but not limited to, those rights arising pursuant to the following series of agreements and commonly known as the Lower River Water Rights, and any powers of attorney relating thereto which Sellers may now have:

1. Kern River Water Right and Storage Allocation Agreement. That certain Kern River Water Right and Storage Allocation Agreement (the "Allocation Agreement") dated March 10, 1961, by and among Hacienda Water District and Kern River Delta Farms, as first parties, and Robert Burhans, Jr., Gertrude B. Burhans and Burhans & Trew, Inc., as second parties, recorded January 25, 1967, Book 4019, Page 311, Kern County which grants certain water and storage rights to the second parties ("Burhans") which rights were transferred, or modified, as follows:

(a) That certain Assignment dated March 10, 1961, recorded January 25, 1967, Book 4019, Page 309, Kern County, by which Burhans transferred their rights under the Allocation Agreement to Miller & Lux Incorporated; and

(b) That certain Agreement dated September 30, 1966, recorded January 25, 1967, Kern County, Book 4019, Pages 305-322 and recorded in Book 899, Pages 824-842 of the Official Records of Kings County ("Kings County"), by and among Hacienda Water District, George W. Nickel, Jr. dba Kern River Delta Farms and Miller & Lux Incorporated confirmed and ratified by the Kern River Water Right and Storage Allocation Agreement; and

(c) That certain Assignment dated January 11, 1974, recorded January 22, 1974, Book 4822, Page 952, Kern County, by which Miller & Lux, Incorporated assigned all of its rights under the Allocation Agreement to J.G. Boswell Company ("Boswell"); and

(d) That certain unrecorded Assignment dated October 4, 1974, by which J.G. Boswell transferred all of its rights under the Allocation Agreement to George W. Nickel, Jr.;

2. 1962 Kern River Water Rights and Storage Agreement. That certain Kern River Water Rights and Storage Agreement (the "1962 Agreement"), dated

December 31, 1962, by and between Buena Vista Water Storage District ("Buena Vista"), North Kern Water Storage District ("North Kern"), collectively the "Upstream Group," and Tulare Lake Basin Water Storage District ("Tulare Lake") and Hacienda Water District ("Hacienda"), collectively the "Downstream Group," and recorded April 5, 1963, in Book 3594 at Page 3, Kern County, which agreement further allocates diversion rights to Kern River water subject to the Miller-Haggin Agreement, and, in addition, certain storage and exchange rights for water so diverted in Isabella Reservoir, between the Upstream Group and the Downstream Group as successors in interest to the parties to the Miller-Haggin Agreement; and

3. <u>Water Settlement Agreements</u>. That certain Kern River Water Settlement Agreement dated January 1, 1963, which divides and apportions the Downstream Group's water and storage and provides for the exchange of water, and that certain Supplement to Kern River Water Settlement Agreement dated August 8, 1974, in which Hacienda has the option of delivering water from the California Aqueduct to Tulare Lake or making dollar payments to Tulare Lake, or both, and both agreements are by and between Tulare Lake and Hacienda (collectively, the "Tulare Lake-Hacienda Agreement") and neither agreement has been recorded; and

4. <u>Agreement of Sale of Hacienda Ranch</u>. That certain Agreement of Sale, and that certain Kern River Water and Storage Reservation Agreement (the "Reservation Agreement") both agreements dated October 16, 1978, and entered into by and between La Hacienda-TLR Agreement"), a California joint venture (the "La Hacienda-TLR Agreement"), and that certain Memorandum of Agreement dated October 12, 1978, recorded October 24, 1978, Book 1130, Page 957, Kings County, which agreements reserve to George Nickel, Adele Nickel and La Hacienda the Kern River water and storage rights allocated to the Downstream Group pursuant to the 1962 Agreement and, in addition, certain other water rights formerly held by Hacienda; and

5. <u>Special Power of Attorney</u>. That certain Special Power of Attorney from Hacienda to La Hacienda dated February 14, 1979, recorded Book 1184, Page 120, Kings County and recorded September 18, 1980, Book 5315, Page 1253, Kern County, as authorized by Hacienda Resolution No. 79-1; and that certain Special Power of Attorney from the Tulare Lake Representatives to La Hacienda dated February 8, 1979, both of which grant all rights to utilize the water and storage rights reserved under the Agreement of Sale of Hacienda Ranch referred to in subparagraph A.4 above for the limited purpose of contracting for, selling, exchanging, transferring, conveying or otherwise dealing with Kern River rights reserved by George Nickel, Adele Nickel, and La Hacienda; and

6. <u>1980 Contract</u>. That certain Contract by and between Hacienda, Olcese, La Hacienda, George Nickel and Adele Nickel dated on or about August 20, 1980; and

7. <u>Olcese-La Hacienda Agreement</u>. That certain contract for the Purchase and Sale of Kern River Water and Storage Rights (the "Olcese-La Hacienda

Agreement"), dated March 18, 1981, by and between Olcese Water District ("Olcese"), La Hacienda, George Nickel and Adele Nickel, recorded May 26, 1981, Book 5377, Page 349, Kern County, which purports to transfer into Olcese the Kern River water and storage rights set forth in subparagraphs A.4 and A.1.a-d above, but reserves to La Hacienda, George Nickel and Adele Nickel "Excess Water" rights, "Option Water" rights, and other "Residential Rights," including the use of the special powers of attorney referred to in subparagraph A.5 above to the extent necessary to exercise Nickel's reserved rights.

8. Water Transfer Agreement. That certain contract entered into on March 29, 1988, by and between George W. Nickel, Jr., Adele R. Nickel, Nickel Enterprises, Rio Bravo Resort, Inc., La Hacienda, Inc., Kern River Development Company, and Lekcin Management Company, Inc., as Transferors and Garces Water Company, Inc. and the McNear-Driver Trust, which transferred eighty-five percent (85%) of the Transferors' combined interest in the Kern River water and storage rights reserved to the Transferors in the Olcese-La Hacienda Agreement referred to in subparagraph A.7 above to the McNear-Driver Trust and the remaining fifteen percent (15%) of those reserved interests to Garces Water Company, Inc. The March 29, 1988 contract granted Garces the right of first refusal to purchase the Trust's interest in those assets upon a sale or disposition of any of them by the Trust.

9. Water Transfer Agreement: Amendment and Consent to Ownership Transfer. That certain contract between the McNear-Driver Trust and Nickel Family, LLC, George W. Nickel, Jr., Adele R. Nickel, Nickel Enterprises, La Hacienda, Inc. and Garces Water Company, Inc. in which the Ttrust stated its desire to transfer the interests it obtained from the Transferors in the Water Transfer Agreement referred to in subparagraph A.8 above to Nickel, LLC, and in which Garces consented to such a transfer.

10. January 1, 1997 Transfer Agreement. That certain transfer agreement dated January 1, 1997, by and between Dudley L. Drake, Trustee of the McNear-Driver Trust and Nickel, LLC, wherein the Trustee granted and conveyed to Nickel LLC the undivided eighty-five percent (85%) interest in the assets obtained by the Trust in the Water Transfer Agreement referred to in subparagraph A8 above.

B. STORAGE RIGHTS. Any and all Sellers' right, title and interest in any right to store water, in Isabella Reservoir including, but not limited to the following:

1. Storage Rights In Isabella Reservoir. The perpetual right of Sellers to rent from North Kern (which has a right to storage space in Isabella Reservoir pursuant to the 1962 Agreement referred to in subparagraph A.2 above and that certain Contract among the United State of America, North Kern, Buena Vista, Tulare Lake and Hacienda, dated October 23, 1964) storage space in Isabella Reservoir for storage of their Kern River water, including Excess Water, as such right is set forth on behalf of the Downstream Group in Paragraph 9 of the 1962 Storage Agreement (such right to rent storage space reserved by Sellers in the Reservation Agreement referred to in subparagraph A.4 currently entitles Sellers

to twenty percent (20%) of the storage capacity of Isabella Reservoir); and

2. <u>1964 Contract with the United States of America</u>. Any and all of Sellers' right to store water pursuant to the Contract with the United States of America, Number 14-06-200-1360A; and

3. <u>Settlement Agreements</u>. Any and all of Sellers' right to store water pursuant to the Reservation Agreement referred to in subparagraph A.4and the Kern River Water Settlement Agreement and the Supplement to Kern River Water Settlement Agreement referred to in subparagraph A.3 above; and

4. <u>Minimum Pool Agreement</u>. Any and all of Sellers' right to store water pursuant to the Agreement for Establishment and Maintenance of Minimum Recreation Pool of 30,000 acre feet in Isabella Reservoir by and between Buena Vista, North Kern, Tulare Lake, Hacienda, and the County of Kern dated November 8, 1963; and

5. <u>Allocation Agreement</u>. Any and all of Sellers' right to store water pursuant to the Allocation Agreement referred to in subparagraph A.1 above assigned to Miller & Lux, Inc. pursuant to the Assignment referred to in subparagraph A.1.a above and confirmed and ratified by the Agreement dated September 30, 1966, referred to in subparagraph A.1.b above; and

6. <u>Spreading Agreements</u>. Any and all of Sellers' rights under the Olcese-La Hacienda Agreement, referred to in subparagraph A.6 above, to store water in the Bakersfield Spreading Area pursuant to the Agreement No. 77-07 W.B. and Agreements No. 78-12 W.B. and 81-76 W.B.; and

C. <u>WATER EXCHANGE AGREEMENTS</u>. Any and all of Sellers' right, title and interest to, exchange water and entitlements arising as a result of contracts executed by Sellers for deliveries of water pursuant to various water exchange agreements for water originating in Kern County regardless of where delivered or regardless of whether the water for which it is exchanged originated in Kern County, including, but not limited to, the following:

1. <u>1962 Agreement; Water Exchange Rights</u>. Such rights and entitlements of Sellers as from time to time arise pursuant to the priority position of Sellers to substitute its Kern River water for Kern River water to be delivered by Buena Vista or North Kern to third parties, and to receive water being returned to such parties in payment of prior exchanges, to the extent Sellers have a credit balance of water to be delivered, as such priority is set forth in Paragraph 14 of the 1962 Agreement; and

2. <u>Right To Purchase Option Water</u>. The annual right of Nickel to purchase all Olcese water in the Bakersfield Spreading Area which is in excess of that needed by Olcese as determined by Sections 8 and 9 of the Olcese-La Hacienda Agreement referred to in subparagraph A.6 above ("Option Water"), on the terms and conditions set forth in Section 10 of the Olcese-La Hacienda Agreement; and

3. Hacienda Water Substitution Agreement. The right of Sellers to substitute Hacienda water for all or a portion of Buena Vista water in exchange for Buena Vista entitlement of State Aqueduct water pursuant to the Water Substitution Agreement dated November 14, 1972, by and between Buena Vista and Hacienda; and

4. Buena Vista-La Hacienda Water Exchange Agreement. The right of Nickel to exchange Option Water for the Kern River water of Buena Vista pursuant to Paragraph 3(f) of the Buena Vista-La Hacienda Agreement; and

5. California Aqueduct Water Exchange Agreement. The right of Sellers to receive California Aqueduct Water from the Kern County Water Agency Improvement District No. 4 (the "Agency") in return for amounts of Kern River water delivered by Sellers or their predecessors to the Agency, pursuant to the terms and conditions set forth in that certain Water Exchange Agreement dated April 17, 1982, by and between the Agency and Nickel; and

D. CONTRACT RIGHTS. Any and all Sellers' right, title and interest in any contract rights relating to the sale or exchange of water originating in Kern County, whether general intangibles or otherwise, including, but not limited to the following:

1. TLR-La Hacienda Agreement. The right of Sellers to the first opportunity to sell Kern River water to TLR for use on that real property commonly referred to as the "Hacienda Ranch" or within the Tulare Lake Basin area, as set forth in Section 2(h) of the Kern River Water and Storage Reservation Agreement referred to in subparagraph A.4 above, and the right of Sellers to payment from TLR as set forth in Section 2 thereof; and

E. TRANSPORTATION RIGHTS. Those certain miscellaneous rights of Sellers to utilize canals, ditches, or other water transportation methods or conveyances or delivery facilities, and pumping equipment such as is necessary to exercise the water conveyance, transportation, and delivery rights, storage rights, water rights, water exchange entitlements, contract rights or any other rights or entitlements Sellers may have now, including, but not limited to, the rights specified in the following agreements:

1. That certain Common Use Agreement Between Buena Vista Water Storage District and Hacienda Water District dated June 18, 1973; and

2. That certain Agreement of Sale referred to in subparagraph A.4 above, as more particularly set forth in Section 2(h) thereof, including the canal parallel to and one mile north of state Highway 46 as said canal is described therein; and

3. That certain 1964 Amendment to Miller-Haggin Agreement referred to in subparagraph A.1.a. above which provides for use of first-point conduit to transport second-point group water pursuant to Section 5 thereof; and

4. That certain Kern River Canal Extension Agreement dated October 14, 1964, by and between Buena Vista, Buena Vista Associates Incorporated, and Miller & Lux Incorporated as more particularly set forth in Section VI thereof; and

5. Any and all agreements that now exist with respect to or regarding the Johnson Ditch.

6. Certain Agreements. Any rights, to the extent owned by Sellers, under the following agreements:

   a. That certain Goose Lake Canal Agreement dated May 13, 1979 by and between Buena Vista as first party, and La Hacienda and Twin Farms, Inc., as second parties, recorded June 5, 1979, Kern County, Book 5203, Page 487; and

   b. That certain goose Lake Canal Allocation of Water and Operating Agreement dated May 13, 1979 by and between La Hacienda, and Nickel Enterprises and Twin Farms: and

   c. That certain Agreement for Joint Use of Burhans Canal System and Introduction of Nondistrict Water Into Burhans Ranch Area dated May 14, 1979, by and between Nickel Enterprises and Lost Hills Water District.

F. EXCLUSIONS. The following rights held by Sellers shall not be included within the definition of Lower River Water Rights:

1. Riparian Rights. Any rights not discussed above that are legally defined as riparian rights under California law; and

2. Groundwater. The right to pump groundwater that naturally occurs beneath land owned by Sellers; and

3. Public Agency Water. The right to obtain water from any Public Agency exclusively for use on land owned or leased by Sellers within that agency's service area.

RECORDING REQUESTED BY:
CHICAGO TITLE COMPANY

WHEN RECORDED MAIL TO
AND MAIL TAX STATEMENTS TO:

NAME **KERN COUNTY WATER AGENCY**
Attention: JOHN STOVALL
ADDRESS P.O. BOX 58

CITY BAKERSFIELD

STATE & ZIP CALIFORNIA 93302-0058

QUITCLAIM DEED

TITLE NO. **ESCROW. NO. 673298-MM** **APN:**

THE UNDERSIGNED GRANTOR(s) DECLARE(s)
DOCUMENTARY TRANSFER TAX is $ -0- (No Consideration) CITY TAX $__________________

- ☐ Computed on full value of property conveyed, or ☐ Computed on full value less value of liens or encumbrances remaining at time of sale,
- ☐ Unincorporated area: ☐ City of Bakersfield, and

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged, NICKEL FAMILY, LLC, a California limited liability company hereby remise, release and forever quitclaim to KERN COUNTY WATER AGENCY, a California public agency, receipt of which is its interest in the real property described in Exhibit B attached hereto and incorporated herein by this reference, together with all improvements thereon and all easements, rights of way, and other rights appurtenant thereto, subject, however, to the lien of non-delinquent real property taxes and assessments and covenants, conditions, restrictions easements, rights-of-way and servitudes of record in the County of Kern, State of California.

See Attached Exhibit B

Dated____________, 2001 ______________________________________

____

(ALL SIGNATURES MUST BE ACKNOWLEDGED)

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

STATE OF CALIFORNIA)
) ss.
COUNTY OF KERN)

On ____________________, before me, ______________________________,
Date — Name and Title of Officer (e.g. "Jane Doe, Notary Public")

personally appeared ______________________________,
Name of Signers

☐ personally known to me -- **OR** -- ☐ proved to me on the basis of satisfactory evidence to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same in their authorized capacities, and that by their signatures on the instrument the persons, or the entity upon behalf of which the persons acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary Public

OPTIONAL

Though the data below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent reattachment of this form.

CAPACITY(IES) CLAIMED BY SIGNER(S)

☐ Individual
☐ Corporate Officer

____
Titles

☐ Partner(s) ☐ Limited
☐ General
☐ Attorney-In-Fact
☐ Trustee(s)
☐ Guardian/Conservator
☐ Other: ______________

Signer is Representing:
Name of Persons or Entity(ies)

____

____

DESCRIPTION OF ATTACHED DOCUMENT

____
Title or Type of Document

____
Number of Pages

____
Date of Document

____
Signers Other Than Named Above

EXHIBIT B

TO QUITCLAIM DEED FROM NICKEL FAMILY, LLC TO KERN COUNTY WATER AGENCY

The real property transferred pursuant to this Quitclaim Deed consists of the undivided interests held by Grantor, NICKEL FAMILY, LLC in and to the real property described in EXHIBIT B-1 attached hereto.

EXHIBIT B-1

A. CASTRO DITCH WATER RIGHTS. Any and all of Nickel's right, title and interest now owned in the so-called Castro Right to divert water from the Kern River evidenced by various instruments, conveyances, contracts and agreements, including, but not limited to, the following:

1. That certain Indenture dated April 5, 1894, recorded April 6, 1894 Kern County, Book 54, Deeds, Pages 30 and 31, by which H.H. Fish, George Daggett, and H.A. Blodget conveyed an undivided 1/18th interest in the Castro Ditch and water right to James M. Keith; and

2. That certain Indenture dated April 5, 1894, recorded April 6, 1894, Kern County, Book 54, Deeds, Pages 32 and 33, by which H.H. Fish, George Daggett, and H.A. Blodget conveyed an undivided 1/9th interest in the Castro Ditch and water right to S.W. Wible; and

3. That certain Indenture dated May 20, 1896, recorded May 20, 1896, Kern County, Book 60, Deeds, Pages 640 and 641, by which Tomas Castro and Manual Castro conveyed an undivided 2/18ths part of the Castro Ditch and all the branches thereof and of the water and water rights appurtenant thereto to William S. Tevis; and

4. That certain Indenture dated May 20, 1896, recorded May 22, 1896 Kern County, Book 60, Deeds, Pages 644 and 645, by which W.L. Dixon and Florence G. Dixon, his wife, conveyed an undivided 2/18ths part of the Castro Ditch and all the branches thereof and of the water and water rights appurtenant thereto to William S. Tevis; and

5. That certain Agreement dated March 31, 1905, which provides for the right to appropriate and divert water from the Kern River at the head of Stine Canal Extension up to 20 cfs; and

6. That certain Corporation Quitclaim Deed dated February 4, 1982, recorded February 25, 1982, Kern County, Book 5440, Pages 2241-2242, by which Miller & Lux, Inc., remised, released and quitclaimed to La Hacienda, Inc., Assessors Parcel Number 700-980-24-00-8; and

7. That certain Corporation Quitclaim Deed recorded February 25, 1982, Kern County, Book 5440, Pages 2243-2244, by which Miller & Lux, Inc., remised, released and quitclaimed to La Hacienda, Inc., Assessors Parcel Number 700-980-25-00-1; and

8. That certain Quitclaim Deed dated November 25, 1986, by which La Hacienda, Inc., remised, released and quitclaimed to the City of Bakersfield the physical facilities of the Castro Ditch excepting all Kern River Rights appurtenant to eight shares of stock in the Castro Ditch; and

9. Any other or additional right, title or interest in or to the Castro Ditch and water right now owned by Nickel.

B. JOHNSON DITCH WATER RIGHTS. The so-called Johnson Right to divert water from the Kern River of which Nickel owns a part as a result of various instruments, conveyances, contracts, and agreements, including, but not limited to, the following:

1. That certain Corporation Quitclaim Deed dated February 4, 1982, recorded February 25, 1982, Kern County, Book 5440, Pages 2245-2246, by which Miller & Lux, Inc., remised, released and quitclaimed to La Hacienda, Inc., Assessors Parcel Number 700-980-26-00-4; and

2. Any other or additional right, title or interest in or to the Johnson Ditch and water right now owned by Nickel.

RECORDING REQUESTED BY:
CHICAGO TITLE COMPANY

WHEN RECORDED MAIL TO
AND MAIL TAX STATEMENTS TO:

NAME **OLCESE WATER DISTRICT**
Attention: Board of Directors
ADDRESS P.O. BOX 651

CITY BAKERSFIELD

STATE & ZIP CALIFORNIA 93302

QUITCLAIM DEED

TITLE NO. **ESCROW. NO. 673298-MM** **APN:**

THE UNDERSIGNED GRANTOR(s) DECLARE(s)
DOCUMENTARY TRANSFER TAX is $ -0- (No Consideration) CITY TAX $____________________
☐ Computed on full value of property conveyed, or ☐ Computed on full value less value of liens or encumbrances remaining at time of sale,
☐ Unincorporated area: ☐ City of Bakersfield, and

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged, KERN COUNTY WATER AGENCY, a California public agency, hereby remise, release and forever quitclaim to OLCESE WATER DISTRICT, a California public agency, receipt of which is its interest in the real property described in Exhibit C attached hereto and incorporated herein by this reference, together with all improvements thereon and all easements, rights of way, and other rights appurtenant thereto, subject, however, to the lien of non-delinquent real property taxes and assessments and covenants, conditions, restrictions easements, rights-of-way and servitudes of record in the County of Kern, State of California.

See Attached Exhibit C

Dated____________________, 2001 ____________________________________

____

(ALL SIGNATURES MUST BE ACKNOWLEDGED)

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

STATE OF CALIFORNIA)
) ss.
COUNTY OF KERN)

On ____________________, before me, ____,
Date — Name and Title of Officer (e.g. "Jane Doe, Notary Public")

personally appeared ____,
Name of Signers

☐ personally known to me – **OR** – ☐ proved to me on the basis of satisfactory evidence to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same in their authorized capacities, and that by their signatures on the instrument the persons, or the entity upon behalf of which the persons acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary Public

OPTIONAL

Though the data below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent reattachment of this form.

CAPACITY(IES) CLAIMED BY SIGNER(S)

☐ Individual
☐ Corporate Officer

____
Titles

☐ Partner(s) ☐ Limited
☐ General
☐ Attorney-In-Fact
☐ Trustee(s)
☐ Guardian/Conservator
☐ Other: ____________________

Signer is Representing:
Name of Persons or Entity(ies)

____

____

DESCRIPTION OF ATTACHED DOCUMENT

____
Title or Type of Document

____
Number of Pages

____
Date of Document

____
Signers Other Than Named Above

EXHIBIT C

TO QUITCLAIM DEED FROM KERN COUNTY WATER AGENCY TO OLCESE WATER DISTRICT

The real property transferred pursuant to this Quitclaim Deed consists of the undivided interests held by Grantor, KERN COUNTY WATER AGENCY in and to the real property described in EXHIBIT C-1 attached hereto.

EXHIBIT C-1

A. CARMEL WATER RIGHT. The so-called Carmel Water right to 3.956% of Kern River water allocated to the Miller-Haggin First Parties of which Nickel's predecessors in interest owned a part as a result of various instruments, conveyances, contracts, and agreements as follows:

1. That certain Agreement dated October 24, 1945, between Buena Vista Water Storage District as first party, and C.E. Houchin and George L. Bradford, co-partners doing business as Carmel Cattle Company, as second party, recorded December 1, 1945, Kern County, Book 1290, Page 176, by which the second party reserved said Carmel Water Right; and

2. That certain Deed dated February 23, 1956, in which Kathryn Houchin, Francis L. Houchin, and Anna Lumis, as executors of the estate of C.E. Houchin, deceased, conveyed to Miller & Lux, Inc. said Carmel Water Right; and

3. That certain Deed dated February 24, 1956, recorded February 1956, Kern County, Book 2567, Page 0527, document no. 11922, in which Miller & Lux, Inc. conveyed to C. Ray Robinson and Pauline Robinson, husband and wife, an undivided 15% of said Carmel Water Right; and

4. That certain Quitclaim Deed Agreement dated August 31, 1973, recorded September 24, 1973, Kern County, Book 4805(?), Page 812(?) by which C. Ray Robinson, as grantor and as successor in interest to Pauline Robinson in said Deed to Mr. & Mrs. Robinson, thereafter transferred all his then remaining 12.75% undivided interest in and right to either water or income in said Carmel Water Right to George Nickel; and

5. That certain Agreement by and between Nickel doing business as Kern River Delta Farms, and Olcese Water District, dated February 27, 1976, to which said 12.75% undivided interest of George Nickel in said Carmel Water Right is subject, pursuant to Sections 1 and 5 thereof.

RECORDING REQUESTED BY:
CHICAGO TITLE COMPANY

WHEN RECORDED MAIL TO
AND MAIL TAX STATEMENTS TO:

NAME **NICKEL FAMILY, LLC**
Attention: James Nickel, President
ADDRESS P.O. BOX 60679

CITY BAKERSFIELD

STATE & ZIP CALIFORNIA 93386-0679

QUITCLAIM DEED

TITLE NO. **ESCROW. NO. 673298-MM** **APN:**

THE UNDERSIGNED GRANTOR(s) DECLARE(s)
DOCUMENTARY TRANSFER TAX is $ -0- (No Consideration) CITY TAX $________________
☐ Computed on full value of property conveyed, or ☐ Computed on full value less value of liens or encumbrances remaining at time of sale,
☐ Unincorporated area: ☐ City of Bakersfield, and

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged, KERN COUNTY WATER AGENCY, a California public agency, hereby remise, release and forever quitclaim to NICKEL FAMILY, LLC, a California limited liability company, receipt of which is its interest in the real property described in Exhibit E attached hereto and incorporated herein by this reference, together with all improvements thereon and all easements, rights of way, and other rights appurtenant thereto, subject, however, to the lien of non-delinquent real property taxes and assessments and covenants, conditions, restrictions easements, rights-of-way and servitudes of record in the County of Kern, State of California.

See Attached Exhibit E

Dated____________________, 2001 ______________________________

____

(ALL SIGNATURES MUST BE ACKNOWLEDGED)

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

STATE OF CALIFORNIA)
) ss.
COUNTY OF)

On ____________________ , before me, ____ ,
Date — Name and Title of Officer (e.g. "Jane Doe, Notary Public")

personally appeared ____ ,
Name of Signers

☐ personally known to me – **OR** – ☐ proved to me on the basis of satisfactory evidence to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same in their authorized capacities, and that by their signatures on the instrument the persons, or the entity upon behalf of which the persons acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary Public

OPTIONAL

Though the data below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent reattachment of this form.

CAPACITY(IES) CLAIMED BY SIGNER(S)

☐ Individual
☐ Corporate Officer

____
Titles

☐ Partner(s) ☐ Limited
☐ General
☐ Attorney-In-Fact
☐ Trustee(s)
☐ Guardian/Conservator
☐ Other: ______________________

Signer is Representing:
Name of Persons or Entity(ies)

____

____

DESCRIPTION OF ATTACHED DOCUMENT

____
Title or Type of Document

____
Number of Pages

____
Date of Document

____
Signers Other Than Named Above

Exhibit D

Power Charge = $/KWH X Avg. KWH/AF X 10,000 AF

1. $/KWH is calculated by using the PG&E, AG 5b rate or future equivalent determined prior to May 1 of each year. Currently AG 5b includes demand charges and electric energy charges for on peak, off peak, and partial peak and California Energy Commision taxes. The 10,000 af is assumed to be pumped at a rate of 1,000 AF per month from March 1 to December 31. The average daily rate is 33 AF. Pumping is assumed to occur throughout the entire 24 hour period for each day of the month.

2. The following table will be used to determine the KWH/AF. Average Depth to Groundwater is a value calculated from the measurements of wells in the Pioneer Project during the spring of each year. This data is compiled for the Kern Fan Monitoring Committee.

Spring Average Depth to Groundwater on the Pioneer Project[1]	Average KWH/AF
10	194
20	211
30	229
40	246
50	264
60	281
70	299
80	317
90	334
100	352
110	369
120	387
130	405
140	422
150	440
160	457
170	475
180	493
190	510
200	528
210	545
220	563
230	581
240	598
250	616
260	633
270	651
280	668
290	686
300	704

Example: If groundwater levels are 102 feet.

$224,005 = $0.0631/KWH X 355 KWH/AF X 10,000 AF

---

[1] If average depth to groundwater drops below 300 feet the KWH/AF will be recalculated.

Summary of Power Costs
Nickel 10,000 AF
2001

Month	AF	KWH	Amount	$/KWH
March	1,000	355,000	$16,972.54	0.05
April	1,000	355,000	16,913.30	0.05
May	1,000	355,000	26,145.30	0.07
June	1,000	355,000	25,853.10	0.07
July	1,000	355,000	26,145.30	0.07
August	1,000	355,000	26,145.30	0.07
September	1,000	355,000	25,853.10	0.07
October	1,000	355,000	26,145.30	0.07
November	1,000	355,000	16,913.30	0.05
December	1,000	355,000	16,972.54	0.05
Total	10,000	3,550,000	$224,059.08	

Average $/KWH........................ $0.06

KERN COUNTY WATER AGENCY

POWER BILLING CALCULATION

LOCATION:	Nickel 10,000 AF	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	B
FACILITY:	Pioneer Project	*MONTH of* Mar 2001		*CODE*	3

		Usage	*Rate*	*TOTAL $*
USTOMER CHARGE:				0.00
ETER CHARGE:				0.00
EMAND CHARGES PER (KW) :		*KW*	*$/KW*	
	per KW of maximum-peak-period demand	564	0.00	0.00
(From PG&E)	per KW of maximum-part-peak-period demand	0	0.00	0.00
	per KW of off-peak-period seasonal billing demand			
	(3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	4.40	2,442.00

LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
otal KWH			355,000			
Base Energy Charges:						
	On Peak	0.0%	0	0.00000	0.00	
(From PG&E)	Partial Peak	38.4%	136,465	0.04661	6,360.63	
	Off Peak	61.6%	218,535	0.03706	8,098.91	
OTAL ELECTRIC ENERGY CHARGES:						14,459.54
					Sub Total	$16,901.54

AXES	*KWH*	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$16,972.54

TOTAL NET BILLING **$16,972.54**

KERN COUNTY WATER AGENCY

POWER BILLING CALCULATION

LOCATION:	Nickel 10,000 AF	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	B
FACILITY:	Pioneer Project	*MONTH of*	Apr 2001	*CODE*	4

		Usage	*Rate*	*TOTAL $*
USTOMER CHARGE:				0.00
ETER CHARGE:				0.00
EMAND CHARGES PER (KW) :		*KW*	*$/KW*	
	per KW of maximum-peak-period demand	564	0.00	0.00
·rom PG&E)	per KW of maximum-part-peak-period demand	0	0.00	0.00
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	4.40	2,442.00

LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
›tal KWH			355,000			
3ase Energy Charges:						
	On Peak	0.0%	0	0.00000	0.00	
·rom PG&E)	Partial Peak	36.7%	130,262	0.04661	6,071.51	
	Off Peak	63.3%	224,738	0.03706	8,328.79	
OTAL ELECTRIC ENERGY CHARGES:						14,400.30
					Sub Total	$16,842.30

'AXES	*KWH*	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$16,913.30

TOTAL NET BILLING **$16,913.30**

KERN COUNTY WATER AGENCY
POWER BILLING CALCULATION

LOCATION:	**Nickel 10,000 AF**	*PG&E SCHEDULE No.*	**AG-5B**	*PERIOD*	**A**
FACILITY:	**Pioneer Project**	*MONTH of* **May 2001**		*CODE*	**5**

		Usage	*Rate*	*TOTAL $*
JSTOMER CHARGE:				**0.00**
ETER CHARGE:				**0.00**
EMAND CHARGES PER (KW) :		*KW*	*$/KW*	
	per KW of maximum-peak-period demand	564	0.00	**0.00**
rom PG&E)	per KW of maximum-part-peak-period demand	555	2.70	**1,498.50**
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	6.55	**3,635.25**

LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
otal KWH			**355,000**			
3ase Energy Charges:						
	On Peak	17.7%	62,984	0.14294	9,002.93	
From PG&E)	Partial Peak	0.0%	0	0.00000	0.00	
	Off Peak	82.3%	292,016	0.04088	11,937.61	
OTAL ELECTRIC ENERGY CHARGES:						**20,940.55**
					Sub Total	**$26,074.30**

	KWH	*$/KWH*	
AXES			
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$26,145.30

TOTAL NET BILLING **$26,145.30**

KERN COUNTY WATER AGENCY

POWER BILLING CALCULATION

LOCATION: **Nickel 10,000 AF** *PG&E SCHEDULE No.* AG-5B *PERIOD* **A**

FACILITY: **Pioneer Project** *MONTH of* **Jun 2001** *CODE* **6**

		Usage	*Rate*		*TOTAL $*
CUSTOMER CHARGE:					0.00
METER CHARGE:					0.00
DEMAND CHARGES PER (KW) :		*KW*	*$/KW*		
	per KW of maximum-peak-period demand	564	0.00		0.00
(From PG&E)	per KW of maximum-part-peak-period demand	555	2.70		1,498.50
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	6.55		3,635.25

ELECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
Total KWH			355,000			
Base Energy Charges:						
	On Peak	16.9%	60,121	0.14294	8,593.70	
(From PG&E)	Partial Peak	0.0%	0	0.00000	0.00	
	Off Peak	83.1%	294,879	0.04088	12,054.65	
TOTAL ELECTRIC ENERGY CHARGES:						20,648.35
					Sub Total	$25,782.10

TAXES	*KWH*	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$25,853.10

TOTAL NET BILLING **$25,853.10**

KERN COUNTY WATER AGENCY
POWER BILLING CALCULATION

LOCATION:	Nickel 10,000 AF	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	A
FACILITY:	Pioneer Project	*MONTH of*	Jul 2001	*CODE*	7

		Usage	*Rate*	*TOTAL $*
USTOMER CHARGE:				0.00
ETER CHARGE:				0.00
EMAND CHARGES PER (KW) :		*KW*	*$/KW*	
	per KW of maximum-peak-period demand	564	0.00	0.00
(From PG&E)	per KW of maximum-part-peak-period demand	555	2.70	1,498.50
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	6.55	3,635.25

LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*
otal KWH			355,000		
Base Energy Charges:					
	On Peak	17.7%	62,984	0.14294	9,002.93
(From PG&E)	Partial Peak	0.0%	0	0.00000	0.00
	Off Peak	82.3%	292,016	0.04088	11,937.61

OTAL ELECTRIC ENERGY CHARGES: 20,940.55

Sub Total $26,074.30

AXES	*KWH*	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$26,145.30

TOTAL NET BILLING **$26,145.30**

KERN COUNTY WATER AGENCY
POWER BILLING CALCULATION

LOCATION:	Nickel 10,000 AF	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	A
FACILITY:	Pioneer Project	*MONTH of*	Aug 2001	*CODE*	8

		Usage	*Rate*		*TOTAL $*
CUSTOMER CHARGE:					0.00
METER CHARGE:					0.00
DEMAND CHARGES PER (KW) :		*KW*	*$/KW*		
	per KW of maximum-peak-period demand	564	0.00		0.00
(From PG&E)	per KW of maximum-part-peak-period demand	555	2.70		1,498.50
	per KW of off-peak-period seasonal billing demand				
	(3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	6.55		3,635.25

ELECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
Total KWH			355,000			
Base Energy Charges:						
	On Peak	17.7%	62,984	0.14294	9,002.93	
(From PG&E)	Partial Peak	0.0%	0	0.00000	0.00	
	Off Peak	82.3%	292,016	0.04088	11,937.61	
TOTAL ELECTRIC ENERGY CHARGES:						20,940.55
					Sub Total	$26,074.30

TAXES

	KWH	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$26,145.30

TOTAL NET BILLING **$26,145.30**

KERN COUNTY WATER AGENCY
POWER BILLING CALCULATION

LOCATION:	Nickel 10,000 AF	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	A
FACILITY:	Pioneer Project	*MONTH of*	Sep 2001	*CODE*	9

		Usage	*Rate*		*TOTAL $*
USTOMER CHARGE:					**0.00**
ETER CHARGE:					**0.00**
EMAND CHARGES PER (KW) :		*KW*	*$/KW*		
	per KW of maximum-peak-period demand	564	0.00		**0.00**
rom PG&E)	per KW of maximum-part-peak-period demand	555	2.70		**1,498.50**
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	6.55		**3,635.25**

LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
otal KWH			**355,000**			
Base Energy Charges:						
	On Peak	16.9%	60,121	0.14294	8,593.70	
From PG&E)	Partial Peak	0.0%	0	0.00000	0.00	
	Off Peak	83.1%	294,879	0.04088	12,054.65	
OTAL ELECTRIC ENERGY CHARGES:						**20,648.35**
					Sub Total	**$25,782.10**

	KWH	*$/KWH*	
AXES			
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$25,853.10

TOTAL NET BILLING **$25,853.10**

KERN COUNTY WATER AGENCY
POWER BILLING CALCULATION

LOCATION:	**Nickel 10,000 AF**	*PG&E SCHEDULE No.*	**AG-5B**	*PERIOD*	**A**
FACILITY:	**Pioneer Project**	*MONTH of*	**Oct 2001**	*CODE*	**10**

		Usage	*Rate*		*TOTAL $*
USTOMER CHARGE:					**0.00**
ETER CHARGE:					**0.00**
EMAND CHARGES PER (KW) :		*KW*	*$/KW*		
	per KW of maximum-peak-period demand	564	0.00		**0.00**
From PG&E)	per KW of maximum-part-peak-period demand	555	2.70		**1,498.50**
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	6.55		**3,635.25**

LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
otal KWH			**355,000**			
Base Energy Charges:						
	On Peak	17.7%	62,984	0.14294	9,002.93	
(From PG&E)	Partial Peak	0.0%	0	0.00000	0.00	
	Off Peak	82.3%	292,016	0.04088	11,937.61	
OTAL ELECTRIC ENERGY CHARGES:						**20,940.55**
					Sub Total	**$26,074.30**

AXES	*KWH*	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$26,145.30

TOTAL NET BILLING **$26,145.30**

KERN COUNTY WATER AGENCY
POWER BILLING CALCULATION

LOCATION:	**Nickel 10,000 AF**	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	B
FACILITY:	**Pioneer Project**	*MONTH of*	**Nov 2001**	*CODE*	**11**

			Usage	*Rate*		*TOTAL $*
USTOMER CHARGE:						**0.00**
ETER CHARGE:						**0.00**
EMAND CHARGES PER (KW) :			*KW*	*$/KW*		
	per KW of maximum-peak-period demand		564	0.00		**0.00**
(From PG&E)	per KW of maximum-part-peak-period demand		0	0.00		**0.00**
	per KW of off-peak-period seasonal billing demand (3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K		555	4.40		**2,442.00**
LECTRIC ENERGY CHARGES:						
		Multiplier	*KWH*	*$/KWH*	*Amount $*	
otal KWH			**355,000**			
Base Energy Charges:						
	On Peak	0.0%	0	0.00000	0.00	
(From PG&E)	Partial Peak	36.7%	130,262	0.04661	6,071.51	
	Off Peak	63.3%	224,738	0.03706	8,328.79	
OTAL ELECTRIC ENERGY CHARGES:						**14,400.30**
					Sub Total	**$16,842.30**
AXES			*KWH*	*$/KWH*		
California Energy Commission			355,000	0.00020		71.00
			TOTAL BILLING			$16,913.30
			TOTAL NET BILLING			**$16,913.30**

KERN

POWER BILLING CALCULATION

LOCATION:	Nickel 10,000 AF	*PG&E SCHEDULE No.*	AG-5B	*PERIOD*	B
FACILITY:	Pioneer Project	*MONTH of*	Dec 2001	*CODE*	12

		Usage	*Rate*	*TOTAL $*
JSTOMER CHARGE:				0.00
ETER CHARGE:				0.00
EMAND CHARGES PER (KW) :		*KW*	*$/KW*	
	per KW of maximum-peak-period demand	564	0.00	0.00
⁼rom PG&E)	per KW of maximum-part-peak-period demand	0	0.00	0.00
	per KW of off-peak-period seasonal billing demand			
	(3 wells - 250 HP @ .74 KW/hp = maximum demand of 555 K	555	4.40	2,442.00

:LECTRIC ENERGY CHARGES:

		Multiplier	*KWH*	*$/KWH*	*Amount $*	
·otal KWH			355,000			
Base Energy Charges:						
	On Peak	0.0%	0	0.00000	0.00	
(From PG&E)	Partial Peak	38.4%	136,465	0.04661	6,360.63	
	Off Peak	61.6%	218,535	0.03706	8,098.91	
ΓOTAL ELECTRIC ENERGY CHARGES:						14,459.54
					Sub Total	$16,901.54

ΓAXES

	KWH	*$/KWH*	
California Energy Commission	355,000	0.00020	71.00
	TOTAL BILLING		$16,972.54

TOTAL NET BILLING **$16,972.54**

EXHIBIT E

TO QUITCLAIM DEED FROM KERN COUNTY WATER AGENCY TO NICKEL FAMILY, LLC

The real property transferred pursuant to this Quitclaim Deed consists of the undivided interests held by Grantor, KERN COUNTY WATER AGENCY in and to the real property described in EXHIBIT E-1 attached hereto.

EXHIBIT E-1

A. WATER INVENTORIES:

1. The Buena Vista Water Storage District forty thousand (40,000) acre-foot inventory;

2. The North Kern Water Storage District five thousand eight hundred eighty-two (5,882) acre-foot inventory;

3. The Preconsolidation fourteen thousand one hundred seventy (14,170) acre-foot inventory;

4. The five thousand (5,000) acre-foot payback water from Kern County Water Agency Improvement District No. 4.

RECORDING REQUESTED BY:
CHICAGO TITLE COMPANY

WHEN RECORDED MAIL TO
AND MAIL TAX STATEMENTS TO:

NAME **NICKEL FAMILY, LLC**
Attention: James Nickel, President
ADDRESS P.O. BOX 60679

CITY BAKERSFIELD

STATE & ZIP CALIFORNIA 93386-0679

QUITCLAIM DEED

TITLE NO. **ESCROW. NO. 673298-MM** **APN:**

THE UNDERSIGNED GRANTOR(s) DECLARE(s)
DOCUMENTARY TRANSFER TAX is $ **-0-** (No Consideration) CITY TAX $__________________
☐ Computed on full value of property conveyed, or ☐ Computed on full value less value of liens or encumbrances remaining at time of sale,
☐ Unincorporated area: ☐ City of Bakersfield, and

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged, KERN COUNTY WATER AGENCY, a California public agency, hereby remise, release and forever quitclaim to NICKEL FAMILY, LLC, a California limited liability company, receipt of which is its interest in the real property described in Exhibit G attached hereto and incorporated herein by this reference, together with all improvements thereon and all easements, rights of way, and other rights appurtenant thereto, subject, however, to the lien of non-delinquent real property taxes and assessments and covenants, conditions, restrictions easements, rights-of-way and servitudes of record in the County of Kern, State of California.

See Attached Exhibit G

Dated__________________, 2001 ______________________________

____

(ALL SIGNATURES MUST BE ACKNOWLEDGED)

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

STATE OF CALIFORNIA)
) ss.
COUNTY OF KERN)

On ______________________, before me, ______________________________________,
Date Name and Title of Officer (e.g. "Jane Doe, Notary Public")

personally appeared ____,
Name of Signers

☐ personally known to me – **OR** – ☐ proved to me on the basis of satisfactory evidence to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same in their authorized capacities, and that by their signatures on the instrument the persons, or the entity upon behalf of which the persons acted, executed the instrument.

WITNESS my hand and official seal.

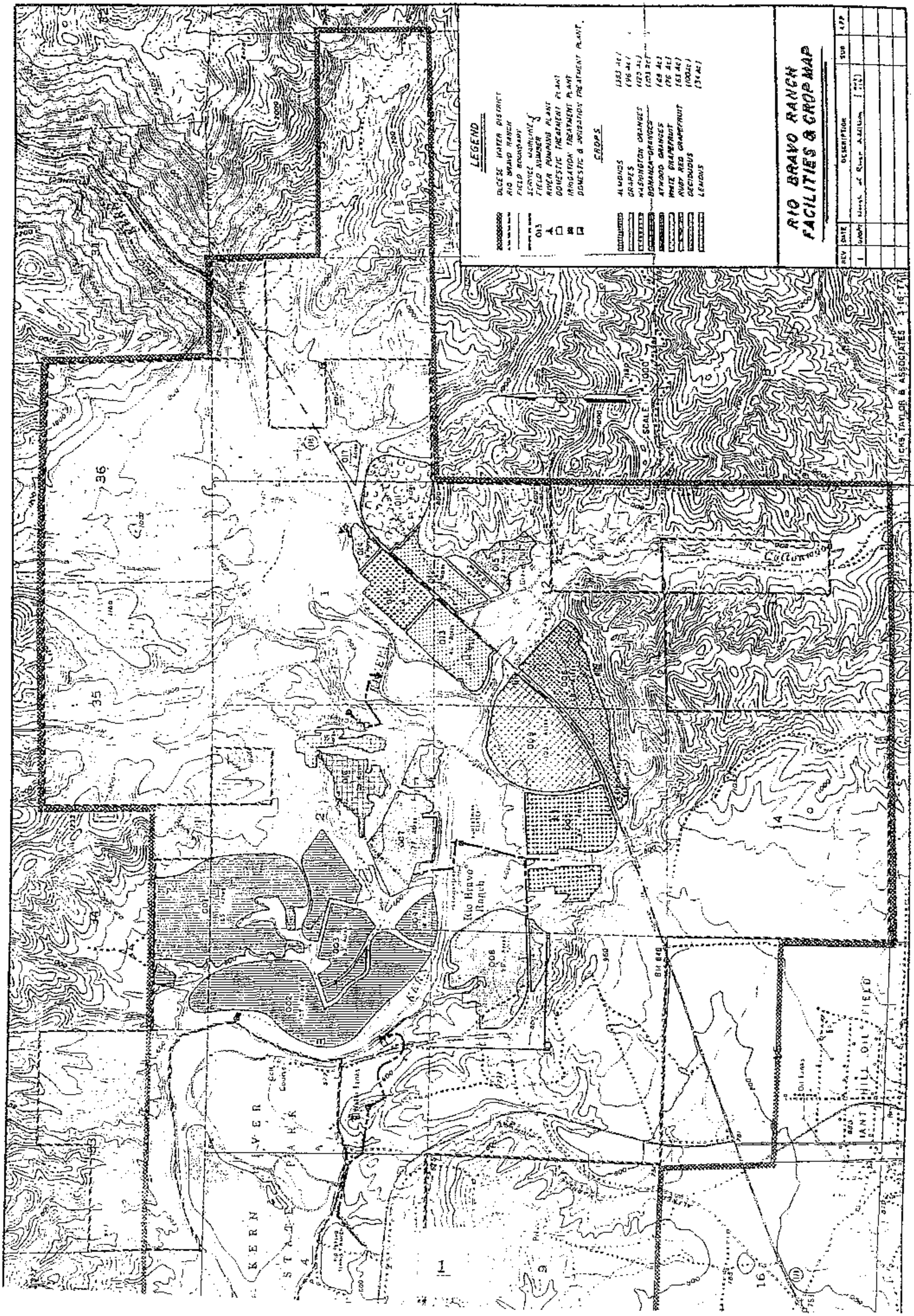
____
Signature of Notary Public

OPTIONAL

Though the data below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent reattachment of this form.

CAPACITY(IES) CLAIMED BY SIGNER(S)	DESCRIPTION OF ATTACHED DOCUMENT
☐ Individual ☐ Corporate Officer	
______________________ Titles	______________________ Title or Type of Document
☐ Partner(s) ☐ Limited ☐ General	
☐ Attorney-In-Fact	______________________ Number of Pages
☐ Trustee(s) ☐ Guardian/Conservator ☐ Other: ______________	______________________ Date of Document
Signer is Representing: Name of Persons or Entity(ies) ______________________ ______________________	______________________ Signers Other Than Named Above

Exhibit F - Map of Rio Bravo Ranch



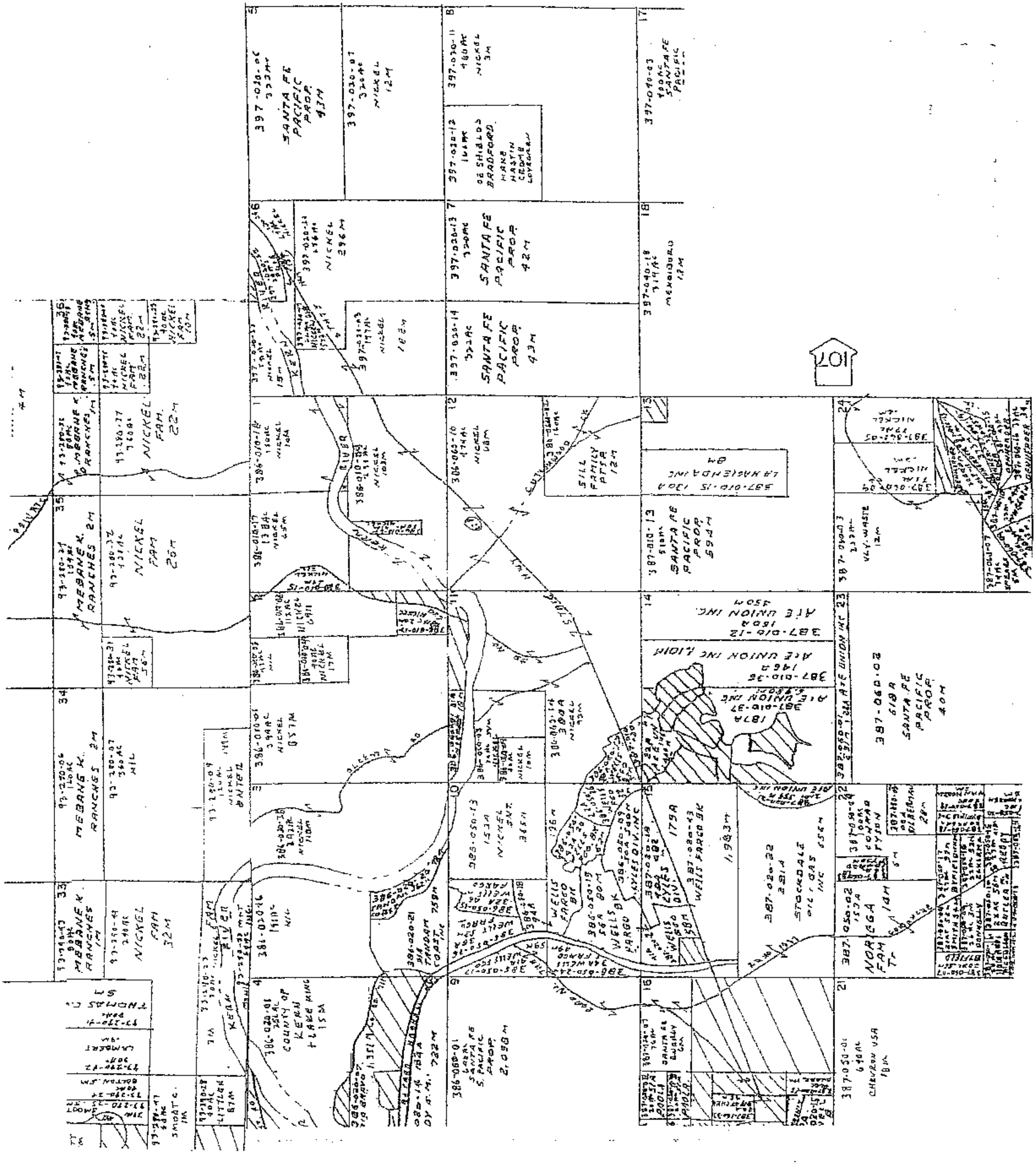

397-030-06 332Ac SANTA FE PACIFIC PROP. 43M
397-030-07 320Ac NICKEL 12M
397-030-11 480Ac NICKEL 3M
397-030-13 160Ac
397-040-03 480Ac SANTA FE PACIFIC
397-020-13 320Ac SANTA FE PACIFIC PROP 42M
397-020-14 321Ac SANTA FE PACIFIC PROP 43M
397-040-18 319Ac
101
NICKEL
KERN RIVER
MEBANE K. RANCHES
NICKEL FAM
SILL FAMILY
LA HASIENDA INC
387-010-13 518Ac SANTA FE PACIFIC PROP. 59.4M
ATE UNION INC
387-060-02 618A SANTA FE PACIFIC PROP. 40M
WELLS FARGO BK
387-020-22 STOCKDALE OIL GAS INC
NORIEGA FAM TR
386-020-10 COUNTY OF KERN + LAKE KING 15M
386-060-01 SANTA FE S. PACIFIC PROP. 2,058M
387-050-01 640Ac CHEVRON USA 18M

EXHIBIT G

TO QUITCLAIM DEED FROM KERN COUNTY WATER AGENCY TO NICKEL FAMILY, LLC

The real property transferred pursuant to this Quitclaim Deed consists of the undivided interests held by Grantor, KERN COUNTY WATER AGENCY in and to the real property described in EXHIBIT G-1 attached hereto.

EXHIBIT G-1

On or about September 1, 2000, Garces Water Company, Inc., a California corporation, hereinafter referred to as "Garces" granted to the Kern County Water Agency, a California public agency, hereinafter referred to as the "Agency", various property rights described in the Grant Deed from Garces to the Agency, which is attached hereto and incorporated herein by reference. This Grant Deed was recorded in the Official Records of Kern County on September 8, 2000, as document No. 0200112678 consisting of 24 pages , and is hereinafter referred to as the "Garces Grant Deed". For valuable consideration, receipt of which is hereby acknowledged, the Agency hereby quitclaims to Nickel Family LLC, a California limited liability company, hereinafter referred to as "Nickel LLC", the following described portions of the property and rights the Agency received from Garces in the Garces Grant Deed; it being the intent of the Agency in this Quit Claim Deed to transfer to Nickel LLC only such property and rights described herein as it received from Garces in the Garces Grant Deed and not to transfer to Nickel LLC any other property or rights that the Agency may now or hereafter own . All references hereinafter to Exhibit WTA-1 refer to that exhibit in the attached Garces Grant Deed.

The following Particular Water Rights referred to in Part I of Exhibit WTA-1:

1. Pre-consolidation Return Water. The Agency's right, title and interest in the Pre-Consolidation Return Water described in Item B of Part I of Exhibit WTA-1, which the Agency received from Garces in the Garces Grant Deed.

2. Right to Use Olcese Water. The Agency's right, title and interest in those portions of the right to use Olcese water described in Item C-3 of Part I of Exhibit WTA-1, which the Agency received from Garces in the Garces Grant Deed.

3. Water Rights Arising From Previously Riparian Rights. The Agency's right, title and interest in any riparian water rights appurtenant to the Rio Bravo Ranch in Kern County, described in Item D of Part I of Exhibit WTA-1, which the Agency received from Garces in the Garces Grant Deed.

4. Storage Rights. The Agency's right, title and interest to any storage rights which the Agency received from Garces in the Garces Grant Deed, which may be hereinafter acquired by Nickel LLC.

5. Storage Rights in Buena Vista Water Storage District. The Agency's right, title and interest in the storage rights in Buena Vista Water Storage District described in Item E-7 of Part I of Exhibit WTA-1, which the Agency received from Garces in the Garces Grant Deed.

6. Buena Vista-La Hacienda Water Exchange Agreement. The Agency's right, title and interest in the Buena Vista-La Hacienda Water Exchange Agreement described in Item F-4 of Part I of Exhibit WTA-1, which the Agency received from Garces in the Garces Grant Deed.

7. General Water Exchange Rights. All the Agency's right, title and interest in all water exchange rights and entitlements which may accrue to Nickel LLC in any future contracts and agreements entered into by Nickel LLC, which the Agency received from Garces in the Garces Grant Deed.

15. Hydro Assets. All of the Agency's right, title and interest in any licenses, guarantees, bills of sale, securities, confidential information and other proceeds and products described in Exhibit HTA-1 of the Garces Grant Deed, that may be hereinafter acquired by Nickel LLC in any hydroelectric projects other than the Rio Bravo Hydroelectric Project described in Exhibit HTA-1 of the Garces Grant Deed, which were conveyed to the Agency by Garces in the Garces Grant Deed.

KERN COUNTY WATER AGENCY
A California Public Agency

By: ______________________________
Chairman, Board of Directors

OPTION AND WATER PURCHASE AGREEMENT

THIS AGREEMENT is made and effective as of October __, 2002 (the "Effective Date") by and between Nickel Family, LLC, a California limited liability company ("Nickel") and The Newhall Land and Farming Company, a California limited partnership ("Newhall") with reference to the following facts:

A. Nickel previously held rights to water from the Kern River. Nickel conveyed those rights to the Kern County Water Agency ("KCWA") in exchange for certain other water (the "Exchange Water") to be made available by KCWA for the benefit of Nickel pursuant to the terms of that certain Contract to Transfer the Kern River Lower River Water Rights between Nickel, the Olcese Water District and the KCWA dated January 23, 2001 (the "KCWA Agreement"). A copy of the KCWA Agreement is attached hereto as Exhibit A and incorporated herein by this reference. Pursuant to the terms of KCWA Agreement, Nickel has the right to transfer and sell the use of the Exchange Water to third parties.

B. Newhall wishes to acquire an option to purchase the use of 1,607 acre feet of the Exchange Water (the "Acquired Water") for the exclusive use by Newhall as described herein, each year, for an initial period of 35 years (the "Transfer Term"). Nickel is willing to grant such an option under the terms and conditions set forth in this Agreement.

THEREFORE, the parties hereby agree as follows:

1. <u>Grant of Option</u>. Subject to the terms and conditions set forth in this Agreement, Nickel hereby grants to Newhall an option (the "Option") to purchase and acquire the exclusive right to the use of the Acquired Water each year during the Transfer Term. The term of the Option shall be one year from the date of this Agreement (the "Initial Option Term"); provided, that Newhall may elect to extend the term of the Option for six additional calendar months (the "Extended Option Term") by giving written notice of extension to Nickel in the manner set forth in Section 18 and paying the Second Option Consideration Payment (as defined below) not less than five days prior to the expiration of the Initial Option Term. If the Option is not extended for the Extended Option Term, the Option will expire one year from the Effective Date. If the Option is extended for the Extended Option Term, the Option will expire 18 calendar months from the Effective Date.

2. <u>Option Consideration</u>. As consideration for the grant of the Option, Newhall shall pay $150,000 to Nickel as a First Option Consideration Payment within five days after the Effective Date. If Newhall elects to extend the Option for the Extended Option Term as provided in Section 1 of this Agreement, Newhall shall pay to Nickel a Second Option Consideration Payment of $100,000. Neither the First Option Consideration Payment nor the Second Option Consideration Payment shall be applied as a credit against the Purchase Price, as defined below. Other than as set forth in this Agreement, the First Option Consideration Payment and the Second Option Consideration Payment shall be non-refundable to Newhall.

3. <u>Exercise of Option</u>. Newhall may exercise the Option by giving written notice (the "Option Notice") to Nickel at any time prior to the expiration of the Option. Once the Option has been exercised, Newhall shall be obligated to purchase, and Nickel shall be obligated to sell, the use of the Acquired Water each year of the entire Transfer Term in accordance with the terms of this Agreement. If the Option Notice is delivered on or before September 1, 2003, the Transfer Term shall commence on January 1, 2004. If the Option Notice is delivered after September 1, 2003, the Transfer Term shall commence on January 1, 2005. The first year of the Transfer Term shall be referred to herein as the "First Water Year."

4. <u>Purchase Price; Payment of Purchase Price</u>. If Newhall exercises the Option, the annual purchase price (the "Purchase Price") for the use of the Acquired Water shall be $763,245 if the First Water Year is 2004; provided that the annual Purchase Price shall be increased on each January 1, commencing on January 1, 2005, by multiplying the Purchase Price in effect on the previous January 1 by 1.0325. The annual Purchase Price shall be paid on or before January 15 of each year during the Transfer Term.

5. Right to Extend Transfer Term. Provided that Newhall is not then in default under the terms of this Agreement, Newhall shall have the right to extend the Transfer Term for an additional 35 years by providing Nickel with written notice of Newhall's election to extend the Transfer Term pursuant to this Section 5 at least 90 days prior to the expiration of the initial Transfer Term. The terms and conditions of this Agreement including, without limitation, the amount of the Purchase Price shall apply to the extended Transfer Term, and all references in this Agreement to the Transfer Term shall include the Transfer Term as extended pursuant to this Section 5.

6. Reversion of Acquired Water to Nickel. The use of the Acquired Water shall revert to Nickel at the end of the Transfer Term, including any valid extension thereof, or upon termination of this Agreement.

7. Delivery Schedule; Point of Delivery.

(a) The Acquired Water shall be made available to Newhall at Tupman, free and clear of all liens, encumbrances, or rights of any other party, at the same time and in the same manner as KCWA schedules deliveries of State Water Project Entitlement Water to the KCWA's Member Units, as set forth in the Agency's contracts with its Member Units as they presently exist or may be changed from time to time.

(b) Nickel shall make or cause the Acquired Water to be available to Newhall at the Tupman turnout, as defined in Article 1.17 of the KCWA Agreement ("Tupman"), as provided in Article 4.4 of the KCWA Agreement.

8. Water Charges. Except as expressly provided in this Agreement, Nickel shall be solely responsible for all conveyance or delivery costs and expenses (including without limitation pumping costs) associated with making the Acquired Water available at Tupman. Newhall shall be responsible for all costs or expenses associated with the conveyance and delivery of the Acquired Water beyond Tupman imposed by KCWA and/or the California Department of Water Resources for conveyance of the Acquired Water beyond Tupman. Further, Newhall shall pay to Nickel that portion of those power charges attributable to the Acquired Water in any year in which Nickel is obligated to pay to KCWA the power charges described in Article 4.5 of the KCWA Agreement (the "Power Charges"), which the parties acknowledge is 16.07 percent of the total power charges payable by Nickel in any year in which such charges are payable under Article 4.5 of the KCWA Agreement. Newhall shall pay Nickel the Power Charges within 30 days of Newhall's receipt of an invoice for the Power Charges from Nickel.

9. KCWA Actions. Nickel and Newhall shall jointly request that KCWA and the Castaic Lake Water Agency ("Castaic") enter into a "point of delivery" agreement with the California Department of Water Resources approving delivery of a portion of KCWA's State Water Project Table A entitlement, used as State Water Project exchange water, to Castaic so that the Acquired Water can be delivered to Castaic for the entire Transfer Term (the "Point of Delivery Agreement"). If the Point of Delivery Agreement is not obtained prior to the expiration of the Option, or if Newhall exercises the Option and the Point of Delivery Agreement is not obtained prior to the commencement of the First Water Year, Newhall may at its election terminate this Agreement without liability to Newhall and receive a refund from Nickel of the First Option Consideration Payment, the Second Option Consideration Payment (if it was paid to Nickel) and any Purchase Price paid to Nickel, without interest, so long as Newhall uses reasonable good faith efforts to obtain the Point of Delivery Agreement.

10. Assignment. Nickel acknowledges that Newhall intends to use the Acquired Water on lands owned by Newhall within the service area of the Castaic and/or the Valencia Water Company ("Valencia"). Newhall may assign this Agreement, in whole or in part, to Castaic and/or Valencia upon notice to Nickel without further consent by Nickel. Any other assignment of this Agreement shall be subject to Nickel's advance written consent, which consent shall not be unreasonably withheld; provided, that in no event may Newhall assign the Option to any party other than Castaic or Valencia. Should Newhall assign this Agreement, or any part, as provided in this Section 10, (i) each assignee shall be required to agree, in writing, to be bound by and timely comply with all terms and provisions of this Agreement and (ii) each assignee shall succeed to the specified rights and obligations of Newhall under this Agreement and shall be recognized by Nickel as possessing all such rights and obligations, and all references to "Newhall" herein shall be deemed to refer to such assignee. Any assignment to Castaic, Valencia or otherwise with Nickel's consent shall relieve Newhall of all further obligations under this Agreement. Newhall may

also sell, on a yearly basis and on terms and conditions acceptable to Newhall, the use of any or all of the Acquired Water Newhall purchases that year to one or more third parties without the consent of Nickel; provided, that Newhall expressly acknowledges that Nickel and KCWA are only obligated to make available any Acquired Water sold by Newhall on a yearly basis to Tupman and only in accordance with this Agreement and the KCWA Agreement.

11. Maintenance of Acquired Water. While this Agreement is in effect, Nickel shall not take or omit to take any action that would render Nickel unable to fully perform its obligations under this Agreement. Without limiting the foregoing, while this Agreement is in effect Nickel shall not (i) amend or revise the KCWA Agreement, or (ii) encumber, commit, transfer or otherwise dispose of the Acquired Water, if any of those that actions would render Nickel unable to fully perform its obligations under this Agreement. Further, Nickel shall take all actions necessary to ensure that it can fully perform its obligations under this Agreement. Notwithstanding the above, Nickel shall have the right to annually market the water that will be the Acquired Water prior to the commencement of the Transfer Term so long as the Acquired Water is available to Newhall during the Transfer Term.

12. Representations and Warranties of Nickel. Nickel hereby makes the following covenants, representations and warranties as of the Effective Date:

(a) Nickel has the authority to enter into this Agreement, sell and transfer the use of the Acquired Water to Newhall, and to otherwise perform as set forth herein. Nickel is the sole owner of the Acquired Water and has the unrestricted right and power to transfer the use of it to Newhall under the terms of this Agreement and to make the Acquired Water available at Tupman for the benefit of Newhall pursuant to the KCWA Agreement. The execution and delivery of this Agreement have been validly authorized by all requisite action on the part of Nickel.

(b) Nickel's execution of this Agreement and performance of its obligations hereunder will not violate any agreement, option, covenant, condition, obligation or undertaking of Nickel, nor to the best of Nickel's actual knowledge will it violate any law, ordinance, statute, order, or regulation.

(c) To the best of Nickel's actual knowledge, there are no actions, suits or proceedings of any kind or nature, legal or equitable, pending or threatened, relating to the KCWA Agreement or the Acquired Water, or potentially affecting or arising out of Nickel's ownership, management, or ability to sell the Acquired Water, in any court or before or by any federal, state, county or municipal department, commission, board, bureau, agency, or other governmental instrumentality.

(d) To the best of Nickel's actual knowledge, neither the Acquired Water nor any portion thereof, is subject to or affected by (i) any assessments, whether or not presently constituting a lien thereon, or (ii) any condemnation, eminent domain, or similar proceedings that render Nickel unable to fully perform its obligations under this Agreement.

(e) The Acquired Water is free and clear of any liens, encumbrances, or rights of any other party, that would render Nickel unable to fully perform its obligations under this Agreement, and Nickel shall maintain the Acquired Water free and clear of any such liens, encumbrances, or rights imposed against Nickel that render Nickel unable to fully perform its obligations under this Agreement while this Agreement is in effect.

(f) To the best of Nickel's actual knowledge, except for the KCWA Agreement and Nickel's obligations to KCWA under the KCWA Agreement, there are no contracts, licenses, commitments, agreements or undertakings respecting the Acquired Water by which Nickel would be obligated or liable to any person.

(g) Except as expressly contemplated by this Agreement, no approval is required from KCWA in order for the transactions contemplated by this Agreement to occur, and no approval is required from any other party in order for the Acquired Water to be made available to Newhall by Nickel at Tupman.

(h) No proceedings are pending or threatened in which Nickel may be adjudicated as bankrupt or discharged from any and all of its debts or obligations or granted an extension of time to pay its debts or a reorganization or readjustment of its debts.

(i) As reasonably requested by Newhall, Nickel shall cooperate with Newhall in obtaining the necessary approvals for the transfer of the Acquired Water for use by Newhall at any time while this Agreement is in effect; provided, that no such assignment or transfer shall extend beyond the Transfer Term. Newhall shall reimburse Nickel for Nickel's reasonable out-of-pocket expenses incurred in connection with any such cooperation requested by Newhall. Notwithstanding the foregoing, Nickel's obligation to cooperate with Newhall shall be subject to the availability of appropriate representatives of Nickel. In no event shall the cooperation required of Nickel impose a material burden on Nickel.

(j) To the best of Nickel's actual knowledge, there is no action, suit, claim, cause of action, or proceeding at law or in equity (or by or before any governmental agency, official or authority of any local, State or Federal government) now pending, wherein an unfavorable decision, ruling or finding would (i) affect the creation, organization, existence or powers of the Nickel or the titles and powers of its Board members and officers to their respective offices; (ii) enjoin or restrain the approval and/or execution of this Agreement, or (iii) in any way question or affect any of the rights, powers.

(k) Nickel is unaware of any fact or circumstance that would prevent Nickel from being able to fully perform its obligations under this Agreement, or that would prevent Newhall from acquiring or using the Acquired Water as contemplated by Newhall.

13. <u>Representations and Warranties of Newhall</u>. Newhall hereby makes the following covenants, representations and warranties as of the Effective Date of this Agreement:

(a) Newhall has the authority to enter into this Agreement, purchase the Acquired Water, and to otherwise perform as set forth herein. The execution and delivery of the Agreement has been validly authorized by all requisite action on the part of Newhall.

(b) Newhall's execution of this Agreement and performance of its obligations hereunder will not violate any agreement, option, covenant, condition, obligation or undertaking of Newhall, nor to the best of Newhall's knowledge will it violate any law, ordinance, statute, order, or regulation.

(c) To the best of Newhall's actual knowledge, there is no action, suit, claim, cause of action, or proceeding at law or in equity (or by or before any governmental agency, official or authority of any local, State or Federal government) now pending, wherein an unfavorable decision, ruling or finding would (i) affect the creation, organization, existence or powers of the Newhall or the titles and powers of its Board members and officers to their respective offices; (ii) enjoin or restrain the approval and/or execution of this Agreement, or (iii) in any way question or affect any of the rights, powers, duties or obligations of the Newhall with respect to implementation of this Agreement.

(d) No proceedings are pending or threatened in which Newhall may be adjudicated as bankrupt or discharged from any and all of its debts or obligations or granted an extension of time to pay its debts or a reorganization or readjustment of its debts.

(e) Newhall has received any and all information from Nickel, KCWA and any other source which it desires or expects in connection with the transactions contemplated by this Agreement. Except as set forth in this Agreement, Newhall is not relying upon Nickel to disclose (or to evaluate any other person's disclosure of) any such matters, and Newhall excuses and releases Nickel from any duty whatsoever to make such disclosures.

14. <u>Condition Precedent to Nickel's Obligations to Perform</u>. If Newhall exercises the Option, Nickel's obligation to transfer the Acquired Water in any year of the Transfer Term is hereby expressly conditioned on satisfaction or waiver by Nickel of the following condition precedent:

(a) Newhall shall have timely performed each of the acts to be performed by it hereunder including, without limitation, payment of the annual Purchase Price.

15. Conditions Precedent to Newhall's Obligation to Perform. If Newhall exercises the Option, Newhall's obligation to purchase the Acquired Water in any year of the Transfer Term is hereby expressly conditioned on satisfaction or waiver by Newhall of each and every one of the following conditions precedent:

(a) Nickel shall have timely performed each of the acts to be performed by it hereunder.

(b) Newhall shall have received any necessary governmental or other consents for the receipt of the Acquired Water at Tupman in that year. Newhall shall diligently pursue such necessary governmental or other consents for this condition precedent to apply.

(c) The Acquired Water is available and can be made available at Tupman in accordance with the terms of this Agreement.

(d) The Point of Delivery Agreement is in effect.

Should any of the foregoing conditions precedent not be satisfied in any year, and as a result thereof Nickel cannot make the Acquired Water available to Newhall at Tupman that year in accordance with the terms of this Agreement, and/or the Point of Delivery Agreement is not in effect, Newhall shall provide written notice thereof to Nickel in accordance with Section 18 of this Agreement. If such condition exists 15 days after Nickel's receipt of such written notice, Newhall shall be under no obligation to purchase the Acquired Water in that year (although Newhall may nevertheless waive such condition). However, this Agreement shall remain in effect during the entire Transfer Term. If Newhall does not purchase the Acquired Water in any year pursuant to this Section, Nickel shall have the right to use, or sell the use of the Acquired Water in that year, so long as the Acquired Water is available to Newhall during the remainder of the Transfer Term.

16. Costs and Expenses. Except as otherwise provided herein, Newhall shall pay all costs and fees associated with the transfer of the Acquired Water under this Agreement, including without limitation any transfer taxes associated with the Acquired Water. Each party shall be responsible for their own attorneys' and other professional fees and internal administrative costs associated with the preparation of this Agreement and the transfer of the Acquired Water.

17. Brokerage Commissions. Newhall and Nickel each represents and warrants to the other that it has not engaged the services of any broker, agent or finder, nor done any other act nor made any statement, promise or undertaking which would result in the imposition of liability for the payment of any brokerage commission, finder's fee or otherwise in connection with the transaction described in this Agreement. In the event that any person or entity perfects a claim for a brokerage commission, finder's fee or otherwise, based upon any agreement, statement or act, the party through whom such person or entity makes such claim shall be responsible therefor and shall indemnify, defend and hold the other party and the Acquired Water harmless from and against such claim and all loss, cost and expense associated therewith, including attorneys' fees.

18. Notices. All notices under this Agreement shall be effective upon personal delivery or confirmed facsimile transmission to Nickel or Newhall, as the case may be, or three business days after deposit in the United States mail, registered or certified, postage fully prepaid and addressed to the respective parties as follows:

To Nickel:
James L. Nickel
President
Nickel Family, LLC
P.O. Box 60679
Bakersfield, CA 93386-0679
Facsimile: 661-872-7141

To Newhall:

Steven Zimmer
Vice President
The Newhall Land and Farming Company
23823 Valencia Boulevard
Valencia, CA 91355
Facsimile: 661-288-1052

or such other address as the parties may from time to time designate in writing.

19. <u>No Third Party Beneficiaries</u>. Except for assignees receiving valid assignments made pursuant to Section 10 of this Agreement, Nickel and Newhall hereto agree that it is not their intent to create any rights or benefits in any third parties and that no third party beneficiaries shall be created or shall be deemed created by this Agreement.

20. <u>Attorneys' Fees</u>. In the event of any action between Newhall and Nickel seeking enforcement of any of the terms and conditions of this Agreement or in connection with the Acquired Water, the prevailing party in such action shall be awarded its reasonable costs and expenses, including but not limited to taxable costs, and its reasonable attorneys' fees.

21. <u>Remedies</u>. The parties understand and agree that use of the Acquired Water is unique, may not be replaceable in the event it is not transferred to Newhall in accordance with this Agreement, and will be relied upon by Newhall through the Transfer Term, including any extension thereof, in connection with its development activities in Los Angeles County. Therefore, in addition to a claim for damages for a breach or default, and in addition and without prejudice to any other right or remedy available at law or in equity Newhall may have in the event of a threatened or actual breach of this Agreement by Nickel, Newhall shall be entitled to injunctive relief, specific performance and other equitable remedies. Nickel acknowledges that in the event of a threatened or actual breach of this Agreement by Nickel, Newhall will be irreparably damaged in the event that this Agreement is not specifically enforced and that equitable relief would be appropriate. If Newhall breaches, or defaults in the performance of its obligations under this Nickel may pursue any remedies available to it at law or in equity for such default or breach. Notwithstanding the foregoing, if one party threatens to breach, breaches or defaults in the performance of its obligations under this Agreement (the "defaulting party"), no remedy at law or equity will be sought until written notice is provided to the defaulting party in accordance with Section 18 and the threat of breach, breach or default exists 15 days after the defaulting party's receipt of written notice of such default.

22. <u>Entire Agreement</u>. This Agreement and items incorporated herein contain all of the agreements of the parties hereto with respect to the matters contained herein, and no prior agreement or understanding pertaining to any such matter shall be effective for any purpose. No provisions hereof may be amended or modified in any manner whatsoever except by an agreement in writing signed by duly authorized representatives of each of the parties.

23. <u>Successors</u>. The terms, covenants and conditions hereof shall be binding upon and shall inure to the benefit of the heirs, executors, administrators and assignees of the respective parties hereto.

24. <u>Further Action</u>. The parties agree to perform all further acts, and to execute, acknowledge, and deliver any documents that may be reasonably necessary, appropriate or desirable to carry out the purposes of this Agreement. Without limiting the foregoing, at the request of Newhall, Nickel shall assist Newhall in obtaining any and all consents or assistance from the KCWA necessary or desirable in connection with the transfer of the use of the Acquired Water to Newhall including, without limitation, any requests for assistance pursuant to Article 4.9 of the KCWA Agreement.

25. <u>Waiver</u>. A waiver of any breach of this Agreement by any party shall not constitute a continuing waiver or a waiver of any subsequent breach of the same or any other provision of this Agreement.

26. Choice of Laws. This Agreement shall be governed by the laws of the State of California and any question arising hereunder shall be construed or determined according to such law.

27. Headings. Headings at the beginning of each numbered Section of this Agreement are solely for the convenience of the parties and are not a part of this Agreement.

28. Time. Time is of the essence, it being understood that each date set forth herein and the obligations of the parties to be satisfied by such dates have been the subject of specific negotiations by the parties.

29. Counterparts. This Agreement may be signed by the parties in different counterparts and the signature pages combined to create a document binding on all parties.

27. Force Majeure. If the performance by any party to this Agreement of any of its obligations or undertakings under this Agreement is interrupted or delayed by any occurrence not occasioned by the conduct of a party to this Agreement, whether that occurrence is an act of God or public enemy, or whether that occurrence is caused by war, riot, storm, earthquake, or other natural forces, or by the acts of anyone not a party to this Agreement, then that party shall be excused from any further performance for whatever period of time after the occurrence is reasonably necessary to remedy the effects of that occurrence. The Transfer Term shall be extended by the period of time such performance is so excused.

28. Quitclaim. Upon the expiration of this Agreement for any reason, including the failure to timely exercise the Option in the manner provided herein, Newhall shall properly execute, acknowledge, and deliver to Nickel a quitclaim in a form suitable to establish the termination of this Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement on the date first hereinabove written.

NICKEL FAMILY, LLC

By:__________________________
James L. Nickel, President

THE NEWHALL LAND AND FARMING COMPANY
(a California Limited Partnership)

By: NEWHALL MANAGEMENT LIMITED
PARTNERSHIP, Managing General Partner

By: NEWHALL MANAGEMENT CORPORATION,
Managing General Partner

By:__________________________
Steven Zimmer, Vice President

EXHIBIT A

"The KCWA Agreement"

KERN COUNTY WATER AGENCY

INITIAL STUDY AND
PROPOSED NEGATIVE DECLARATION
FOR THE
KERN RIVER RESTORATION
AND
WATER SUPPLY PROGRAM

Prepared by the Kern County Water Agency, July 27, 2000

KERN COUNTY WATER AGENCY
Environmental Initial Study Form
[for CEQA Guideline section 15063]

1. Project title: Kern River Restoration and Water Supply Project

2. Lead agency name and address:

Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield CA 93302-0058

3. Contact person and phone number: Thomas N. Clark, General Manager, 661-634-1400

4. Project location: The Project is located in the City of Bakersfield primarily along the Kern River corridor from the projected extension of Haley Street on the east side, to the California Aqueduct on the west end, and south and west of Bakersfield in the unincorporated portion of the county along the Cross Valley Canal and Arvin-Edison Canal and including other local water conveyance facilities. Also, see attached Project location maps.

5. Project sponsor's name and address: Same as lead agency.

6. Description of project:

Summary. Project proposes to provide significant water quality, water supply, environmental and community benefits for the metropolitan Bakersfield area and a broad range of Kern County water users through the coordinated implementation of a number of program components including: (1) acquisition of the Lower Kern River water right (Lower Right), i.e., Hacienda/Garces pre-1914 water right, including associated Lake Isabella Storage; (2) Purchase of land from Castle and Cooke California, Inc., for additional recharge and recovery facilities; (3) construction of 12 new agricultural water recovery wells and construction of enough Urban area wells to achieve a flow capacity of 60 cfs; and (4) Construction of water exchange facilities, interconnection of water conveyance facilities and modification of the Pool 1 portion of the Cross Valley Canal.

Expanded Description. See attached Initial Study Project Description.

7. General plan designation and zoning: No change to the existing General Plan or Zoning laws is anticipated.

8. Surrounding land uses and environmental setting: The Kern River Parkway Plan and EIR were adopted in 1988 by the City of Bakersfield. The natural site presently includes 1,400 acres along the majestic Kern River corridor extending from Manor Street on the northeast side of the City of Bakersfield to a point one mile below the Stockdale Highway bridge on the city's western edge. A bike path meanders alongside the course of the Kern River, providing for 12 miles of uninterrupted scenic activity. The primary benefits of the Parkway include flood control, water recharge and conservation, preservation and restoration of native riparian habitats and open space for greenbelt and recreational uses. The Kern River Parkway is a community project involving active, on-going public participation and has resulted in improved community image and attractiveness of the natural environment; a unique family oriented recreational area for all to enjoy. Major features of the Kern River Parkway include: 1) 320 acres of primary river channel; 2) 275 acres of natural and riparian land; 3) 460 acres of natural habitat for educational studies; 4) 25 acre Truxtun Lake Recharge Area; 5) 12 miles of uninterrupted bike path with 9 rest areas; 6) 8 miles of equestrian trails; 7) Multi-station exercise par course; 8) 3 professional quality sand volleyball courts; 9) 4 public parks with group picnic areas.

In November of 1999, a landmark water agreement was approved between the City of Bakersfield and the Kern County Water Agency designed to keep water flowing in the Kern River during the May through September recreation period in years when ID4's SWP entitlement allocation is 50% or greater. The proposed Project helps the historic pact to ensure a that in most years water will flow in the river throughout the summer months, even during years of less than 50% SWP supplies, providing for expanded recreational activities, especially at the popular Beach Park and Yokuts Park.

Also the proposed Project will complement and supplement existing and ongoing urban and agricultural programs to recharge water in wet years for recovery of recharged water through extraction by wells in dry years. The proposed Project is fully compatible with existing land uses and environmental settings.

9. Other public agencies whose approval is required: None.

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:
The environmental factors checked below would be potentially affected by this Project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics ☐ Agriculture ☐ Resources Air Quality
☐ Biological Resources ☐ Cultural Resources ☐ Geology /Soils
☐ Hazards & Hazardous Materials ☐ Hydrology / Water Quality ☐ Land Use/ Planning
☐ Mineral Resources ☐ Noise ☐ Population / Housing
☐ Public Services ☐ Recreation ☐ Transportation/Traffic
☐ Utilities / Service Systems ☐ Mandatory Findings of Significance ☒ None.

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

☒ find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects of the (a) have been analyzed adequately in the Previous CEQA Documents pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to the Previous CEQA Documents, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Thomas N. Clark
General Manager
Kern County Water Agency

July 27, 2000
Date

California Environmental Quality Act
INITIAL STUDY
Project Description of the Kern River Restoration and Water Supply Program

The Kern River Restoration and Water Supply Program proposes the integration of newly acquired assets and coordinated operation of existing and new water recharge, recovery and conveyance facilities. The Kern County Water Agency, (Agency) along with other local water leaders have been working to implement the Kern River Restoration and Water Supply Program, (Project) utilizing funds from the "Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act" (Proposition 13). The purpose of the Project is to generate broad local water supply, environmental and community benefits, and targeted drinking water quality benefits within the metropolitan Bakersfield area. The proposed Project consists of the four following broad components, and further defined below.

1. Acquisition of the Kern River Lower Water Right
2. Construction of enough urban area water wells to achieve a flow capacity of about 60 cfs
3. Construction of water quality exchange facilities
4. Construction and acquisition of local facilities to enhance groundwater recharge and recovery opportunities and associated appurtenances, including modification of the Pool 1 portion of the Cross Valley Canal (CVC), and interconnection of other existing canals.

Water quality and water supply benefits from the Project will be realized through the acquisition of the high flow Lower Kern River water right (Lower Right), i.e., La Hacienda and Garces pre-1914 water right to the Kern River. This high flow water is estimated to be available when the Kern River is at or above 120% of normal run-off or in about one out of every five years. Table 1 below shows a 105 year summary of historical annual Kern River entitlements for La Hacienda.

TABLE 1

Year	First Point flows in (AF)	April-July flows (AF)	% of Normal	La Hacienda Entitlement (AF)		
				Jan-Mar	Apr-Jul	Total
1895	1,023,061	694,729	146	0	36,181	36,181
1897	893,433	654,262	138	0	18,375	18,375
1906	1,900,540	1,391,636	293	0	399,190	399,190
1907	990,900	678,748	143	0	45,649	45,649
1909	1,838,644	1,218,975	256	40,306	294,730	335,036
1911	1,013,385	701,168	147	0	39,014	39,014
1914	1,113,515	685,012	144	10,512	31,906	42,418
1916	2,520,149	1,571,597	331	165,981	508,066	674,047
1917	823,083	560,304	118	0	3,401	3,401
1922	964,080	617,710	130	0	5,844	5,844
1937	1,260,182	852,047	179	7,358	105,401.	112,759
1938	1,358,668	961,769	202	0	170,179	170,179
1941	1,401,078	995,657	209	0	168,590	168,590
1943	1,220,628	687,182	147	53,036	37,260	90,296
1952	1,500,998	1,119,815	236	0	234,738	234,738
1958	1,104,730	831,669	175	0	96,435	96,435
1967	1,396,229	924,005	197	0	137,063	137,063
1969	2,461,369	1,747,674	373	65,152	614,714	679,866
1973	979,652	723,768	154	0	48,958	48,958
1978	1,653,505	1,094,376	249	29,209	219,348	248,557
1980	1,639,968	991,025	225	67,337	166,551	233,888
1982	1,271,139	796,794	171	0	81,089	81,089
1983	2,489,131	1,545,810	323	79,848	508,966	588,814
1986	1,444,941	886,674	184	48,645	120,637	169,282
1995	1,353,037	929,221	199	658	139,357	140,015
1996	1,038,261	599,331	128	0	16,279	16,279
1997	1,181,969	571,476	122	73,010	0	73,010
1998	1,717,967	1,137,373	239	27,587	245,361	272,948
Total	39,554,452	26,180,006		668,639	4,493,282	5,161,921

As can be seen from the Table 1, deliveries of the Lower Right are highly variable from year to year. For example, over the 105 year period of record, 1969 was the maximum total delivery year with a quantity of 679,866 acre-feet.
During seventy-seven (77) years over the 105 year period, no Lower Right flow is available. The lowest quantity on record of the years Lower Right flow was available was 3,401 acre-feet delivered in 1917. As shown in Table 1, Lower Right water has a high range of variability in flow. A goal of the Project is to maximize the opportunities to use this water for urban and agricultural purposes, either for direct urban use or for groundwater recharge. The long-term average annual yield of the Lower Right water is estimated at 40,000 acre-feet. Another one of the goals of the Project is to make available for urban use, the highest quality water. Due to the high quality nature of Kern River water, when available for use up to a maximum of 40,000 acre-feet of annual Lower Right water will be given priority for delivery to the Improvement District No. 4 (ID4) Henry C. Garnett Water Purification Plant (Purification Plant) and delivered for urban use in the greater Bakersfield area. This will assist the Purification Plant in meeting existing and future water quality standards for the public water supplies as administered by the Environmental Protection Agency and other government regulators responsible for Public Health. Annual Lower Right water available above the amount used by the Treatment Plant will be used for groundwater recharge and provide a water supply benefit to local agricultural water districts as described elsewhere in the description.

Environmental and community benefits are an important part of the Project. The Project plans to assure through acquisition of the Lower Right and by annual water exchanges with local water district having other Kern River water rights, that the heart of the City of Bakersfield (from Manor Street downstream to Allen Road) will enjoy a 12 mile stretch of re-watered Kern River, at least from May through September. This stretch of the Kern River has been usually dry since the mid-1950's, except in wet years, and will complement the existing Kern River Parkway Plan and EIR adopted in 1988 by the City of Bakersfield.

An integral component of the program is the proposed construction of urban area wells along the right-of-way of the Kern Island and Cross Valley Canals, east of Highway 99 (see attached maps). In dry years, estimated to be when the Kern River is at or below 50% of normal, these wells will be pumped as part of the exchange to keep the Kern River channel wet between Manor Street on the east end, and the Stockdale bridge at the west end of the City. Water that has previously been released down the Kern River channel and percolated will be recaptured and recirculated by these wells. The ability to recirculate water is accomplished by an exchange among ID4 and Kern Delta WD (KD)/North Kern WSD (NK). These wells will only be pumped during the driest of years to pay water back when NK and KD for release of their Kern River water into the Channel. This component of the Project will serve to keep the river flowing during the peak recreational use months of May through September, without decreasing the supplies that are needed during the critical water short years. The Table below shows an example of an operation during a year when the wells will be maximized and water is available for reregulation in Isabella by NK and KD.

TABLE 2

Month	Water delivery to KD and NK from urban area wells via Kern Island and Beardsley Canals (AF)	Change in Isabella Storage do to reregulation (AF)	KD and NK entitlement Kern River deliveries (AF)	KD/NK deliveries to wet the Kern River Channel (AF)
Jan	2,918	2,918		0
Feb	2,918	2,916		0
Mar	2,918	2,918		0
Apr	2,918	2,918		0
May	2,916	(4,084)	2,916	4,084
Jun	2,916	(4,084)	2,916	4,084
Jul	2,916	(4,084)	2,916	4,084
Aug	2,916	(4,084)	2,916	4,084
Sep	2,916	(4,084)	2,916	4,084
Oct	2,916	2,916		0
Nov	2,916	2,916		0
Dec	2,916	2,916		0
Total	35,000	0	14,580	20,420

When required, the KCWA/ID4 will annually provide up to 35,000 acre-feet of water directly or by exchange for delivery into the Kern River Channel beginning at Manor Street in order to help maintain the flow for recreational, community and environmental benefits to the citizens of Metropolitan Bakersfield. The target period to wet the Kern River Channel is the months of May through September or a 150 day continuos period. It is estimated with a high degree of confidence, that a total flow of 35,000 acre-feet is required to wet the targeted River Channel area for the 5-month period. To allocate a continuous flow of the 35,000 acre-feet over this period requires an approximate instantaneous capacity of 117 cfs. The exchange to keep the Kern River Channel wet for the 5-month period would be accomplished under the following programs:

- <u>No use of wells, normal Kern River hydrology:</u> KD and NK release a combined flow capacity of 117 cfs of their respective Kern River entitlement in the Kern River Channel during the months of May through September, that would otherwise have been delivered to the districts, via the Beardsley and Kern Island Canals. In exchange (either simultaneously or by payback), ID4 conveys an equal amount of SWP water entitlement or other water in the CVC for delivery to KD/NK via the CVC extension, the Arvin-Edison turnout, or the proposed cross river pipeline.
- <u>Use of wells, dry SWP and/or Kern River hydrology:</u> KCWA pumps the Urban area wells. The east wells pump water into the CVC and/or Kern Island Canal for delivery to KD and for delivery to NK via the Beardsley Canal. In addition, wells pump recovered water into the CVC for delivery to KDWD via the Arvin-Edison turnout and connection to the Kern Island Canal. The wells supply approximately 35,000 acre-feet over a 10 to 12 month period. KD and NK reregulate their Kern River supply during the first and last months of the year as shown in the example in Table 2 above and deliver water out of storage down the Kern River channel during the May through September period.
- <u>In the wettest years:</u> During wet years on the Kern River, there will be plenty of high flow water available to wet the Channel and no water will be required from ID4 and KD/NK.

1. To facilitate the water exchanges described above, a number of new facilities would be constructed described below:
    a. Facilities would be modified as needed on the Arvin-Edison Canal used to divert water to the various canal owned by KD. These diversion facilities would have a targeted capacity of 150 cfs. See attached map for facility locations.
    b. A pipeline would be constructed in order to divert well water, SWP and/or Friant-Kern water from the CVC to the Kern Island Canal to a point just east of Manor Street. This pipeline facility would have a targeted capacity of 150 cfs.
    c. As an alternative to item "b" above, the existing eastside pipeline owned and operated by ID4 would be modified to deliver water from the CVC to the same location in the Kern Island Canal. This pipeline facility has a targeted capacity of 60 cfs.

In years when the Lower Right water is available, the first 40,000 acre-feet will be used to meet the needs of the ID4 Purification Plant for delivery to the Urban Bakersfield area. The next increment of yield (40,000 acre-feet to 125,000 acre-feet) can be regulated within the same year. Any yield above that will be available for immediate delivery. Historically, the flows have been as high as 550,000 acre-feet. Currently not all the water can be captured.

Another program component is to acquire and construct facilities to enhance local groundwater recharge and recovery operations. To accomplish this goal, additional regulation/recharge basins will be constructed on approximately 80 acres property which has been targeted for acquisition from Castle and Cooke California, Inc. The property is located along both sides of the Kern River near the Stockdale bridge. Portions of the property will be dedicated to groundwater recharge and other portions will be used for a multi-propose Park facility, with groundwater recharge given a priority when the Kern River is in a high flow year, thus combining a prominent water feature into the park.

Lower Right water available for use above what is needed by the Purification Plant would be recharged in the facilities listed below:

- In the new land acquired from Castle and Cooke California, Inc., (CCC) located near the Stockdale bridge on both sides of the Kern River. These lands will consist of one 10-acre recharge pond north of the River and one 5-acre recharge pond south of the Kern River. A potential annual recharge of 5,500 acre-feet can be achieved in these ponds, based on a recharge rate of 1.0ac-ft/ac/day.
- In the 40 new acres of land acquired from CCC located on the north side of the Kern River near the Stockdale bridge. This land is proposed to be used as a multi-purpose recreation facility and during wet years will be used to recharge the high flow months that Lower Right water is available. A potential monthly recharge of 120 acre-feet can be achieved in this area, based on a recharge rate of 1.0ac-ft/ac/day.
  The existing banking projects will also have access to this water.
- The Berrenda Mesa Project recharge facility. This Project has a potential annual recharge capacity of 58,000 acre-feet. The Pioneer Project recharge facility has a potential annual recharge capacity of 146,000 acre-feet. The Kern Water Bank Project has a potential annual recharge capacity of 450,000 acre-feet.
- This water may also be used to meet other Ag, urban or groundwater management purposes.

To enhance the capability of existing canals to convey recovered water, the Project proposes to interconnect the Kern River Canal with the Kern Water Bank canal and to raise the lining of the CVC in Pool 1. The CVC would be modified to "float" off the Aqueduct to increase the operational opportunity for water exchanges. The modification will also reduce water over-topping the lining, increase flexibility to move water around the County, reduce energy costs, and reduce operations and maintenance costs. This work covers the portion of the CVC that extends from the California Aqueduct turnout near Tupman to the forebay of Pumping Plant 1. All work would be done within the existing CVC right-of way.

The Project proposes to construct 12 new agricultural groundwater recovery wells. The 12 wells will be located on either the Agency's Pioneer property, Kern Water Bank, and/or private land in the vicinity of existing projects. The wells are estimated to have an annual recovery capacity of 36,000 acre-feet. In dry years the banked Lower Right water will be recovered using the 12 new agricultural wells constructed as described above. The recovered banked water will be delivered to the CVC, Kern River Canal or the Kern Water Bank Canal and directly or by exchange delivered to the Participants of the Banking Projects to supplement shortages in surface water deliveries. The operation of the urban and agricultural wells will be governed by the principles substantially similar to those found in the Memorandum of Understanding (MOU) regarding the Operation and Monitoring of the Kern Water Bank Groundwater Banking Program. The MOU outlines the terms, methods and procedures for the monitoring program appropriate for groundwater recharge and recovery projects. Each year, a report will be published by the Monitoring Committee which presents the following information:

A. A summary of ground water levels collected during the year;

B. A summary of water quality analyses of water collected during the year from recovery wells and monitoring wells;

C. Records of water recharged during the year and its source;

D. Records of water recovered during the year.

E. The status of current accounts of stored water, including losses, and the quantities of water available for recovery;

F. Information regarding any ongoing groundwater quality remedial concerns that may arise from time to time.

Environmental Checklist:

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES - - Would the project:				
a) Convert/reduce Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland) to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☐	☒
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
<u>IV. BIOLOGICAL RESOURCES</u> -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☐	☒
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☐	☒
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☐	☒
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒
<u>V. CULTURAL RESOURCES</u> -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☒
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☒
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:	☐	☐	☐	☒
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☒
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
) Create a significant hazard to the public or the environment through easonably foreseeable upset and accident conditions involving the elease of hazardous materials into the environment?	☐	☐	☐	☒
) Emit hazardous emissions or handle hazardous or acutely azardous materials, substances, or waste within one-quarter mile of n existing or proposed school?	☐	☐	☐	☒
l) Be located on a site which is included on a list of hazardous naterials sites compiled pursuant to Government Code Section 5962.5 and, as a result, would it create a significant hazard to the ublic or the environment?	☐	☐	☐	☒
) For a project located within an airport land use plan or, where such plan has not been adopted, within two miles of a public airport or ublic use airport, would the project result in a safety hazard for people esiding or working in the project area?	☐	☐	☐	☒
) For a project within the vicinity of a private airstrip, would the project esult in a safety hazard for people residing or working in the project rea?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted mergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury or leath involving wildland fires, including where wildlands are adjacent o urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY -- Would the roject:				
a) Violate any water quality standards or waste discharge equirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially vith groundwater recharge such that there would be a net deficit in quifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which ermits have been granted)?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
<u>IX. LAND USE AND PLANNING</u> - Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒

<u>X. MINERAL RESOURCES</u> – Would the project:

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral, resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE -- Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	☒
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☐	☒
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS -- Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the projects projected demand in addition to the providers existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the projects solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

	Potentially Significant Impact	*Less Than Significant with Mitigation Incorporated*	*Less Than Significant Impact*	*No Impact*
XVII. MANDATORY FINDINGS OF SIGNIFICANCE –				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☒
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☐	☒
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

EXPLANATION OF RESPONSES
INITIAL STUDY CHECKLIST

Project:	Kern River Restoration and Water Supply Program
Agency:	Kern County Water Agency

I. Aesthetics.

a. The Project will have the potential to increase the aesthetic value of the Kern River corridor area during wetting periods.

b. The Project will not damage scenic visual character or quality because new activities are complementing existing operations.

c. See 1b above.

d. The Project may create a new source of light during well construction, since well drilling occurs around the clock. However, this will be a temporary effect.

II. Agriculture Resources.

a. No farmland will be taken out of production as a result of construction and acquisition of assets proposed under this Project.

b. No. None of the lands at the Project locations proposed for facility construction are under a Williamson Act contract.

c. No

III. Air Quality.

a. The project will result in increased air emissions from vehicles and equipment during the construction and operation and maintenance periods. However, the emissions will be short term and no more than from existing urban and agricultural activities.

b. During construction and operation, the Project will not result in violation of any air quality standards or generate any objectionable odors.

c. The project is not expected to generate a cumulative net increase in any pollutant for which the region is in non-attainment under federal or state standards.

d. No.

e. No.

IV. **Biological Resources.**

a. No threatened or endangered, or other sensitive plant or wildlife species, pursuant to State and Federal Endangered Species Act, are known to be present at or near the proposed project sites. The project is not expected to reduce or enhance the diversity of native plants at the project site. All construction will occur in existing maintained right-of-way, or on actively farmed land, or on an area with an existing Habitat Conservation Plan permitted for such activity.

b. The Project will not have any adverse impact on riparian habitat or other sensitive natural communities. The Project may have a positive benefit on riparian habitat identified in the Kern River Parkway, since one of the goals of this Project is to maintain a wetted 12-mile stretch of Kern River Channel through the center of Bakersfield.

c. No federally protected wetlands pursuant Section 404 of the Clean Water Act will be impacted by the Project.

d. Construction and operation on project sites will not impact migration of fish, movement of native residents or wildlife species because construction and operation will occur on actively farmed areas or in existing maintained project right-of-ways areas.

e. No. In fact, the Project as proposed will complement existing polices and ordinances pertaining to the City of Bakersfield Kern River Parkway Plan and Environmental Impact Report adopted in 1988. No large trees, such as the heritage oak, will be removed by the Project.

f. It is the intent of the proposed project to the extent practical, to cooperate and complement the existing Metropolitan Bakersfield Habitat Conservation Plan and the Kern Water Bank Habitat Conservation Plan.

V. **Cultural Resources.**

a. Preliminary field reconnaissance surveys indicate that historical and archeological sites are present in areas of higher elevation on portions of project lands. However, no construction will occur on or near any known sites.

b. Based on the best information available to the Agency no impacted are expected..

c. No known paleontological resource or unique geologic feature will be impacted.

d. Based on the best information available to the Agency no impacted are expected.

VI. **Geology and Soils.**

a. The Project as proposed will not expose people or structures to potential substantial adverse effects resulting from earthquakes, seismic ground shaking, seismic-related ground failure or landslides.

b. No

c. The project will not uncover or expose any unstable earth conditions and/or unstable geologic substructures or unit.

d. No.

e. No.

VII. Hazards and Hazardous Materials.

a. The project will not involve the use of any hazardous substances.

b. No.

c. No.

d. No.

e. No.

f. No.

g. No.

h. No.

VIII. Hydrology and Water Quality

a. No.

b. This project is designed to enhance local groundwater supplies by maximizing recharge and use of Kern River flood flows that would other be loss to the Kern County groundwater basin. During recharge periods, the project will change the absorption rate and pattern at the project where the recharge/regulation ponds are to be built, because water will be impounded in recharge ponds. Surface runoff patterns at the site will be slightly altered due to construction of the shallow ponds. Recovery of previously recharged groundwater will lower groundwater levels but not less than pre-project conditions. Over the term of the project, recovery of water will not be more than has been recharged by the project, after accounting for recharge losses. Therefore, nearby wells will not be impacted by the project, or will be mitigated to less than significant pursuant to the Kern Fan Monitoring Committee.

c. No.

d. Because the a purpose of the proposed project is to maximize recharge of flood and other Kern River water, flooding of the recharge ponds and the multipurpose recreational facility may occur during flood flows on the Kern River. The flooding will have no impact because facilities are designed for this operation and this is expected to occur about 20% of the years.

e. No.

f. No.

g. No.

h. As has been previously described elsewhere in this section, the purpose of the project is to maximize opportunities for beneficial use of Kern River water that would otherwise be loss to the Kern County groundwater basin. As such, the project proposes to construct facilities that will divert, imped and redirect flood flows. However, any impacts to the environment will be less than significant.

i. No.

j. No.

IX. Land Use and Planning.

a. No

b. The Kern River Parkway Plan and EIR were adopted in 1988 by the City of Bakersfield. The natural site presently includes 1,400 acres along the majestic Kern River corridor extending from Manor Street on the northeast side of the City of Bakersfield to a point one mile below the Stockdale Highway bridge on the city's western edge. A bike path meanders alongside the course of the Kern River, providing for 12 miles of uninterrupted scenic activity. The primary benefits of the Parkway include flood control, water recharge and conservation, preservation and restoration of native riparian habitats and open space for greenbelt and recreational uses. The Kern River Parkway is a community project involving active, on-going public participation and has resulted in improved community image and attractiveness of the natural environment; a unique family oriented recreational area for all to enjoy. Major features of the Kern River Parkway include: 1) 320 acres of primary river channel; 2) 275 acres of natural and riparian land; 3) 460 acres of natural habitat for educational studies; 4) 25 acre Truxtun Lake Recharge Area; 5) 12 miles of uninterrupted bike path with 9 rest areas; 6) 8 miles of equestrian trails; 7) Multi-station exercise par course; 8) 3 professional quality sand volleyball courts; 9) 4 public parks with group picnic areas.

c. No. See response number IX b, above.

X. Mineral Resources

a. No.
b. No.

XI. Noise

a. Construction of new facilities and operation of well drilling equipment will temporarily increase local noise levels. Operation of wells in dry years may cause noise. However, noise levels are expected to be no greater than existing urban and agricultural activities and there are no noise-sensitive land uses in proximity to the proposed facilities that could be affected.

b. Persons living south of Stockdale Highway may be able to here elevated noise levels. See "a" above

c. No.

d. Yes. See answer XI a, above

e. No.

f. No.

XII. Population and Housing.

a. No.

b. No.

c. No.

XIII. Public Services.

a. The project as proposed will have no effect on any public service, including fire protection, police protection, schools, and parks, and/or other public facilities.

XIV. Recreation.

a. The Kern River Parkway adjacent to and at the center of the project and would be completed by the project. See answer to IX b above.

b. No.

XV. Transportation and Traffic.

a. There will be additional vehicular and truck traffic on local roads and highways, and on dirt roads within the project sites, during construction. However, the volume of this short-term traffic is expected to be very low and readily accommodated by available capacity on local public roads and highways.

b. The project will not alter existing public road systems or circulation patterns because no public road will be closed or re-aligned as a result of the project. Construction of the project may increase the number and location of private access roads within the sites.

c. No.

d. No.

e. No.

f. No.

g. No.

XVI. Utilities and Services Systems.

a. No.

b. No.

c. No.

d. Yes, the project proposes acquisition of the Lower Kern River right from the pre-1914 La Hacienda/Garces right.

e. No.

f. No.

g. Yes.

XVII. Mandatory Findings of Significance.

a. The project will not have an adverse effect on environment, substantially reduce the habitat of fish or wildlife populations, threaten or eliminate a plant or animal community, or adversely impact sensitive plants and wildlife, reduce the number or restrict the range of a rare or endangered plant or animal species. This is because the project as proposed will construct, operate and maintain facilities in existing maintained right-of-ways, farm land, areas having an existing Habitat Conservation Plan permitting the activities and/or areas not considered as habitat or occupied by threatened or endangered species or any sensitive species.

b. The project is designated to achieve long-term enhancement of local water supplies by increasing reliability of local supplies in the future. As such, the long-term environmental benefits of the project are primary. Project is to be implemented concurrent with similar ongoing projects by City of Bakersfield, Berrenda Mesa WD, Rosedale Rio-Bravo WSD, Buena Vista WSD, West Kern WD and the Kern Water Bank Authority. The proposed project could have cumulative impacts on ground water due to concurrent and overlapping impacts of these similar projects. Participation in the Kern Fan Monitoring Committee under the Memorandum of Understanding regarding operation and monitoring of the Kern Water Bank ground water banking programs will oversee these projects and recommend measures to mitigate these impacts to less than significant.

c. The project does not have the environmental effects to potentially cause substantive adverse effects on human beings either directly or indirectly.

EXHIBIT A

KERN COUNTY WATER AGENCY
PROPOSED NEGATIVE DECLARATION

This is prepared pursuant to the California Environmental Quality Act of 1970 (CEQA), [1] and the State CEQA Guidelines, [2].

NAME OF PROJECT: Kern River Restoration and Water Supply Program.

PROPOSED PROJECT LOCATION: The Project is primarily located along the Kern River corridor from the projected extension of Haley Street on the east side, to the California Aqueduct on the west end, and south and west of Bakersfield in the unincorporated portion of the county along the Cross Valley Canal and Arvin-Edison Canal and including other local water conveyance facilities. Also, see attached Project location maps.

DESCRIPTION OF PROPOSED PROJECT: Summary. Project proposes to provide significant water quality, water supply, environmental and community benefits for the metropolitan Bakersfield area and a broad range of Kern County water users through the coordinated implementation of a number of program components including the: (1) acquisition of the Lower Kern River water right (Lower Right), i.e., Hacienda/Garces pre-1914 water right, including associated Lake Isabella Storage; (2) Purchase of land from Castle and Cooke California, Inc., for additional recharge and recovery facilities; (3) construction of 12 new water Ag recovery wells and enough Urban wells to achieve a maximum flow capacity of 60 cfs; and (4) Construction of water exchange facilities and modification of the Pool 1 portion of the Cross Valley Canal.

Expanded Description. See Initial Study for Proposed Project, attached.

FINDINGS WHICH SUPPORT NEGATIVE DECLARATION: After making an assessment of the possible impacts of the proposed Project and reviewing an Initial Study dated July 27, 2000, the Board of Directors of the Kern County Water Agency has determined that the proposed Project as presented will not have any significant effect on the environment, either directly or indirectly.

INITIAL STUDY: A copy of the Initial Study and environmental checklist prepared by Agency staff, dated July 27, 2000, is attached.

EXHIBIT A

MITIGATION MEASURES: Mitigation measures which have been incorporated into the proposed Project to avoid potentially significant environmental effects are as follows:

1. Throughout the term of the proposed Project, Project water quality, groundwater monitoring, and groundwater recharge losses will be consistent with the Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program, dated October 26, 1995, and consistent with the Operation and Monitoring Procedure for the Pioneer Project, dated May 28, 1998.

2. Project recharge and recovery well areas will be designed and located to avoid areas suspected to have hydrocarbon contamination, and to the extent practical, not to interfere with oil (crude or refined) or natural gas pipelines or other sensitive oilfield areas.

3. Project recharge and recovery well areas will be designed and located to minimize potential impacts to the Agency's Cross Valley Canal.

4. A mitigation, Monitoring and Reporting Program (attached as Exhibit D)

CONTACT PERSON, TELEPHONE NUMBER: Mr. Thomas N. Clark, General Manager, Kern County Water Agency, P.O. Box 58, Bakersfield, CA. 93302; (661)-634-1400. If you require additional information regarding this proposed Project, please contact Mr. Kane Totzke, Kern County Water Agency, (661) 634-1468; e-mail: kane@kcwa.com

Thomas N. Clark, General Manager

9-7-00

Date

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1. Public Resources Code, Section 2100, et seq.

2. Title 14, Division 6, California Administrative Code, as amended.

EXHIBIT B

CEQA Notice of Determination

To: X Office of Planning and Research
1400 Tenth Street, Room 121
Sacramento, CA 95814

X County Clerk
County of Kern
1115 Truxton Ave., 1st Floor
Bakersfield, CA 93301-4639

From: Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield, CA 93302

Subject: Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code.

Project Title: Kern River Restoration and Water Supply Program

State Clearinghouse Number: SCH #2000081017
(If submitted to Clearinghouse)

Lead Agency: Kern County Water Agency
Contact Person: Thomas N. Clark, General Manager
Telephone: (661) 634-1400

Project Location: (include county) See attached Negative Declaration.

Project Description: See attached Negative Declaration.

This is to advise that on September 7, 2000, the Kern County Water Agency (as lead agency) approved the project (more particularly described in the attached Negative Declaration) and has determined that no additional environmental review is required.

An Initial Study and Subsequent Negative Declaration with findings were prepared for the Agency's recent action pursuant to the provisions of CEQA Guidelines sections 15070 through 15075 concluding that no additional environmental review is required. The recent action will not have any significant effect on the environment. Mitigation measures were made a condition of the Agency's recent action on the project. A Statement of Overriding Considerations was not adopted in connection with the Agency's recent action on this project.

This is to certify that the Initial Study with comments and responses and record of project approval is available to the general public at: Kern County Water Agency, P.O. Box 58, 3200 Rio Mirada Drive, Bakersfield, Kern County, CA 93302.

Signature, ______________________
Thomas N. Clark, General Manager, Kern County Water Agency

Date 9-7-00

Date received for filing at OPR: ______________________

EXHIBIT C

CALIFORNIA DEPARTMENT OF FISH AND GAME

CERTIFICATE OF FEE EXEMPTION

De Minimis Impact Finding

Project Title: Kern River Restoration and Water Supply Program

Location: Kern River Corridor area, fromMetropolitan Bakersfield to the California Aqueduct, Kern County

Project Description: This project will generate broad local water supply, environmental and community benefits, and targeted drinking water quality benefits within the metropolitan Bakersfield area.
The Project consists of the four components, generally described below.

1. Acquisition of the Kern River lower water right;
2. Construction of enough urban area wells to achieve a flow capacity of about 60 cfs;
3. Construction of water conveyance exchange facilities;
4. Construction and acquisition of local facilities to enhance groundwater recharge and recovery opportunities.

Findings of Exemption:

1. The project consists of water right transfer and minimal construction and/or modification of water transfer and exchange facilities.

2. The lead agency has no evidence before it, including the information in the Initial Study and comments of appropriate reviewing agencies, to indicate that the proposed project could have any potential for adverse effects on fish and wildlife resources.

Certification:

I hereby certify that the public agency has made the above finding(s) and that the project will not individually or cumulatively have an adverse effect on wildlife resources, as defined in Section 71.2 of the Fish and Game Code.

Date: September 7, 2000 Local Lead Agency: Kern County Water Agency

Title: General Manger Manager

EXHIBIT D

MITIGATION, MONITORING AND REPORTING PROGRAM

OVERVIEW

Comments received on the Proposed Negative Declaration regarding the Kern River Program highlight a significant feature of the design of the program: the program has been designed and will be implemented to comply with all aspects of existing law. Important laws with which the project has been designed to comply are the Federal Endangered Species Act, State Endangered Species Act, and a variety of laws and regulations governing water quality and impacts on legal users of water. While compliance with such laws and regulations is an integral feature of the program, the Agency understands that some entities would prefer a formal acknowledgment of intended compliance as a form of mitigation, and appropriate monitoring and reporting. Accordingly, the Agency agrees to clarify the following mitigation measures which are part of the program as designed and adopt appropriate monitoring and reporting measures.

MONITORING & REPORTING FOR DESIGNED MITIGATION ELEMENTS

1. ADOPTED MITIGATION ELEMENT: Federal and State Endangered Species Act

(a) Program Design:

The program has been designed to avoid any impact on known endangered or threatened species, federal or state, or other species of concern. In the first instance, the program has been designed to have an extremely small footprint of disrupted land in the construction of facilities. Additionally, the facility construction will occur primarily on existing highly cultivated farmland or highly maintained rights of way in which it is unlikely that such species or their habitat will be encountered. Further, care will be utilized to have such locations examined by personnel knowledgeable in the identification of endangered and threatened

species and their habitat to ensure the avoidance of any impact. In the unlikely event that unavoidable impacts are encountered, the Agency will comply fully with Federal and State Endangered Species Acts to ensure that such impacts are mitigated to insignificance.

In summary, the Agency commits to full compliance with both Federal and State Endangered Species Act requirements. While no impact on such species is contemplated due to the design of the program, any unexpected impacts will be handled in full compliance with federal and state law.

(b) Monitoring & Reporting:

The General Manager is hereby directed to provide knowledgeable staff assistance, and consultants where required, to monitor the progress of construction and implementation to ensure compliance with federal and state endangered species laws and regulations.

(1) During the construction phase of the program, the General Manager shall report to the Board on a quarterly basis regarding the following:

- **(i)** The identification, if any, of any potentially impacted federal or state threatened or endangered species.
- **(ii)** Specification of all measures taken to avoid any impact on such species or on the habitat of such species.
- **(iii)** Where impact proves to be unavoidable, whether a project component was abandoned or whether sufficient mitigation measures were utilized to reduce the level of impact to insignificance.

(2) After construction, the General Manager shall include in annual reports to the Board the following:

- **(i)** Whether any potential significant impacts on federal or state endangered or threatened species have been identified, and
- **(ii)** What measures have been taken to reduce such potential impacts to

insignificance.

2. ADOPTED MITIGATION ELEMENT: Injury to Rights of Legal Users of Water and Facilities

(a) Program Design:

The program is designed to ensure that all water and facilities utilized by the program are obtained with full protection of the rights of existing legal users. Full compensation will be provided by the Agency where such rights of legal users of water or facilities are impaired, and absent such compensation such rights of legal users will not be impaired. This extends to the legal users of ground water as the program has been designed to avoid significant impact on such users. In the event of disputes regarding the existence of such impacts, the Agency will submit such disputes to the previously established Kern Fan Monitoring Committee for handling under established rules.

(b) Monitoring and Reporting:

The General Manager shall include in an annual report to the Board a report on the following items of concern:

(1) The alleged occurrence of any impact on the rights of legal users of water or facilities, including any alleged impacts on groundwater;

(2) The measures utilized to investigate such alleged impacts;

(3) The results of such investigation;

(4) The measures utilized to avoid impacts to such rights of legal users, or the measures utilized to reduce such impacts to insignificance.

3. ADOPTED MITIGATION ELEMENT: Water Quality

(a) Program Design:

The program is designed to avoid any potential adverse impacts on water quality. Utilization of the water rights acquired under the program will not significantly differ in water quality impacts from the existing uses of such water. The intent of

the program is to secure the benefits of Kern River water quality for drinking water quality and Kern County. The program will be operated to avoid significant adverse impact on the water quality available to any legal user of water.

(b) **Monitoring and Reporting:**

The General Manager shall include in an annual report to the Board of Directors the following items:

(1) A statement regarding the water quality status of the program during the prior year;

(2) An identification of all problem areas encountered, if any, and the measures taken to avoid any significant adverse impact on the water quality of any legal user of water.

GENERAL REPORTING REQUIREMENTS

The annual report referred to herein shall be prepared under the direction of the General Manager and a registered engineer of the State of California, in consultation with individual(s) knowledgeable in the identification of endangered or threatened species and their habitats. The report may include additional operational, and economic data of interest to the community, but at a minimum shall contain the information specified above as required elements of the report.

KERN COUNTY
WATER AGENCY

GROUNDWATER Kern River Program

August 29, 2000

Mr. Rob Quiring, District Manager
Kern Mosquito and Vector Control District
4705 Allen Road
Bakersfield, CA 93312

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Mr. Quiring:

Thank you for your letter dated August 3, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). The Agency has reviewed your concerns expressed in the letter and outlined below is the Agency's response.

Under the Program , two (2) recharge ponds (10 acre and 5 acre) are proposed for construction, both located just east of Allen Road and near the Kern River Stockdale Highway bridge . A proposed 40 acre to 50 acre Soccer field to be constructed may be used for groundwater recharge in the wettest years on the Kern River. This proposed field is also located east of Allen Road and north of the Kern River near the Stockdale bridge. The recharge ponds will be operated very similar to the Truxtun Lake recharge ponds owned by the City of Bakersfield, which we understand have not created a mosquito concern to the surrounding community. The Soccer field will probably be operated by the North of the River Parks and Recreation District under an arrangement with the City of Bakersfield. The two recharge ponds may be jointly managed by the Agency's Improvement District No. 4 and the City of Bakersfield's Water Resources Department. The recharge ponds and Soccer field are planned as part of a community park under a residential and commercial development proposed by Castle and Cooke California, Inc.

As with other existing recharge basins under the Agency's control, we do not anticipate any concerns with mosquitoes , however, we will comply with any applicable regulations and cooperate with your District to address any concerns you may have, should any arise at some future time. Please contact Kane Totzke at (661) 634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manger

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

KR/KRP

MANAGER
ROBERT A. QUIRING

SUPERINTENDENT
TOM BLANTON

KERN
MOSQUITO AND VECTOR CONTROL DISTRICT
DISTRICT OFFICE
4705 ALLEN RD. BAKERSFIELD, CALIFORNIA 93312
PH: (661) 589-2744 FAX: (661) 589-4913 E MAIL: kmvcd@lightspeed.net

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Kern County Water Agency

August 3, 2000

Tom Clark, General Manager
Kern County Water Agency
P. O. Box 58
Bakersfield, California 93302-0058

RE: Kern River Restoration & Water Supply Project

Tom:

The District has several comments in regard to the recharge basins that would be constructed as part of this proposed project.

During years when groundwater recharge operations were being conducted, it would not be feasible to treat these basins by aircraft if they produced mosquitoes because of the proximity of residential areas and heavily-traveled roads (i.e Stockdale, Buena Vista, Allen). During the last couple of years when performing mosquito control operations, the District's airplane pilot has encountered increasing numbers of joggers, bikers, horseback riders, etc. in the "2800" and the other recharge areas west of Allen Road. These new basins will, also, attract similar attention by the public.

Ideally, vegetation in the basins would be managed in a manner that would allow the control of the aquatic stage of mosquitoes through the use of mosquitofish. Due to the size of these basins, treatment by ground rigs spraying around the perimeter would be ineffective. The use of insecticides in areas frequented by the public is a real challenge these days due to the increasingly negative reaction by people to pesticide usage in general.

Hopefully, these concerns will be considered by the Agency when the basins are constructed.

Sincerely,

Rob Quiring

Rob Quiring
District Manager

KERN COUNTY
WATER AGENCY

GROUNDWATER Kern River Program

August 29, 2000

Ms. Susan Jones
U.S. Fish and Wildlife Service
2800Cottage Way, W-2605
Sacramento, CA 95825

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Ms. Jones:

Thank you for your letter dated August 21, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). We concur with the U.S. Fish and Wildlife Service's (Service) statement that the Program as proposed will provide environmental benefits to the local environment: the Agency believes the Program is an opportunity to secure environmental local benefits along the Kern River corridor for wildlife and the community of Bakersfield.

In response to the Service's concern regarding participation in the Metropolitan Bakersfield Habitat Conservation Plan (HCP), the Agency plans to comply with any regulations including those requiring participation in payment of habitat management fees, where applicable. We note however that,the Program facilities proposed for modification and/or construction taking place within the Metropolitan Bakersfield HCP are projects less than ten (10) acres in size undertaken for strictly public purposes and therefore exempt from the Habitat Management Fees, pursuant to the City of Bakersfield Ordinance 3556.

Other Program facilities, as described in the Initial Study and proposed Negative Declaration may occur on active farmland owned by the Agency, on well maintained right-of-ways owned by the Agency or other local water districts. These proposed facilities will have a very small footprint of permanently disturbed land, e.g., less than 1/10th of an acre disturbance per well site, in areas devoid of species subject to the Federal Endangered Species Act. Furthermore, since no take of threatened or endangered species will occur due to construction of facilities on farmland, fallow land, grazing land or natural land, the Agency believes no incidental take permit or compensation is required for the Program. The Agency will, of course, comply with the regulations if avoidance of impacts is not feasible.

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

The Agency hopes this letter resolves any concerns you may have with the Program. Again, we believe the overall Program will secure significant water quality, water supply, environmental and community benefits to the citizens of the greater Bakersfield area. The Program will also complement and supplement the existing the Kern River Parkway Plan adopted by the City of Bakersfield in 1988 through cooperative water exchanges and groundwater recovery to keep the Kern River wet through the center of Bakersfield during the peak recreational months of May through September. Please contact Kane Totzke at (661) 634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manager

GW/KKP

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825

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Kern County Water Agency
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IN REPLY REFER TO:
1-1-00-TA-2553

August 14, 2000

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, California 93302-0058

Subject: California Environmental Quality Act (CEQA) Compliance for the Kern River Restoration and Water Supply Program, Kern County, California

Dear Mr. Clark:

This is in response to your July 27, 2000, letter concerning the Initial Study and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program in Kern County, California. We understand from the materials enclosed with your letter that some of the property proposed for development is inside, and some is outside the boundaries of the Metropolitan Bakersfield Habitat Conservation Plan (HCP). We appreciate your efforts to provide water in the river channel for a greater part of the year, and we agree that this will enhance riparian vegetation and could provide habitat for some protected species in an area where they historically occurred, such as the least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*).

1 We expect that some parts of the project will occur within the boundaries of the Metropolitan Bakersfield HCP, and that fees will be paid into the habitat compensation fund. We think this should be mentioned in the Negative Declaration, as it is a mitigation under CEQA for effects on protected species. We are concerned about the effects of portions of the project outside the Metropolitan Bakersfield HCP on San Joaquin kit foxes (*Vulpes macrotis mutica*), Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*), and blunt-nosed leopard lizards (*Gambelia silus*), which are protected under the Federal Endangered Species Act of 1973, as amended (Act). The map of the project mentions potential agricultural and urban area well sites, and installation of recharge ponds on an 80-acre parcel now belonging to Castle and Cooke. Kit fox are known to forage on, and disperse across natural land, fallow land, farmland in row crops, and grazing land. 2 Any construction of structures on farmland, fallow land, grazing land, or natural land likely will require compensation under the Act. No indication is given of the present land uses and

project footprints for portions of the project outside the MB HCP, so we cannot provide an adequate evaluation at this time.

Section 9 of the Act and its implementing regulations prohibit the "take" of federally listed fish and wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any listed wildlife species. "Harm" in this definition includes significant habitat modification or degradation where it actually kills or injures wildlife, by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures. If a Federal agency is involved with the permitting, funding, or carrying out of the project, then initiation of formal consultation between that agency and the Service pursuant to section 7 of the Act is required if it is determined that the proposed project will adversely affect a listed species. Such a consultation would result in a biological opinion that addresses the anticipated effects of the project to the listed species and may authorize a limited level of incidental take. If a Federal agency is not involved with the project, and a listed species may be taken as a result of the project, then an incidental take permit pursuant to section 10(a)(1)(B) of the Act should be obtained. The Service may issue a permit upon completion of a satisfactory HCP for the listed species that would be subject to take as a result of the project. Applicants approved by the Service and the California Department of Fish and Game, as applicable, may satisfy the Act by buying credits and obtaining incidental take authority through the Kern Water Bank HCP and Master Permit.

While the Metropolitan Bakersfield HCP is not applicable to portions of the project outside its borders, it sets a precedent in Kern County for providing endangered species compensation for conversion of farmland to buildings and other structures. For example, we worked with the Kern County Planning Department in the development of the compensation measures that were required for the Rio Bravo Tomato Company plant, which was sited on row crop farmland.

We appreciate you contacting us about your proposed project. We would appreciate receiving more detailed information about the project concerning proposed construction locations and footprints, related access roads if any, and schedule. Thank you for your interest in conserving threatened and endangered species. Please contact Susan Jones or Peter Cross at (916) 414-6600 if you have any questions about this letter.

Sincerely,

Karen J. Miller

Karen J. Miller
Chief, Endangered Species Division

cc: Andy Gordus, CDFG, Fresno, California
Steve Strait, Kern County Planning Department
Cheryl Harding, Kern Water Bank Authority

GW/KRP
Govst/RWQCB

California Regional Water Quality Control Board

Central Valley Region

Steven T. Butler, Chair

I. Hickox
ry for
onmental
otection

Fresno Branch Office
Internet Address: http://www.swrcb.ca.gov/~rwqcb5
3614 East Ashlan Avenue, Fresno, California 93726
Phone (559) 445-5116 • FAX (559) 445-5910

Gray Davis
Governor

RECEIVED
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Kern County Water Agency

TNC ☐
~~JBS~~ ☑
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JWP ☐
SHR ☐
SMR ☐
ALL ☐

xc:
Kern
Rick

23 August 2000

Ir. Thomas N. Clark, General Manager
ern County Water Agency
P. O. Box 58
akersfield, CA 93302-0058

SCH # 2000081017, KERN RIVER RESTORATION AND WATER SUPPLY PROJECT, KERN COUNTY

/e have reviewed the Initial Study and Proposed Negative Declaration to provide groundwater and surface water augmentations to the Kern River as it flows through the City of Bakersfield. The augmentations will occur uring the summer months and be used for recreation. We understand that the project will involve construction of new agricultural and urban wells, modification of existing water exchange facilities and, possibly, construction of an interconnection in the area of the Kern River.

more than five acres will be disturbed, the construction activities will be subject to regulation under the General Construction Activity Storm Water Permit, State Water Resources Control Board Order No. 99-08-WQ, National Pollutant Discharge Elimination System, General Permit No. CA000002 (general permit). A copy of the permit is enclosed. Before construction begins, a Notice of Intent to comply with the permit must be submitted to the State Water Resources Control Board at the address indicated in the permit, and a Storm Water ollution Prevention Plan must be prepared. Further information regarding the storm water program is available at the State Board web site at: http://www.swrcb.ca.gov or you may call Jarma Bennett at (559) 445-6046.

the construction activities will involve the discharge of dredged or fill material into navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the US Army Corps of Engineers. For more information, please call Kathy Norton with the US Army Corps of Engineers at 916) 557-5260.

f a permit is needed from the US Army Corps of Engineers, certification of conformance with water quality tandards pursuant to Section 401 of the Clean Water Act will be needed. Enclosed is a summary of information that we would need to consider a request for water quality certification.

f you have any questions, please call Betty Yee of this office at (559) 445-5128.

Lonnie M. Wass

LONNIE M. WASS
enior Engineer
CE No. 38917

nclosure

'LANNING DEPARTMENT
TED JAMES, AICP, Director
'700 "M" STREET, SUITE 100
AKERSFIELD, CA 93301-2323
hone: (661) 862-8600
FAX: (661) 862-8601 TTY Relay 1-800-735-2929
E-Mail: planning@co.kern.ca.us
b Address: www.co.kern.ca.us/planning/info.htm

RESOURCE MANAGEMENT AGENCY
DAVID PRICE III, RMA DIRECTOR
Community Development Program Department
Engineering & Survey Services Department
Environmental Health Services Department
Planning Department
Roads Department

September 5, 2000

Tom Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield CA 93302-0058

Re: Initial Study - Kern River Restoration and Water Supply Program

Dear Mr. Clark:

Thank you for the opportunity to review the Initial Study for this project. The Planning Department has no comments on this phase of the project. If you have any questions, please call Steve Strait at (661) 862-8643.

Very truly yours,

TED JAMES, AICP, Director
Kern County Planning Department

Steve Strait

by Steve Strait, Associate Planner

abandonment will be reviewed at that time. If the well cannot be identified, remedial operations may be required.

Thank you for the opportunity to comment on the initial study and proposed negative declaration. If you have questions, or require technical assistance or information, please contact Jack Truschel at the Bakersfield district office: 4800 Stockdale Highway, Suite 417, Bakersfield, CA 93309; or, phone (661) 322-4031. You may also call me at (916) 445-8733.

Jason Marshall
Assistant Director

cc: Jack Truschel
Division of Oil, Gas, and Geothermal Resources, Bakersfield
Linda Campion
Division of Oil, Gas, and Geothermal Resources, Sacramento

DIRECTORS
WILLIAM D. PHILLIMORE
PRESIDENT
DAVID L. BARGER
VICE PRESIDENT
DAVID K. BANKER
SECRETARY
LARRY STARRH
TREASURER
ROBERT E. BAKER

BELRIDGE WATER STORAGE DISTRICT

J. PAUL HENDRIX
GENERAL MANAGER

WILLIAM C. KUHS
COUNSEL

September 6, 2000

Board of Directors
Kern County Water Agency
P. O. Box 58
Bakersfield, CA 93302-0058

Re: Funding for Kern River Restoration Project, Purchase of Lower River Rights and Associated Activities

Dear Sirs and Madam:

Further to the policy meeting of Tuesday, August 29, 2000, and the Belridge Water Storage District (BWSD) Board meeting held on September 5, 2000, I am writing to you on behalf of the Belridge Board of Directors.

We appreciate the recent efforts of the Kern County Water Agency (KCWA) staff to explain the project as it develops, and acknowledge that this is still an evolving program. While we support the general direction of the Agency in this instance, and in deed applaud the efforts of Agency staff which made such a project possible, we ask that during the finalization of the project that staff attempt to assure that the BWSD is no worse off in its access to banking operations or water than it was prior to the acquisition of the Lower River Rights by the KCWA.

We would also like to point out that currently BWSD has no opportunity to bank high flow river water in times of plenty, in order to withdraw such water during times of shortage. We would very much like to have access to some of this water.

While we know that there have been questions raised as to the equity of the distribution of the monies which, we understand, were originally intended to compensate for shortages on the State Water Project, we are sure that the KCWA Directors and staff will strive to be fair to all. We would hope, however, the substantial benefits that accrue to the City of Bakersfield from the project will lead to the City becoming further involved in water matters within the County. We believe that both the County and the City have

POST OFFICE BOX 1087 BAKERSFIELD, CALIFORNIA 93302-1087 TELEPHONE (661) 762-7316
FAX (661) 762-7223

suffered from the absence of the City on many of the discussions regarding water and how it effects the future of the County. Hopefully this will now change.

Please let us know if there are any questions on any of the above.

Sincerely,

William D. Phillimore
President

WDP/et

GOVERNOR'S OFFICE OF
Planning and Research

1400 Tenth Street • Sacramento, California 95814 • 916-445-0613

FACSIMILE TRANSMITTAL

Date: 9-7-00

Facsimile phone number: 661/634-1428

To: Kane Totzke

At: Kern County

From: Sheila - State Clearinghouse

Special instructions: Closing Letter with comments for SCH #2000081017

State Clearinghouse Fax: 916-323-3018

Number of pages
(including cover page)

5

If you do not receive all the pages of this facsimile, please contact:

STATE OF CALIFORNIA
Governor's Office of Planning and Research
State Clearinghouse

Gray Davis
GOVERNOR

Steve Nissen
ACTING DIRECTOR

September 6, 2000

Kane Totzke
Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield, CA 93308

Subject: Kern River Restoration and Water Supply Program
SCH#: 2000081017

Dear Kane Totzke:

The State Clearinghouse submitted the above named Negative Declaration to selected state agencies for review. On the enclosed Document Details Report please note that the Clearinghouse has listed the state agencies that reviewed your document. The review period closed on September 5, 2000, and the comments from the responding agency (ies) is (are) enclosed. If this comment package is not in order, please notify the State Clearinghouse immediately. Please refer to the project's ten-digit State Clearinghouse number in future correspondence so that we may respond promptly.

Please note that Section 21104(c) of the California Public Resources Code states that:

> "A responsible or other public agency shall only make substantive comments regarding those activities involved in a project which are within an area of expertise of the agency or which are required to be carried out or approved by the agency. Those comments shall be supported by specific documentation."

These comments are forwarded for use in preparing your final environmental document. Should you need more information or clarification of the enclosed comments, we recommend that you contact the commenting agency directly.

This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act. Please contact the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process.

Sincerely,

Terry Roberts

Terry Roberts
Senior Planner, State Clearinghouse

Enclosures
cc: Resources Agency

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
916-445-0613 FAX 916-323-3018 WWW.OPR.CA.GOV/CLEARINGHOUSE.HTML

Document Details Report
State Clearinghouse Data Base

SCH# **2000081017**
Project Title Kern River Restoration and Water Supply Program
Lead Agency Kern County Water Agency

Type **Neg** Negative Declaration

Description Acquisition of Kern River lower right, modification and construction of water conveyance, recharge and recovery facilities.

Lead Agency Contact

Name Kane Totzke
Agency Kern County Water Agency
Phone 661-634-1468 ***Fax***
email
Address P.O. Box 58
3200 Rio Mirada Drive
City Bakersfield ***State*** CA ***Zip*** 93308

Project Location

County Kern
City Bakersfield
Region
Cross Streets Buena Vista Road
Parcel No.
Township 30 ***Range*** 26/25 ***Section*** all ***Base*** MDB&M

Proximity to:

Highways Stockdale Highway
Airports
Railways
Waterways Kern River
Schools
Land Use Agricultural

Project Issues

Reviewing Agencies Resources Agency; Department of Conservation; Department of Fish and Game, Region 4; Office of Historic Preservation; Department of Parks and Recreation; Reclamation Board; Department of Water Resources; Caltrans, District 6; Department of Health Services; State Water Resources Control Board, Division of Water Rights; Regional Water Quality Control Bd., Region 5 (Fresno); Native American Heritage Commission; State Lands Commission

Date Received 08/07/2000 ***Start of Review*** 08/07/2000 ***End of Review*** 09/05/2000

Note: Blanks in data fields result from insufficient information provided by lead agency.

State of California **The Resources Agency**

MEMORANDUM

To: Project Coordinator
Resources Agency

Date: August 31, 2000

CCS 9/5/00

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, CA 93302-0058

RECEIVED
SEP 1 2000
STATE CLEARINGHOUSE

From: **Department of Conservation**
Office of Governmental and Environmental Relations

Subject: Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program, Kern County – **SCH #2000081017**

The Department of Conservation's Division of Oil, Gas and Geothermal Resources (Division) has reviewed the initial study for the referenced project. The Division supervises the drilling, maintenance, and plugging and abandonment of oil, gas and geothermal wells in California. We offer the following comments for your consideration.

The proposed project area encompasses all, or a portion of the following oil fields: Bellevue, Canal, Canfield Ranch, Fruitvale, Kern River, McClung, North Coles Levee, Strand, Stockdale and Ten Section. There are numerous plugged and abandoned, producing and injection wells within or in proximity to these fields. Proposed project construction includes water wells, water quality exchange facilities, and facilities to enhance groundwater recharge and recovery. The project also proposes mitigation measures such as avoiding areas suspected to have hydrocarbon contamination and, where practical, avoiding interference with petroleum pipelines and oilfield areas.

In support of these proposed mitigation measures, the Division recommends that the proposed construction projects be plotted accurately on the appropriate Division maps, and submitted to the Division's Bakersfield office for review. Upon receipt of the maps, the Division will provide locations of the affected wells. Also based on our review of the maps, the Division will convey information to the applicant on any applicable well work requirements. In addition, the Division requests that these oilfield wells be plotted accurately on all future maps related to this project, and that a legible copy of the final project map be submitted to the Division's Bakersfield office.

Finally, the Division district office in Bakersfield must be notified if excavation uncovers a previously plugged and abandoned well. If the well can be identified, its

Mr. Thomas N. Clark
August 31, 2000
Page 2

abandonment will be reviewed at that time. If the well cannot be identified, remedial operations may be required.

Thank you for the opportunity to comment on the initial study and proposed negative declaration. If you have questions, or require technical assistance or information, please contact Jack Truschel at the Bakersfield district office: 4800 Stockdale Highway, Suite 417, Bakersfield, CA 93309; or, phone (661) 322-4031. You may also call me at (916) 445-8733.

for Jason Marshall
Assistant Director

cc: Jack Truschel
Division of Oil, Gas, and Geothermal Resources, Bakersfield
Linda Campion
Division of Oil, Gas, and Geothermal Resources, Sacramento

KERN COUNTY
WATER AGENCY

GW/Kern River Program

September 7, 2000

Mr. Jack Truschel
Division of Oil, Gas, and Geothermal Resources
4800 Stockdale Highway, Suite 417
Bakersfield, CA 93309

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Mr. Truchel:

Thank you for your letter dated August 31, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). The Agency has reviewed your concerns expressed in the letter and outlined below is the Agency's response.

Under the Program, up to 24 water production wells, several recharge areas and modifications to existing canal systems are proposed for construction. Site assessments will be made prior to construction to identify oil and gas wells. As part of the site assessments, the project facilities will be plotted on Division of Oil and Gas maps and submitted to you for review.

The Agency will also notify your office if the proposed Program activities uncover a previously plugged and abandoned oil or gas well. The Agency will comply with any other applicable regulations and cooperate with your District to address concerns you may have, should any arise at some future time. Please contact Rick Iger at 661/634-1469 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manger

Mailing Address:
P.O. Box 58
akersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

KERN COUNTY
WATER AGENCY

SECRETARY'S CERTIFICATE

I, Pam Bosworth, Secretary of the Board of Directors of the Kern County Water Agency, do hereby certify that the foregoing is a full, true and correct copy of Resolution No. 56-00 duly passed and adopted by said Board of Directors at an official meeting of the Board held on the 24th day of August 2000, by the following vote:

AYES: Garnett, Frick, Radon, Lundquist, Rogers & Mathews

NOES: None

ABSENT: None

Pam Bosworth

Secretary of the Board of Directors
of the Kern County Water Agency

SEAL:

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

BEFORE THE BOARD OF DIRECTORS

OF THE

KERN COUNTY WATER AGENCY

In the matter of:
ACCEPTANCE OF PROPOSITION 13
GRANT FOR THE KERN RIVER
RESTORATION PROJECT, AUTHORIZATION
OF PRESIDENT TO EXECUTE AGREEMENT,
DESIGNATION OF PROJECT DIRECTOR FOR
ADMINISTRATION AND DWR LIAISON, AND
APPROVAL OF BUDGET, TIMELINE AND INVOICE
______________________________________/

I, PAMELA BOSWORTH, Secretary of the Board of Directors of the Kern County Water Agency, of the County of Kern, State of California, do hereby certify that the following resolution proposed by Director Frick and seconded by Director Radon, was duly passed and adopted by said Board of Directors at an official meeting hereof this 24th day of August, 1998 by the following vote, to-wit:

Ayes: Garnett, Frick, Radon, Lundquist, Rogers & Mathews

Noes: None

Absent: Starrh

Pam Bosworth
Secretary of the Board of Directors
of the Kern County Water Agency

Resolution No. 56-00

WHEREAS, the Governor's Budget Act for 2000, Chapter 52, Statutes of 2000 appropriated to the Department of Water Resources grant funds by budget item 3860-01-6027 for the Interim Water Supply and Water Quality Infrastructure and Management Subaccount to fund among other things the Kern River Restoration Project specified herein;

WHEREAS, DWR has proposed entry into an agreement with the Agency as demonstrated in attached Exhibit A to govern the grant and Agency acceptance thereof along with certain terms and conditions;

WHEREAS, the Agency is prepared to continue implementation of the project and has established a separate "Proposition 13 Fund" to allow for appropriate accounting of all income and expenditures of the project; and

WHEREAS, the General Manager has selected an Agency Executive Manager as Project Director.

NOW THEREFORE BE IT RESOLVED by the Board of Directors of the Kern County Water Agency that:

1. The foregoing recitals are found to be true and correct;

2. The Agency hereby accepts the offered $23 million dollar grant from the Department of Water Resources for the purposes of the project, and authorizes President Fred Starrh to enter into the Department of Water Resources proposed agreement attached as Exhibit A, subject to the approval of General Counsel as to form.

3. Assistant General Manager James M. Beck is designated as the Project Director to be the Agency's representative for the administration of the project and liaison with DWR for submission of required documents.

4. The proposed budget for the project attached as Exhibit B, and the proposed timeline for project development (conditioned upon CEQA compliance) attached as Exhibit C are hereby approved.

5. The Controller is directed to invoice the Department of Water Resources for the $23 million grant in accordance with the terms of the agreement, with the funds to be deposited in the Proposition 13 Fund and to maintain appropriate accounting for such funds in accordance with Generally Accepted Accounting Practices and the agreement.

EXHIBIT A

Advance Copy
Information Only

Mr. Fred L. Starrh, President
Board of Directors
Kern County Water Agency
Post Office Box 58
Bakersfield, California 93302-0058

Interim Water Supply Construction Grant Commitment –
Safe Drinking Water, Clean Water, Watershed Protection and
Flood Protection Act (Proposition 13, Chapter 9, Article 4)

Dear Mr. Starrh:

The Governor□s Budget Act for 2000, Chapter 52, Statutes of 2000, appropriated to the Department of Water Resources local assistance grant funds in the amount of $161,544,000 by budget item 3860-01-6027, payable from the Interim Water Supply and Water Quality Infrastructure and Management Subaccount. The Kern County Water Agency's Kern River Restoration Project has been selected for funding from this appropriation. This letter agreement serves as our commitment of $23 million this project.

This letter sets forth the terms and conditions under which the transfer of funds will be made from DWR to KCWA. Before the funds can be transferred your agency must complete the following:

- Submit to DWR a formally adopted resolution of your governing body, accepting the grant, designating a representative to sign this letter agreement, and designating a Project Director to be your agency□s representative for the administration of the project and liaison with DWR for submission of required documents.
- Sign and date both originals of this agreement and return one signed original to:

  Division of Planning & Local Assistance
  Department of Water Resources
  Post Office Box 942836
  Sacramento, California 94236-0001
  Attention: Linda Buchanan Herzberg

- Provide to DWR a copy of all memoranda of understanding or other cooperative agreements between your agency and all other participating agencies for the project.

DNA

Advance Copy
Information Only

- Provide to DWR an itemized budget projection of project costs and an invoice, on your letterhead, stating the purpose of the funds as outlined in this letter.

- Provide to DWR a detailed description of the proposed project, including a narrative description that details the project's purpose and defines the project scope. Include with your description a detailed list of project components to be funded by this grant and a time line for completion with major benchmarks noted. In addition, attach a map indicating the project location.

By signature of this letter agreement the Kern County Water Agency agrees to comply with the following terms and conditions for completion of your project:

1. Your agency agrees to faithfully and expeditiously perform or cause to be performed all project work, to apply State funds received only to eligible project costs and to expeditiously commence and to continue efficient and economical operation of the project in accordance with applicable law. You further agree to provide for all repairs, renewals, and replacements necessary to the efficient operation of the project; and to maintain in as good and efficient condition as upon its construction, ordinary and reasonable wear and depreciation excepted.

2. Your agency, its contractors, subcontractors, and their respective agents and employees required for performing any work in connection with the project shall act in an independent capacity and not as officers, employees or agents of the State.

3. Your agency is solely responsible for design, construction, operation and maintenance of the project.

4. Your agency shall be responsible for obtaining any and all permits, licenses and approvals required for the design, construction or operation of the project. You shall also be responsible for observing and complying with any applicable federal, state and local laws, rules or regulations affecting such work, specifically including, but not limited to, environmental, procurement and safety laws, rules, regulations and ordinances.

5. Your agency shall be responsible for work and for persons or entities engaged in work, including, but not limited to, subcontractors, suppliers and providers of services. You shall give personal supervision to any work required for the project or employ a competent representative with the authority to act for your agency. Your agency shall give attention to completion of the project, and shall keep work under control.

Advance Copy
Information Only

6. Your agency shall be responsible for any and all disputes arising out of its contracts for work on the project, including but not limited to bid disputes and payment disputes with your contractors and subcontractors. The State will not mediate disputes between your agency and any other entity concerning responsibility for performance of work.

7. During project planning and construction, your agency shall provide semiannual progress reports detailing the activities completed for the reporting period, the amount of funds expended and the purpose of those expenditures. The first report shall be due six (6) months from the date of your agency's signature on this letter agreement. Subsequent reports shall be due every six (6) months thereafter.

8. Your agency must comply with all applicable requirements of the California Environmental Quality Act and the National Environmental Policy Act and complete appropriate environmental documentation including, but not limited to, any required environmental impact reports, environmental impact statements, negative declarations, mitigation agreements and environmental permits, prior to beginning construction.

9. All contracts let for project construction shall be let by competitive bid procedures that assure award of the contract to the lowest responsible bidder, except as may be otherwise authorized under your agency's enabling authority.

10. Procurement of necessary supplies or equipment shall be undertaken in such a manner as to encourage fair and competitive treatment of potential suppliers.

11. The project shall be completed not later than March 8, 2009.

12. Upon completion of the project your agency shall provide for a final inspection and a written certification by a California Registered Civil Engineer that the project has been completed in accordance with final plans and specifications and any modifications thereto. Such certification shall be submitted to the State with a copy of the final report of project expenditures required in item 13 below. You shall keep on file, for the useful life of the project, as built plans and specifications for the project. Such documents shall be made available for inspection by the State upon reasonable notice.

13. Upon project completion your agency shall furnish to the State, within sixty (60) days, a final statement of incurred eligible costs.

14. The State shall withhold ten (10) percent of the total project funding until the audit report, required in item 20, is received and accepted by the State.

15. Within a period of sixty (60) days from project completion, your agency shall remit to the State any unexpended funds that were disbursed that were not needed to pay eligible project costs.

16. Pursuant to Government Code Section 8546.7, your agency and its subcontractors shall be subject to the examination and audit of the State for a period of three years after project completion. All of your records or those of your subcontractors shall be preserved for this purpose for at least three years after project completion.

17. Your agency shall account for the money disbursed separately from all other agency funds. You shall maintain audit and accounting procedures that are in accordance with generally accepted accounting principles and practices, consistently applied. You shall keep complete and accurate records of all receipts, disbursements, and interest earned on expenditures of such funds. Your agency shall require its contractors or subcontractors to maintain books, records, and other documents pertinent to their work in accordance with generally accepted accounting principles and practices. Records are subject to inspection by the State at any and all reasonable times, upon reasonable notice.

18. All money disbursed for your project shall be deposited, administered, and accounted for pursuant to the provisions of law applicable to your agency.

19. During regular office hours, each of the parties to this letter agreement and their duly authorized representatives shall have the right to inspect and to make copies of any books, records, or reports of either party pertaining to the project. Each of the parties shall maintain and shall make available at all times for such inspection accurate records of all its costs, disbursements, and receipts with respect to this project.

20. The State reserves the right to conduct an audit at any time between the execution of this letter agreement and the completion of the project, with the costs of such audit borne by the State. Within sixty (60) days of project completion, the State shall require your agency to conduct, at your agency=s expense, a final financial and compliance audit of revenue and expenditures. Such audit shall be conducted and a report prepared by an independent Certified Public Accountant in compliance with generally accepted auditing standards and California government auditing standards. Upon its completion, said report shall submitted to the State for review and acceptance.

21. The State shall have the right to inspect the work being performed at any and all reasonable times during project construction. This right shall extend to any subcontracts, and your agency shall include provisions ensuring such access in all its contracts or subcontracts entered into for completion of the

project.

22. Your agency shall not sell, abandon, lease, transfer, exchange, mortgage, hypothecate, or encumber in any manner whatsoever all or any portion of any real or other property necessarily connected or used in conjunction with the project, or with your agency's service of water, without prior approval of the State.

23. Your agency, its contractors and subcontractors shall comply with the provisions of the Fair Employment and Housing Act (Government Code, Section 12900 et seq.), the regulations promulgated thereunder (California Code of Regulations, Title 2, Section 7285.0 et seq.), the provisions of Article 9.5, Chapter 1, Part 1, Division 3, Title 2 of the Government Code (Government Code, Sections 11135-11139.5) and the regulations or standards adopted by the awarding State Agency to implement such article. Your agency, its contractors and subcontractors shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement. Your agency shall include the nondiscrimination and compliance provisions of this clause in all contracts and subcontracts let for the construction of the project.

24. Your agency agrees, unless exempted, to comply with the nondiscrimination program requirements of Government Code, Section 12990, and Title 2, California Code of Regulations, Section 8103.

25. Your agency shall comply with the provisions of Section 3700 of the California Labor Code, requiring every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and you affirm that the agency will comply with such provisions before commencing the construction of the project and will make the agency=s contractors and subcontractors aware of this provision.

26. Your agency agrees to indemnify the State and its officers, agents, and employees against and to hold the same free and harmless from any and all claims, demands, damages, losses, costs, expenses, or liability due or incident to, either in whole or in part, and whether directly or indirectly, arising out of the project.

27. Your agency, its contractors or subcontractors agree to comply with the requirements of the Drug-Free Workplace Act of 1990 (Government Code 8350 et seq.) and have or will provide a drug-free workplace.

28. The agency agrees to comply with the Americans with Disabilities Act (ADA) of 1990, (42 U.S.C. 12101 et seq.), which prohibits discrimination on the basis of disability, as well as all applicable regulations and guidelines issued pursuant to the ADA.

Advance Copy
Information Only

Your expeditious handling of this letter agreement is appreciated. If you have any questions, please contact Linda Buchanan Herzberg at (916) 327-1663.

Approved as to Legal Form and Sufficiency:	Sincerely,
By:________________________ Chief Counsel Department of Water Resources	________________________ William J. Bennett, Chief Division of Planning and Local Assistance

Kern County Water Agency

By:______________________________ Date:________________

Title:____

Enclosure

cc: Ms. Linda Adams
Chief Deputy Assembly Relations
Governor's Office, First Floor
Sacramento, California 95814

Honorable Jim Costa
Member of the Senate
State Capitol, Room 5100
Sacramento, California 95814

~~Honorable Abel Maldonado~~
~~Member of the Assembly~~
~~State Capitol, Room 4015~~
~~Sacramento, California 95814~~

Will add other appropriate Reps.

Mr. Thomas N. Clark
General Manager
Kern County Water Agency
Post Office Box 58
Bakersfield, California 93302-0058

Advance Copy
Information Only

Mr. Rick Iger
Engineering and Operations Manager
Kern County Water Agency
Post Office Box 58
Bakersfield, California 93302-0058

Ms. Holly Melton
Kern County Water Agency
Post Office Box 58
Bakersfield, California 93302-0058

EXHIBIT B

Kern River Program
Capital Budget Projection Summary

Item	**Allotment ($ Million)**
1) Purchase Water Supplies	
a) Garces undivided interest in Lower Kern River Right	2.5
b) Nickel portion of Lower Kern River Right	7.5
Subtotal	*10*
2) Urban Area Recharge and Recreational Facilities Enhancements	
a) Purchase Property	3
b) Facilities	0.1
Subtotal	*3.1*
3) Urban Area Recovery and Flow Restoration Facilities	
a) Wells	2.9
b) Conveyance	1
Subtotal	*3.9*
4) Exchange Facilities Improvements for Water Quality Benefits	
a) Intertie/Turnout Improvements	0.5
b) Pump Station Improvements	1.5
Subtotal	*2*
5) Banking Project Recovery Facilities Enhancements	
a) Recovery Facilities	1.4
b) Conveyance and Recharge Facilities	2.6
Subtotal	*4*
Total	**23**

GW/KRP
GovSt/Misc

STATE OF CALIFORNIA

Governor's Office of Planning and Research

State Clearinghouse

Gray Davis
GOVERNOR

Steve Nissen
ACTING DIRECTOR

ACKNOWLEDGEMENT OF RECEIPT

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Kern County Water Agency
KFT

DATE: August 17, 2000

TO: Kane Totzke
Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield, CA 93308

RE: Kern River Restoration and Water Supply Program
SCH#: 2000081017

This is to acknowledge that the State Clearinghouse has received your environmental document for state review. The review period assigned by the State Clearinghouse is:

Review Start Date: August 7, 2000
Review End Date: September 5, 2000

We have distributed your document to the following agencies and departments:

Caltrans, District 6
Department of Conservation
Department of Fish and Game, Region 4
Department of Health Services
Department of Parks and Recreation
Department of Water Resources
Native American Heritage Commission
Office of Historic Preservation
Reclamation Board
Regional Water Quality Control Bd., Region 5 (Fresno)
Resources Agency
State Lands Commission
State Water Resources Control Board, Division of Water Rights

The State Clearinghouse will provide a closing letter with any state agency comments to your attention on the date following the close of the review period.

Thank you for your participation in the State Clearinghouse review process.

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
916-445-0613 FAX 916-323-3018 WWW.OPR.CA.GOV/CLEARINGHOUSE.HTML

KR/KRP

MANAGER
ROBERT A. QUIRING

SUPERINTENDENT
TOM BLANTON

KERN
MOSQUITO AND VECTOR CONTROL DISTRICT
DISTRICT OFFICE
4705 ALLEN RD. BAKERSFIELD, CALIFORNIA 93312
PH: (661) 589-2744 FAX: (661) 589-4913 E MAIL: kmvcd@lightspeed.net

RECEIVED
~~TNO~~ ☑
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Kern County Water Agency

August 3, 2000

Tom Clark, General Manager
Kern County Water Agency
P. O. Box 58
Bakersfield, California 93302-0058

RE: Kern River Restoration & Water Supply Project

Tom:

The District has several comments in regard to the recharge basins that would be constructed as part of this proposed project.

During years when groundwater recharge operations were being conducted, it would not be feasible to treat these basins by aircraft if they produced mosquitoes because of the proximity of residential areas and heavily-traveled roads (i.e Stockdale, Buena Vista, Allen). During the last couple of years when performing mosquito control operations, the District's airplane pilot has encountered increasing numbers of joggers, bikers, horseback riders, etc. in the "2800" and the other recharge areas west of Allen Road. These new basins will, also, attract similar attention by the public.

Ideally, vegetation in the basins would be managed in a manner that would allow the control of the aquatic stage of mosquitoes through the use of mosquitofish. Due to the size of these basins, treatment by ground rigs spraying around the perimeter would be ineffective. The use of insecticides in areas frequented by the public is a real challenge these days due to the increasingly negative reaction by people to pesticide usage in general.

Hopefully, these concerns will be considered by the Agency when the basins are constructed.

Sincerely,

Rob Quiring

Rob Quiring
District Manager

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825

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Kern County Water Agency
KFT

IN REPLY REFER TO:
1-1-00-TA-2553

August 14, 2000

Kane
Sellers etc for
Response
Jord

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, California 93302-0058

Subject: California Environmental Quality Act (CEQA) Compliance for the Kern River Restoration and Water Supply Program, Kern County, California

Dear Mr. Clark:

This is in response to your July 27, 2000, letter concerning the Initial Study and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program in Kern County, California. We understand from the materials enclosed with your letter that some of the property proposed for development is inside, and some is outside the boundaries of the Metropolitan Bakersfield Habitat Conservation Plan (HCP). We appreciate your efforts to provide water in the river channel for a greater part of the year, and we agree that this will enhance riparian vegetation and could provide habitat for some protected species in an area where they historically occurred, such as the least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*).

X Insert — [illegible] will pay where applicable.

See [illegible] comment

We expect that some parts of the project will occur within the boundaries of the Metropolitan Bakersfield HCP, and that fees will be paid into the habitat compensation fund. We think this should be mentioned in the Negative Declaration, as it is a mitigation under CEQA for effects on protected species. We are concerned about the effects of portions of the project outside the Metropolitan Bakersfield HCP on San Joaquin kit foxes (*Vulpes macrotis mutica*), Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*), and blunt-nosed leopard lizards (*Gambelia silus*), which are protected under the Federal Endangered Species Act of 1973, as amended (Act). The map of the project mentions potential agricultural and urban area well sites, and installation of recharge ponds on an 80-acre parcel now belonging to Castle and Cooke. Kit fox are known to forage on, and disperse across natural land, fallow land, farmland in row crops, and grazing land. Any construction of structures on farmland, fallow land, grazing land, or natural land likely will require compensation under the Act. No indication is given of the present land uses and

Recite current use as farmland and emphasize avoidance strategy
Clarify that no structures will impair foraging.
Must say that if unexpected ~~[illegible]~~ [illegible] event [illegible] mitigate w/ Approved Credits

[illegible] to (estimate) [illegible] Footprint (sq ft) [illegible]

project footprints for portions of the project outside the MB HCP, so we cannot provide an adequate evaluation at this time.

Section 9 of the Act and its implementing regulations prohibit the "take" of federally listed fish and wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any listed wildlife species. "Harm" in this definition includes significant habitat modification or degradation where it actually kills or injures wildlife, by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures. If a Federal agency is involved with the permitting, funding, or carrying out of the project, then initiation of formal consultation between that agency and the Service pursuant to section 7 of the Act is required if it is determined that the proposed project will adversely affect a listed species. Such a consultation would result in a biological opinion that addresses the anticipated effects of the project to the listed species and may authorize a limited level of incidental take. If a Federal agency is not involved with the project, and a listed species may be taken as a result of the project, then an incidental take permit pursuant to section 10(a)(1)(B) of the Act should be obtained. The Service may issue a permit upon completion of a satisfactory HCP for the listed species that would be subject to take as a result of the project. Applicants approved by the Service and the California Department of Fish and Game, as applicable, may satisfy the Act by buying credits and obtaining incidental take authority through the Kern Water Bank HCP and Master Permit.

While the Metropolitan Bakersfield HCP is not applicable to portions of the project outside its borders, it sets a precedent in Kern County for providing endangered species compensation for conversion of farmland to buildings and other structures. For example, we worked with the Kern County Planning Department in the development of the compensation measures that were required for the Rio Bravo Tomato Company plant, which was sited on row crop farmland.

We appreciate you contacting us about your proposed project. We would appreciate receiving more detailed information about the project concerning proposed construction locations and footprints, related access roads if any, and schedule. Thank you for your interest in conserving threatened and endangered species. Please contact Susan Jones or Peter Cross at (916) 414-6600 if you have any questions about this letter.

Sincerely,

Karen J. Miller

Karen J. Miller
Chief, Endangered Species Division

cc: Andy Gordus, CDFG, Fresno, California
Steve Strait, Kern County Planning Department
Cheryl Harding, Kern Water Bank Authority

PLANNING DEPARTMENT
TED JAMES, AICP, Director
2700 "M" STREET, SUITE 100
BAKERSFIELD, CA 93301-2323
Phone: (661) 862-8600
FAX: (661) 862-8601 TTY Relay 1-800-735-2929
E-Mail: planning@co.kern.ca.us
Web Address: www.co.kern.ca.us/planning/info.htm

RESOURCE MANAGEMENT AGENCY
DAVID PRICE III, RMA DIRECTOR
Community Development Program Department
Engineering & Survey Services Department
Environmental Health Services Department
Planning Department
Roads Department

FACSIMILE TRANSMITTAL SHEET

FAX SERVICE FROM: **KERN COUNTY PLANNING DEPARTMENT**

SENT BY: Steve Strait
Name of Sender

****

Date: 9-5-00

FAX NO. ____________________

TO: KCWA
Company

ATTN: Tom Clark

2 TOTAL PAGES (Including this cover sheet)

COMMENTS: Original to follow in mail.

h:\jvb\planning\faxsht

'LANNING DEPARTMENT
TED JAMES, AICP, Director
700 "M" STREET, SUITE 100
AKERSFIELD, CA 93301-2323
hone: (661) 862-8600
FAX: (661) 862-8601 TTY Relay 1-800-735-2929
-Mail: planning@co.kern.ca.us
eb Address: www.co.kern.ca.us/planning/info.htm

RESOURCE MANAGEMENT AGENCY
DAVID PRICE III, RMA DIRECTOR
Community Development Program Department
Engineering & Survey Services Department
Environmental Health Services Department
Planning Department
Roads Department

September 5, 2000

Tom Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield CA 93302-0058

Re: Initial Study - Kern River Restoration and Water Supply Program

Dear Mr. Clark:

Thank you for the opportunity to review the Initial Study for this project. The Planning Department has no comments on this phase of the project. If you have any questions, please call Steve Strait at (661) 862-8643.

Very truly yours,

TED JAMES, AICP, Director
Kern County Planning Department

Steve Strait

by Steve Strait, Associate Planner

KERN COUNTY
WATER AGENCY

MEMORANDUM

GROUNDWATER krp
Agency B. of D.

TO: Kern County Water Agency Board of Directors
Agenda Item No. 1

FROM: John Stovall/Kane Totzke KT

DATE: September 7, 2000

SUBJECT: Agency adoption of a Negative Declaration pursuant to CEQA Guideline section 15072 for the Kern River Restoration Program

Issue:

Consider adoption of the draft Negative Declaration for the Kern River Restoration and Water Supply Program.

Recommended Motion:

At the close of the public hearing and absent any significant comments or testimony received at the hearing, adopt Resolution 59-00 entitled *Determinations and Findings with Respect to the Kern River Restoration and Water Supply Program*, thereby approving the Negative Declaration.

Discussion

At the July 27, 2000, meeting, the Board reviewed an Initial Study, Environmental Checklist, Response to Checklist prepared by staff for the Kern River Restoration and Water Supply Program. The Board also authorized the publication of the "Notice of Intent" to adopt a Negative Declaration and distribution of the documents to interested parties and responsible agencies for comments. During the public review period, the Agency has held a number of meetings with local water districts to address concerns and resolve outstanding issues regarding the proposed Project. As a result of the meeting and to resolve those issues the Agency is proposing to include a Mitigation, Monitoring and Reporting Program as part of the Negative Declaration. The Agency has also received a number of written comments from responsible agencies and these together with our responses are incorporated in the Negative Declaration, which will all be discussed in more detail at the public hearing.

At the public hearing, the Board will receive any additional comments on the environmental assessment of the Project and absent any significant comments or testimony received at the hearing, adopt Resolution 59-00, approving the Negative Declaration for the Project.

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BEFORE THE BOARD OF DIRECTORS

OF THE

KERN COUNTY WATER AGENCY

In the Matter of:
DETERMINATIONS AND FINDINGS *
WITH RESPECT TO THE *
KERN RIVER RESTORATION AND *
AND WATER SUPPLY PROGRAM *

I, Pam Bosworth, Secretary of the Board of Directors to the Kern County Water Agency, of the County of Kern, State of California, do hereby certify that the following resolution proposed by Director ____________ and seconded by Director __________________, was duly passed and adopted by said Board of Directors at an official meeting hereof this ___day of ___________________, 2000, by the following vote, to wit:

Ayes:

Noes:

Absent:

Secretary of the Board of Directors
of the Kern County Water Agency

RESOLUTION NO. 59-00

WHEREAS, the Board of Directors (the "Board") of the Kern County Water Agency (the "Agency") has had prepared, circulated and presented to it, and has reviewed and considered an Initial Study, Environmental Checklist, dated July 27, 2000, and a proposed Negative Declaration (Exhibit "A") attached thereto, all pertaining to the Kern River Restoration and Water Supply Program; and

WHEREAS, the Agency has received comments from several responsible agencies and interested parties and incorporated those comments, together with the Agency's response to those comments, in the appendix of the Negative Declaration; and

WHEREAS, the Agency has incorporated into and made part of the Negative Declaration, a Mitigation, Monitoring and Reporting Program that satisfactorily addresses the Federal and State Endangered Species Act, Injury to Rights of Legal Users of Water and Water Quality issues; and

WHEREAS, in recognition of the Agency securing the $23 million grant pursuant to Proposition 13, the Agency will continue to work with the Member Units and other local water districts to acquire additional grants and loans for the purpose of constructing water supply and/or water management facilities in Kern County.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Agency as follows:

The Board hereby finds and determines that the foregoing recitals, are true and correct.

1. Section 1, Review of Evidence

   The Board has reviewed and considered the contents of the Initial Study and proposed Negative Declaration, the presentation to the Board made by staff pertaining to same, and the comments received from the public both during a public hearing conducted by the Board on September 7, 2000 and received during the required environmental review period; and

2. Section 2, Approval of Negative Declaration

   Based upon the afore-described evidence, the Board hereby finds;

   a) that there is no substantial evidence that the Kern River Restoration and Water Supply Program with the mitigation measures provided therein will have a significant effect on the environment;

   b) that the mitigation measures therein are incorporated within the scope of the project, and the project as defined will not have a significant effect on the environment. Therefore, in accordance with such findings, the Board approves the Negative Declaration submitted in conjunction with the Initial Study and hereby directs staff to prepare and file a Notice of Determination (in the form attached hereto as Exhibit "B") in compliance with the California Environmental Quality Act (Public Resources Code Sections 21000, et seq.); and

3. Section 3. Finding of No Impact on Wildlife

The Board hereby further finds that, when considering the record as a whole, there is no substantial evidence before the Board that the proposed Project will have potential for an adverse effect on wildlife resources or the habitat upon which the wildlife depends on. As such, the Board directs the General manager to sign a Certificate of a De Minimis Impact Finding exempting payment of the $1,250 Department of Fish and Game fee (in the form attached hereto as Exhibit "C"). If subsequent information becomes available indicating potential impacts to Federal and State listed or sensitive species as defined under the State and Federal Endangered Species Act, the Agency will comply with all mandatory State and Federal laws.

4. Section 4, Mitigation, Monitoring and Reporting Program

The Board hereby incorporates the Mitigation, Monitoring and Reporting Program (in the form attached hereto as Exhibit "D") to address concerns with local water districts regarding water use, distribution of benefits and water quality.

5. Section 5, Continued efforts towards securing Proposition 13 funds

The Board hereby directs staff to continue working , in a timely manner, with Member Units and other local Kern County water districts towards maximizing the acquisition additional Proposition 13 grants and loans for local water supply projects and/or other water management projects as deemed appropriate by the General manager.

EXHIBIT A

KERN COUNTY WATER AGENCY
PROPOSED NEGATIVE DECLARATION

This is prepared pursuant to the California Environmental Quality Act of 1970 (CEQA), [1] and the State CEQA Guidelines, [2].

NAME OF PROJECT: Kern River Restoration and Water Supply Program.

PROPOSED PROJECT LOCATION: The Project is primarily located along the Kern River corridor from the projected extension of Haley Street on the east side, to the California Aqueduct on the west end, and south and west of Bakersfield in the unincorporated portion of the county along the Cross Valley Canal and Arvin-Edison Canal and including other local water conveyance facilities. Also, see attached Project location maps.

DESCRIPTION OF PROPOSED PROJECT: Summary. Project proposes to provide significant water quality, water supply, environmental and community benefits for the metropolitan Bakersfield area and a broad range of Kern County water users through the coordinated implementation of a number of program components including the: (1) acquisition of the Lower Kern River water right (Lower Right), i.e., Hacienda/Garces pre-1914 water right, including associated Lake Isabella Storage; (2) Purchase of land from Castle and Cooke California, Inc., for additional recharge and recovery facilities; (3) construction of 12 new water Ag recovery wells and enough Urban wells to achieve a maximum flow capacity of 60 cfs; and (4) Construction of water exchange facilities and modification of the Pool 1 portion of the Cross Valley Canal.

Expanded Description. See Initial Study for Proposed Project, attached.

FINDINGS WHICH SUPPORT NEGATIVE DECLARATION: After making an assessment of the possible impacts of the proposed Project and reviewing an Initial Study dated July 27, 2000, the Board of Directors of the Kern County Water Agency has determined that the proposed Project as presented will not have any significant effect on the environment, either directly or indirectly.

INITIAL STUDY: A copy of the Initial Study and environmental checklist prepared by Agency staff, dated July 27, 2000, is attached.

EXHIBIT A

MITIGATION MEASURES: Mitigation measures which have been incorporated into the proposed Project to avoid potentially significant environmental effects are as follows:

1. Throughout the term of the proposed Project, Project water quality, groundwater monitoring, and groundwater recharge losses will be consistent with the Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program, dated October 26, 1995, and consistent with the Operation and Monitoring Procedure for the Pioneer Project, dated May 28, 1998.

2. Project recharge and recovery well areas will be designed and located to avoid areas suspected to have hydrocarbon contamination, and to the extent practical, not to interfere with oil (crude or refined) or natural gas pipelines or other sensitive oilfield areas.

3. Project recharge and recovery well areas will be designed and located to minimize potential impacts to the Agency's Cross Valley Canal.

4. A mitigation, Monitoring and Reporting Program (attached as Exhibit C)

CONTACT PERSON, TELEPHONE NUMBER: Mr. Thomas N. Clark, General Manager, Kern County Water Agency, P.O. Box 58, Bakersfield, CA. 93302; (661)-634-1400. If you require additional information regarding this proposed Project, please contact Mr. Kane Totzke, Kern County Water Agency, (661) 634-1468; e-mail: kane@kcwa.com

Thomas N. Clark, General Manager　　　　Date

---

1. Public Resources Code, Section 2100, et seq.

2. Title 14, Division 6, California Administrative Code, as amended.

KERN COUNTY
WATER AGENCY

Directors:

Fred L. Starrh
President
Division 1

Terry Rogers
Division 2

Peter Frick
Division 3

Michael Radon
Division 4

Adrienne J. Mathews
Division 5

Henry C. Garnett
Vice President
Division 6

Gene A. Lundquist
Division 7

Thomas N. Clark
General Manager

John F. Stovall
General Counsel

GROUNDWATER krp

September 7, 2000

Ms. Karen Fowler
Office of the Governor
Office of Planning and Research
State Clearinghouse
P.O. Box 3044
Sacramento, Ca 95812-3044

RE: SCH # 2000081017 - Notice of Determination and De Minimis Impact Finding

Dear Ms. Fowler:

Transmitted herein are the Kern County Water Agency's (Agency) "Notice of Determination" and a "California Department of Fish and Game Certificate of Fee Exemption -De Minimis Impact Finding" for the *Kern River Restoration and Water Supply Program* Negative Declaration. The Agency Board of Directors took action to adopt the Negative Declaration at a meeting held on September 7, 2000. The De Minimis Impact finding exempts the Agency from the $1,250 filing fee. Please contact Kane Totzke at 661-634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manager

enclosures

cc: Office of the County Clerk (Kern)

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

EXHIBIT B
CEQA Notice of Determination

X Office of Planning and Research
1400 Tenth Street, Room 121
Sacramento, CA 95814

From: Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield, CA 93302

X County Clerk
County of Kern
1115 Truxton Ave., 1st Floor
Bakersfield, CA 93301-4639

ect: Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code.

ɔject Title: Kern River Restoration and Water Supply Program

ə Clearinghouse Number: SCH #2000081017
submitted to Clearinghouse)

ɟ Agency: Kern County Water Agency
tact Person: Thomas N. Clark, General Manager
ɘlephone: (661) 634-1400

ect Location: See attached Negative Declaration.
ude county)

ɲiect Description: See attached Negative Declaration.

is to advise that on September 7, 2000, the Kern County Water Agency (as lead agency) approved the project (more particularly əscribed in the attached Negative Declaration) and has determined that no additional environmental review is required.

nitial Study and Subsequent Negative Declaration with findings were prepared for the Agency's recent action pursuant to the ʼisions of CEQA Guidelines sections 15070 through 15075 concluding that no additional environmental review is required. The ɜcent action will not have any significant effect on the environment. Mitigation measures were made a condition of the Agency's ɲent action on the project. A Statement of Overriding Considerations was not adopted in connection with the Agency's recent action his project.

his is to certify that the Initial Study with comments and responses and record of project approval is available to the general public at: ɾn County Water Agency, P.O. Box 58, 3200 Rio Mirada Drive, Bakersfield, Kern County, CA 93302.

ɲnature, ______________________________
Thomas N. Clark, General Manager, Kern County Water Agency

ɔate ______________________

ɛe received for filing at OPR: ______________________

EXHIBIT C

CALIFORNIA DEPARTMENT OF FISH AND GAME

CERTIFICATE OF FEE EXEMPTION

De Minimis Impact Finding

Project Title: Kern River Restoration and Water Supply Program

Location: Kern River Corridor area, fromMetropolitan Bakersfield to the California Aqueduct, Kern County

Project Description: This project will generate broad local water supply, environmental and community benefits, and targeted drinking water quality benefits within the metropolitan Bakersfield area.
The Project consists of the four components, generally described below.

1. Acquisition of the Kern River lower water right;
2. Construction of enough urban area wells to achieve a flow capacity of about 60 cfs;
3. Construction of water conveyance exchange facilities;
4. Construction and acquisition of local facilities to enhance groundwater recharge and recovery opportunities.

Findings of Exemption:

1. The project consists of water right transfer and minimal construction and/or modification of water transfer and exchange facilities.

2. The lead agency has no evidence before it, including the information in the Initial Study and comments of appropriate reviewing agencies, to indicate that the proposed project could have any potential for adverse effects on fish and wildlife resources.

Certification:

I hereby certify that the public agency has made the above finding(s) and that the project will not individually or cumulatively have an adverse effect on wildlife resources, as defined in Section 71.2 of the Fish and Game Code.

Date: September 7, 2000 Local Lead Agency: Kern County Water Agency

Title: General Manger Manager

EXHIBIT D

MITIGATION, MONITORING AND REPORTING PROGRAM

OVERVIEW

Comments received on the Proposed Negative Declaration regarding the Kern River Program highlight a significant feature of the design of the program: the program has been designed and will be implemented to comply with all aspects of existing law. Important laws with which the project has been designed to comply are the Federal Endangered Species Act, State Endangered Species Act, and a variety of laws and regulations governing water quality and impacts on legal users of water. While compliance with such laws and regulations is an integral feature of the program, the Agency understands that some entities would prefer a formal acknowledgment of intended compliance as a form of mitigation, and appropriate monitoring and reporting. Accordingly, the Agency agrees to clarify the following mitigation measures which are part of the program as designed and adopt appropriate monitoring and reporting measures.

MONITORING & REPORTING FOR DESIGNED MITIGATION ELEMENTS

1. ADOPTED MITIGATION ELEMENT: Federal and State Endangered Species Act

(a) Program Design:

The program has been designed to avoid any impact on known endangered or threatened species, federal or state, or other species of concern. In the first instance, the program has been designed to have an extremely small footprint of disrupted land in the construction of facilities. Additionally, the facility construction will occur primarily on existing highly cultivated farmland or highly maintained rights of way in which it is unlikely that such species or their habitat will be encountered. Further, care will be utilized to have such locations examined by personnel knowledgeable in the identification of endangered and threatened

insignificance.

2. ADOPTED MITIGATION ELEMENT: Injury to Rights of Legal Users of Water and Facilities

(a) Program Design:

The program is designed to ensure that all water and facilities utilized by the program are obtained with full protection of the rights of existing legal users. Full compensation will be provided by the Agency where such rights of legal users of water or facilities are impaired, and absent such compensation such rights of legal users will not be impaired. This extends to the legal users of ground water as the program has been designed to avoid significant impact on such users. In the event of disputes regarding the existence of such impacts, the Agency will submit such disputes to the previously established Kern Fan Monitoring Committee for handling under established rules.

(b) Monitoring and Reporting:

The General Manager shall include in an annual report to the Board a report on the following items of concern:

(1) The alleged occurrence of any impact on the rights of legal users of water or facilities, including any alleged impacts on groundwater;

(2) The measures utilized to investigate such alleged impacts;

(3) The results of such investigation;

(4) The measures utilized to avoid impacts to such rights of legal users, or the measures utilized to reduce such impacts to insignificance.

3. ADOPTED MITIGATION ELEMENT: Water Quality

(a) Program Design:

The program is designed to avoid any potential adverse impacts on water quality. Utilization of the water rights acquired under the program will not significantly differ in water quality impacts from the existing uses of such water. The intent of

the program is to secure the benefits of Kern River water quality for drinking water quality and Kern County. The program will be operated to avoid significant adverse impact on the water quality available to any legal user of water.

(b) Monitoring and Reporting:

The General Manager shall include in an annual report to the Board of Directors the following items:

(1) A statement regarding the water quality status of the program during the prior year;

(2) An identification of all problem areas encountered, if any, and the measures taken to avoid any significant adverse impact on the water quality of any legal user of water.

GENERAL REPORTING REQUIREMENTS

The annual report referred to herein shall be prepared under the direction of the General Manager and a registered engineer of the State of California, in consultation with individual(s) knowledgeable in the identification of endangered or threatened species and their habitats. The report may include additional operational, and economic data of interest to the community, but at a minimum shall contain the information specified above as required elements of the report.

KR/KRP

MANAGER
ROBERT A. QUIRING

SUPERINTENDENT
TOM BLANTON

KERN
MOSQUITO AND VECTOR CONTROL DISTRICT

DISTRICT OFFICE

4705 ALLEN RD. BAKERSFIELD, CALIFORNIA 93312
PH: (661) 589-2744 FAX: (661) 589-4913 E MAIL: kmvcd@lightspeed.net

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Kern County Water Agency

August 3, 2000

Tom Clark, General Manager
Kern County Water Agency
P. O. Box 58
Bakersfield, California 93302-0058

RE: Kern River Restoration & Water Supply Project

Tom:

The District has several comments in regard to the recharge basins that would be constructed as part of this proposed project.

During years when groundwater recharge operations were being conducted, it would not be feasible to treat these basins by aircraft if they produced mosquitoes because of the proximity of residential areas and heavily-traveled roads (i.e Stockdale, Buena Vista, Allen). During the last couple of years when performing mosquito control operations, the District's airplane pilot has encountered increasing numbers of joggers, bikers, horseback riders, etc. in the "2800" and the other recharge areas west of Allen Road. These new basins will, also, attract similar attention by the public.

Ideally, vegetation in the basins would be managed in a manner that would allow the control of the aquatic stage of mosquitoes through the use of mosquitofish. Due to the size of these basins, treatment by ground rigs spraying around the perimeter would be ineffective. The use of insecticides in areas frequented by the public is a real challenge these days due to the increasingly negative reaction by people to pesticide usage in general.

Hopefully, these concerns will be considered by the Agency when the basins are constructed.

Sincerely,

Rob Quiring

Rob Quiring
District Manager

KERN COUNTY
WATER AGENCY

GROUNDWATER Kern River Program

August 29, 2000

Mr. Rob Quiring, District Manager
Kern Mosquito and Vector Control District
4705 Allen Road
Bakersfield, CA 93312

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Mr. Quiring:

Thank you for your letter dated August 3, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). The Agency has reviewed your concerns expressed in the letter and outlined below is the Agency's response.

Under the Program , two (2) recharge ponds (10 acre and 5 acre) are proposed for construction, both located just east of Allen Road and near the Kern River Stockdale Highway bridge . A proposed 40 acre to 50 acre Soccer field to be constructed may be used for groundwater recharge in the wettest years on the Kern River. This proposed field is also located east of Allen Road and north of the Kern River near the Stockdale bridge. The recharge ponds will be operated very similar to the Truxtun Lake recharge ponds owned by the City of Bakersfield, which we understand have not created a mosquito concern to the surrounding community. The Soccer field will probably be operated by the North of the River Parks and Recreation District under an arrangement with the City of Bakersfield. The two recharge ponds may be jointly managed by the Agency's Improvement District No. 4 and the City of Bakersfield's Water Resources Department. The recharge ponds and Soccer field are planned as part of a community park under a residential and commercial development proposed by Castle and Cooke California, Inc.

As with other existing recharge basins under the Agency's control, we do not anticipate any concerns with mosquitoes , however, we will comply with any applicable regulations and cooperate with your District to address any concerns you may have, should any arise at some future time. Please contact Kane Totzke at (661) 634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manger

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825

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Kern County Water Agency

IN REPLY REFER TO:
1-1-00-TA-2553

August 14, 2000

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, California 93302-0058

Subject: California Environmental Quality Act (CEQA) Compliance for the Kern River Restoration and Water Supply Program, Kern County, California

Dear Mr. Clark:

This is in response to your July 27, 2000, letter concerning the Initial Study and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program in Kern County, California. We understand from the materials enclosed with your letter that some of the property proposed for development is inside, and some is outside the boundaries of the Metropolitan Bakersfield Habitat Conservation Plan (HCP). We appreciate your efforts to provide water in the river channel for a greater part of the year, and we agree that this will enhance riparian vegetation and could provide habitat for some protected species in an area where they historically occurred, such as the least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*).

1 We expect that some parts of the project will occur within the boundaries of the Metropolitan
Bakersfield HCP, and that fees will be paid into the habitat compensation fund. We think this
should be mentioned in the Negative Declaration, as it is a mitigation under CEQA for effects on
protected species. We are concerned about the effects of portions of the project outside the
Metropolitan Bakersfield HCP on San Joaquin kit foxes (*Vulpes macrotis mutica*), Tipton
kangaroo rats (*Dipodomys nitratoides nitratoides*), and blunt-nosed leopard lizards (*Gambelia
silus*), which are protected under the Federal Endangered Species Act of 1973, as amended (Act).
The map of the project mentions potential agricultural and urban area well sites, and installation
of recharge ponds on an 80-acre parcel now belonging to Castle and Cooke. Kit fox are known
to forage on, and disperse across natural land, fallow land, farmland in row crops, and grazing
2 land. Any construction of structures on farmland, fallow land, grazing land, or natural land likely
will require compensation under the Act. No indication is given of the present land uses and

project footprints for portions of the project outside the MB HCP, so we cannot provide an adequate evaluation at this time.

Section 9 of the Act and its implementing regulations prohibit the "take" of federally listed fish and wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any listed wildlife species. "Harm" in this definition includes significant habitat modification or degradation where it actually kills or injures wildlife, by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures. If a Federal agency is involved with the permitting, funding, or carrying out of the project, then initiation of formal consultation between that agency and the Service pursuant to section 7 of the Act is required if it is determined that the proposed project will adversely affect a listed species. Such a consultation would result in a biological opinion that addresses the anticipated effects of the project to the listed species and may authorize a limited level of incidental take. If a Federal agency is not involved with the project, and a listed species may be taken as a result of the project, then an incidental take permit pursuant to section 10(a)(1)(B) of the Act should be obtained. The Service may issue a permit upon completion of a satisfactory HCP for the listed species that would be subject to take as a result of the project. Applicants approved by the Service and the California Department of Fish and Game, as applicable, may satisfy the Act by buying credits and obtaining incidental take authority through the Kern Water Bank HCP and Master Permit.

While the Metropolitan Bakersfield HCP is not applicable to portions of the project outside its borders, it sets a precedent in Kern County for providing endangered species compensation for conversion of farmland to buildings and other structures. For example, we worked with the Kern County Planning Department in the development of the compensation measures that were required for the Rio Bravo Tomato Company plant, which was sited on row crop farmland.

We appreciate you contacting us about your proposed project. We would appreciate receiving more detailed information about the project concerning proposed construction locations and footprints, related access roads if any, and schedule. Thank you for your interest in conserving threatened and endangered species. Please contact Susan Jones or Peter Cross at (916) 414-6600 if you have any questions about this letter.

Sincerely,

Karen J. Miller

Karen J. Miller
Chief, Endangered Species Division

cc: Andy Gordus, CDFG, Fresno, California
Steve Strait, Kern County Planning Department
Cheryl Harding, Kern Water Bank Authority

KERN COUNTY
WATER AGENCY

August 29, 2000

Ms. Susan Jones
U.S. Fish and Wildlife Service
2800Cottage Way, W-2605
Sacramento, CA 95825

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Ms. Jones:

Thank you for your letter dated August 21, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). We concur with the U.S. Fish and Wildlife Service's (Service) statement that the Program as proposed will provide environmental benefits to the local environment: the Agency believes the Program is an opportunity to secure environmental local benefits along the Kern River corridor for wildlife and the community of Bakersfield.

In response to the Service's concern regarding participation in the Metropolitan Bakersfield Habitat Conservation Plan (HCP), the Agency plans to comply with any regulations including those requiring participation in payment of habitat management fees, where applicable. We note however that,the Program facilities proposed for modification and/or construction taking place within the Metropolitan Bakersfield HCP are projects less than ten (10) acres in size undertaken for strictly public purposes and therefore exempt from the Habitat Management Fees, pursuant to the City of Bakersfield Ordinance 3556.

Other Program facilities, as described in the Initial Study and proposed Negative Declaration may occur on active farmland owned by the Agency, on well maintained right-of-ways owned by the Agency or other local water districts. These proposed facilities will have a very small footprint of permanently disturbed land, e.g., less than 1/10th of an acre disturbance per well site, in areas devoid of species subject to the Federal Endangered Species Act. Furthermore, since no take of threatened or endangered species will occur due to construction of facilities on farmland, fallow land, grazing land or natural land, the Agency believes no incidental take permit or compensation is required for the Program. The Agency will, of course, comply with the regulations if avoidance of impacts is not feasible.

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

The Agency hopes this letter resolves any concerns you may have with the Program. Again, we believe the overall Program will secure significant water quality, water supply, environmental and community benefits to the citizens of the greater Bakersfield area. The Program will also complement and supplement the existing the Kern River Parkway Plan adopted by the City of Bakersfield in 1988 through cooperative water exchanges and groundwater recovery to keep the Kern River wet through the center of Bakersfield during the peak recreational months of May through September. Please contact Kane Totzke at (661) 634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manager

GW/KRP
Gov't/RWQCB

California Regional Water Quality Control Board
Central Valley Region
Steven T. Butler, Chair

ston H. Hickox
cretary for
vironmental
Protection

Gray Davis
Governor

Fresno Branch Office
Internet Address: http://www.swrcb.ca.gov/~rwqcb5
3614 East Ashlan Avenue, Fresno, California 93726
Phone (559) 445-5116 • FAX (559) 445-5910

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Kern County Water Agency

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xc: [illegible]

23 August 2000

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P. O. Box 58
Bakersfield, CA 93302-0058

SCH # 2000081017, KERN RIVER RESTORATION AND WATER SUPPLY PROJECT, KERN COUNTY

We have reviewed the Initial Study and Proposed Negative Declaration to provide groundwater and surface water augmentations to the Kern River as it flows through the City of Bakersfield. The augmentations will occur during the summer months and be used for recreation. We understand that the project will involve construction of new agricultural and urban wells, modification of existing water exchange facilities and, possibly, construction of an interconnection in the area of the Kern River.

If more than five acres will be disturbed, the construction activities will be subject to regulation under the General Construction Activity Storm Water Permit, State Water Resources Control Board Order No. 99-08-DWQ, National Pollutant Discharge Elimination System, General Permit No. CA000002 (general permit). A copy of the permit is enclosed. Before construction begins, a Notice of Intent to comply with the permit must be submitted to the State Water Resources Control Board at the address indicated in the permit, and a Storm Water Pollution Prevention Plan must be prepared. Further information regarding the storm water program is available at the State Board web site at: http://www.swrcb.ca.gov or you may call Jarma Bennett at (559) 445-6046.

If the construction activities will involve the discharge of dredged or fill material into navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the US Army Corps of Engineers. For more information, please call Kathy Norton with the US Army Corps of Engineers at (916) 557-5260.

If a permit is needed from the US Army Corps of Engineers, certification of conformance with water quality standards pursuant to Section 401 of the Clean Water Act will be needed. Enclosed is a summary of information that we would need to consider a request for water quality certification.

If you have any questions, please call Betty Yee of this office at (559) 445-5128.

Lonnie M. Wass

LONNIE M. WASS
Senior Engineer
RCE No. 38917

Enclosure

PLANNING DEPARTMENT
TED JAMES, AICP, Director
2700 "M" STREET, SUITE 100
BAKERSFIELD, CA 93301-2323
Phone: (661) 862-8600
FAX: (661) 862-8601 TTY Relay 1-800-735-2929
E-Mail: planning@co.kern.ca.us
Web Address: www.co.kern.ca.us/planning/info.htm

RESOURCE MANAGEMENT AGENCY
DAVID PRICE III, RMA DIRECTOR
Community Development Program Department
Engineering & Survey Services Department
Environmental Health Services Department
Planning Department
Roads Department

September 5, 2000

Tom Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield CA 93302-0058

Re: Initial Study - Kern River Restoration and Water Supply Program

Dear Mr. Clark:

Thank you for the opportunity to review the Initial Study for this project. The Planning Department has no comments on this phase of the project. If you have any questions, please call Steve Strait at (661) 862-8643.

Very truly yours,

TED JAMES, AICP, Director
Kern County Planning Department

Steve Strait

by Steve Strait, Associate Planner

State of California **The Resources Agency**

MEMORANDUM

To: Project Coordinator
Resources Agency

Date: August 31, 2000

ccs 9/5/00

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, CA 93302-0058

RECEIVED
SEP 1 2000
STATE CLEARINGHOUSE

From: **Department of Conservation**
Office of Governmental and Environmental Relations

Subject: Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program, Kern County – **SCH #2000081017**

The Department of Conservation's Division of Oil, Gas and Geothermal Resources (Division) has reviewed the initial study for the referenced project. The Division supervises the drilling, maintenance, and plugging and abandonment of oil, gas and geothermal wells in California. We offer the following comments for your consideration.

The proposed project area encompasses all, or a portion of the following oil fields: Bellevue, Canal, Canfield Ranch, Fruitvale, Kern River, McClung, North Coles Levee, Strand, Stockdale and Ten Section. There are numerous plugged and abandoned, producing and injection wells within or in proximity to these fields. Proposed project construction includes water wells, water quality exchange facilities, and facilities to enhance groundwater recharge and recovery. The project also proposes mitigation measures such as avoiding areas suspected to have hydrocarbon contamination and, where practical, avoiding interference with petroleum pipelines and oilfield areas.

In support of these proposed mitigation measures, the Division recommends that the proposed construction projects be plotted accurately on the appropriate Division maps, and submitted to the Division's Bakersfield office for review. Upon receipt of the maps, the Division will provide locations of the affected wells. Also based on our review of the maps, the Division will convey information to the applicant on any applicable well work requirements. In addition, the Division requests that these oilfield wells be plotted accurately on all future maps related to this project, and that a legible copy of the final project map be submitted to the Division's Bakersfield office.

Finally, the Division district office in Bakersfield must be notified if excavation uncovers a previously plugged and abandoned well. If the well can be identified, its

Mr. Thomas N. Clark
August 31, 2000
Page 2

abandonment will be reviewed at that time. If the well cannot be identified, remedial operations may be required.

Thank you for the opportunity to comment on the initial study and proposed negative declaration. If you have questions, or require technical assistance or information, please contact Jack Truschel at the Bakersfield district office: 4800 Stockdale Highway, Suite 417, Bakersfield, CA 93309; or, phone (661) 322-4031. You may also call me at (916) 445-8733.

Kenneth E. [illegible]
for Jason Marshall
Assistant Director

cc: Jack Truschel
Division of Oil, Gas, and Geothermal Resources, Bakersfield
Linda Campion
Division of Oil, Gas, and Geothermal Resources, Sacramento

BEFORE THE BOARD OF DIRECTORS

OF THE

KERN COUNTY WATER AGENCY

In the Matter of:
DETERMINATIONS AND FINDINGS *
WITH RESPECT TO THE *
KERN RIVER RESTORATION AND *
AND WATER SUPPLY PROGRAM *

I, Pam Bosworth, Secretary of the Board of Directors to the Kern County Water Agency, of the County of Kern, State of California, do hereby certify that the following resolution proposed by Director Radon and seconded by Director Garnett, was duly passed and adopted by said Board of Directors at an official meeting hereof this 7th day of September, 2000, by the following vote, to wit:

Ayes: Garnett, Radon, Rogers, Mathews & Starrh

Noes: None

Absent: Frick & Lundquist

Pam Bosworth
Secretary of the Board of Directors
of the Kern County Water Agency

RESOLUTION NO. 59-00

WHEREAS, the Board of Directors (the "Board") of the Kern County Water Agency (the "Agency") has had prepared, circulated and presented to it, and has reviewed and considered an Initial Study, Environmental Checklist, dated July 27, 2000, and a proposed Negative Declaration (Exhibit "A") attached thereto, all pertaining to the Kern River Restoration and Water Supply Program; and

WHEREAS, the Agency has received comments from several responsible agencies and interested parties and incorporated those comments, together with the Agency's response to those comments, in the appendix of the Negative Declaration; and

WHEREAS, the Agency has incorporated into and made part of the Negative Declaration, a Mitigation, Monitoring and Reporting Program that satisfactorily addresses the Federal and State Endangered Species Act, Injury to Rights of Legal Users of Water and Water Quality issues; and

WHEREAS, in recognition of the Agency securing the $23 million grant pursuant to Proposition 13, the Agency will continue to work with the Member Units and other local water districts to acquire additional grants and loans for the purpose of constructing water supply and/or water management facilities in Kern County.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Agency as follows:

The Board hereby finds and determines that the foregoing recitals, are true and correct.

1. <u>Section 1, Review of Evidence</u>

The Board has reviewed and considered the contents of the Initial Study and proposed Negative Declaration, the presentation to the Board made by staff pertaining to same, and the comments received from the public both during a public hearing conducted by the Board on September 7, 2000 and received during the required environmental review period; and

2. <u>Section 2, Approval of Negative Declaration</u>

Based upon the afore-described evidence, the Board hereby finds;

a) that there is no substantial evidence that the <u>Kern River Restoration and Water Supply Program</u> with the mitigation measures provided therein will have a significant effect on the environment;

b) that the mitigation measures therein are incorporated within the scope of the project, and the project as defined will not have a significant effect on the environment. Therefore, in accordance with such findings, the Board approves the Negative Declaration submitted in conjunction with the Initial Study and hereby directs staff to prepare and file a Notice of Determination (in the form attached hereto as Exhibit "B") in compliance with the California Environmental Quality Act (Public Resources Code Sections 21000, et seq.); and

3. Section 3, Finding of No Impact on Wildlife

The Board hereby further finds that, when considering the record as a whole, there is no substantial evidence before the Board that the proposed Project will have potential for an adverse effect on wildlife resources or the habitat upon which the wildlife depends on. As such, the Board directs the General manager to sign a Certificate of a De Minimis Impact Finding exempting payment of the $1,250 Department of Fish and Game fee (in the form attached hereto as Exhibit "C"). If subsequent information becomes available indicating potential impacts to Federal and State listed or sensitive species as defined under the State and Federal Endangered Species Act, the Agency will comply with all mandatory State and Federal laws.

4. Section 4, Mitigation, Monitoring and Reporting Program

The Board hereby incorporates the Mitigation, Monitoring and Reporting Program (in the form attached hereto as Exhibit "D") to address concerns with local water districts regarding water use, distribution of benefits and water quality.

5. Section 5, Continued efforts towards securing Proposition 13 funds

The Board hereby directs staff to continue working , in a timely manner, with Member Units and other local Kern County water districts towards maximizing the acquisition additional Proposition 13 grants and loans for local water supply projects and/or other water management projects as deemed appropriate by the General manager.

EXHIBIT A

KERN COUNTY WATER AGENCY
PROPOSED NEGATIVE DECLARATION

This is prepared pursuant to the California Environmental Quality Act of 1970 (CEQA), [1] and the State CEQA Guidelines, [2].

NAME OF PROJECT: Kern River Restoration and Water Supply Program.

PROPOSED PROJECT LOCATION: The Project is primarily located along the Kern River corridor from the projected extension of Haley Street on the east side, to the California Aqueduct on the west end, and south and west of Bakersfield in the unincorporated portion of the county along the Cross Valley Canal and Arvin-Edison Canal and including other local water conveyance facilities. Also, see attached Project location maps.

DESCRIPTION OF PROPOSED PROJECT: Summary. Project proposes to provide significant water quality, water supply, environmental and community benefits for the metropolitan Bakersfield area and a broad range of Kern County water users through the coordinated implementation of a number of program components including the: (1) acquisition of the Lower Kern River water right (Lower Right), i.e., Hacienda/Garces pre-1914 water right, including associated Lake Isabella Storage; (2) Purchase of land from Castle and Cooke California, Inc., for additional recharge and recovery facilities; (3) construction of 12 new water Ag recovery wells and enough Urban wells to achieve a maximum flow capacity of 60 cfs; and (4) Construction of water exchange facilities and modification of the Pool 1 portion of the Cross Valley Canal.

Expanded Description. See Initial Study for Proposed Project, attached.

FINDINGS WHICH SUPPORT NEGATIVE DECLARATION: After making an assessment of the possible impacts of the proposed Project and reviewing an Initial Study dated July 27, 2000, the Board of Directors of the Kern County Water Agency has determined that the proposed Project as presented will not have any significant effect on the environment, either directly or indirectly.

INITIAL STUDY: A copy of the Initial Study and environmental checklist prepared by Agency staff, dated July 27, 2000, is attached.

EXHIBIT A

MITIGATION MEASURES: Mitigation measures which have been incorporated into the proposed Project to avoid potentially significant environmental effects are as follows:

1. Throughout the term of the proposed Project, Project water quality, groundwater monitoring, and groundwater recharge losses will be consistent with the Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program, dated October 26, 1995, and consistent with the Operation and Monitoring Procedure for the Pioneer Project, dated May 28, 1998.

2. Project recharge and recovery well areas will be designed and located to avoid areas suspected to have hydrocarbon contamination, and to the extent practical, not to interfere with oil (crude or refined) or natural gas pipelines or other sensitive oilfield areas.

3. Project recharge and recovery well areas will be designed and located to minimize potential impacts to the Agency's Cross Valley Canal.

4. A mitigation, Monitoring and Reporting Program (attached as Exhibit C)

CONTACT PERSON, TELEPHONE NUMBER: Mr. Thomas N. Clark, General Manager, Kern County Water Agency, P.O. Box 58, Bakersfield, CA. 93302; (661)-634-1400. If you require additional information regarding this proposed Project, please contact Mr. Kane Totzke, Kern County Water Agency, (661) 634-1468; e-mail: kane@kcwa.com

Thomas N. Clark, General Manager   Date

---

1. Public Resources Code, Section 2100, et seq.

2. Title 14, Division 6, California Administrative Code, as amended.

KERN COUNTY
WATER AGENCY

GROUNDWATER krp

September 7, 2000

Ms. Karen Fowler
Office of the Governor
Office of Planning and Research
State Clearinghouse
P.O. Box 3044
Sacramento, Ca 95812-3044

RE: SCH # 2000081017 - Notice of Determination and De Minimis Impact Finding

Dear Ms. Fowler:

Transmitted herein are the Kern County Water Agency's (Agency) "Notice of Determination" and a "California Department of Fish and Game Certificate of Fee Exemption -De Minimis Impact Finding" for the *Kern River Restoration and Water Supply Program* Negative Declaration. The Agency Board of Directors took action to adopt the Negative Declaration at a meeting held on September 7, 2000. The De Minimis Impact finding exempts the Agency from the $1,250 filing fee. Please contact Kane Totzke at 661-634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manager

enclosures

cc: Office of the County Clerk (Kern)

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

EXHIBIT B
CEQA Notice of Determination

To: X Office of Planning and Research
1400 Tenth Street, Room 121
Sacramento, CA 95814

X County Clerk
County of Kern
1115 Truxton Ave., 1st Floor
Bakersfield, CA 93301-4639

From: Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield, CA 93302

Subject: Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code.

Project Title: Kern River Restoration and Water Supply Program

State Clearinghouse Number: SCH #2000081017
(If submitted to Clearinghouse)

Lead Agency: Kern County Water Agency
Contact Person: Thomas N. Clark, General Manager
Telephone: (661) 634-1400

Project Location: See attached Negative Declaration.
(include county)

Project Description: See attached Negative Declaration.

This is to advise that on September 7, 2000, the Kern County Water Agency (as lead agency) approved the project (more particularly described in the attached Negative Declaration) and has determined that no additional environmental review is required.

An Initial Study and Subsequent Negative Declaration with findings were prepared for the Agency's recent action pursuant to the provisions of CEQA Guidelines sections 15070 through 15075 concluding that no additional environmental review is required. The recent action will not have any significant effect on the environment. Mitigation measures were made a condition of the Agency's recent action on the project. A Statement of Overriding Considerations was not adopted in connection with the Agency's recent action on this project.

This is to certify that the Initial Study with comments and responses and record of project approval is available to the general public at: Kern County Water Agency, P.O. Box 58, 3200 Rio Mirada Drive, Bakersfield, Kern County, CA 93302.

Signature, ______________________________
Thomas N. Clark, General Manager, Kern County Water Agency

Date ____________________

Date received for filing at OPR:____________________

EXHIBIT C

CALIFORNIA DEPARTMENT OF FISH AND GAME

CERTIFICATE OF FEE EXEMPTION

De Minimis Impact Finding

Project Title:	Kern River Restoration and Water Supply Program
Location:	Kern River Corridor area, fromMetropolitan Bakersfield to the California Aqueduct, Kern County
Project Description:	This project will generate broad local water supply, environmental and community benefits, and targeted drinking water quality benefits within the metropolitan Bakersfield area. The Project consists of the four components, generally described below.

1. Acquisition of the Kern River lower water right;
2. Construction of enough urban area wells to achieve a flow capacity of about 60 cfs;
3. Construction of water conveyance exchange facilities;
4. Construction and acquisition of local facilities to enhance groundwater recharge and recovery opportunities.

Findings of Exemption:

1. The project consists of water right transfer and minimal construction and/or modification of water transfer and exchange facilities.

2. The lead agency has no evidence before it, including the information in the Initial Study and comments of appropriate reviewing agencies, to indicate that the proposed project could have any potential for adverse effects on fish and wildlife resources.

Certification:

I hereby certify that the public agency has made the above finding(s) and that the project will not individually or cumulatively have an adverse effect on wildlife resources, as defined in Section 71.2 of the Fish and Game Code.

Date: September 7, 2000 Local Lead Agency: Kern County Water Agency

Title: General Manger Manager

EXHIBIT D

MITIGATION, MONITORING AND REPORTING PROGRAM

OVERVIEW

Comments received on the Proposed Negative Declaration regarding the Kern River Program highlight a significant feature of the design of the program: the program has been designed and will be implemented to comply with all aspects of existing law. Important laws with which the project has been designed to comply are the Federal Endangered Species Act, State Endangered Species Act, and a variety of laws and regulations governing water quality and impacts on legal users of water. While compliance with such laws and regulations is an integral feature of the program, the Agency understands that some entities would prefer a formal acknowledgment of intended compliance as a form of mitigation, and appropriate monitoring and reporting. Accordingly, the Agency agrees to clarify the following mitigation measures which are part of the program as designed and adopt appropriate monitoring and reporting measures.

MONITORING & REPORTING FOR DESIGNED MITIGATION ELEMENTS

1. **ADOPTED MITIGATION ELEMENT: Federal and State Endangered Species Act**

   (a) **Program Design:**

   The program has been designed to avoid any impact on known endangered or threatened species, federal or state, or other species of concern. In the first instance, the program has been designed to have an extremely small footprint of disrupted land in the construction of facilities. Additionally, the facility construction will occur primarily on existing highly cultivated farmland or highly maintained rights of way in which it is unlikely that such species or their habitat will be encountered. Further, care will be utilized to have such locations examined by personnel knowledgeable in the identification of endangered and threatened

species and their habitat to ensure the avoidance of any impact. In the unlikely event that unavoidable impacts are encountered, the Agency will comply fully with Federal and State Endangered Species Acts to ensure that such impacts are mitigated to insignificance.

In summary, the Agency commits to full compliance with both Federal and State Endangered Species Act requirements. While no impact on such species is contemplated due to the design of the program, any unexpected impacts will be handled in full compliance with federal and state law.

(b) Monitoring & Reporting:

The General Manager is hereby directed to provide knowledgeable staff assistance, and consultants where required, to monitor the progress of construction and implementation to ensure compliance with federal and state endangered species laws and regulations.

(1) During the construction phase of the program, the General Manager shall report to the Board on a quarterly basis regarding the following:

  (i) The identification, if any, of any potentially impacted federal or state threatened or endangered species.

  (ii) Specification of all measures taken to avoid any impact on such species or on the habitat of such species.

  (iii) Where impact proves to be unavoidable, whether a project component was abandoned or whether sufficient mitigation measures were utilized to reduce the level of impact to insignificance.

(2) After construction, the General Manager shall include in annual reports to the Board the following:

  (i) Whether any potential significant impacts on federal or state endangered or threatened species have been identified, and

  (ii) What measures have been taken to reduce such potential impacts to

insignificance.

2. ADOPTED MITIGATION ELEMENT: Injury to Rights of Legal Users of Water and Facilities

(a) Program Design:

The program is designed to ensure that all water and facilities utilized by the program are obtained with full protection of the rights of existing legal users. Full compensation will be provided by the Agency where such rights of legal users of water or facilities are impaired, and absent such compensation such rights of legal users will not be impaired. This extends to the legal users of ground water as the program has been designed to avoid significant impact on such users. In the event of disputes regarding the existence of such impacts, the Agency will submit such disputes to the previously established Kern Fan Monitoring Committee for handling under established rules.

(b) Monitoring and Reporting:

The General Manager shall include in an annual report to the Board a report on the following items of concern:

(1) The alleged occurrence of any impact on the rights of legal users of water or facilities, including any alleged impacts on groundwater;

(2) The measures utilized to investigate such alleged impacts;

(3) The results of such investigation;

(4) The measures utilized to avoid impacts to such rights of legal users, or the measures utilized to reduce such impacts to insignificance.

3. ADOPTED MITIGATION ELEMENT: Water Quality

(a) Program Design:

The program is designed to avoid any potential adverse impacts on water quality. Utilization of the water rights acquired under the program will not significantly differ in water quality impacts from the existing uses of such water. The intent of

the program is to secure the benefits of Kern River water quality for drinking water quality and Kern County. The program will be operated to avoid significant adverse impact on the water quality available to any legal user of water.

(b) Monitoring and Reporting:

The General Manager shall include in an annual report to the Board of Directors the following items:

(1) A statement regarding the water quality status of the program during the prior year;

(2) An identification of all problem areas encountered, if any, and the measures taken to avoid any significant adverse impact on the water quality of any legal user of water.

GENERAL REPORTING REQUIREMENTS

The annual report referred to herein shall be prepared under the direction of the General Manager and a registered engineer of the State of California, in consultation with individual(s) knowledgeable in the identification of endangered or threatened species and their habitats. The report may include additional operational, and economic data of interest to the community, but at a minimum shall contain the information specified above as required elements of the report.

KR/KRP

MANAGER
ROBERT A. QUIRING

SUPERINTENDENT
TOM BLANTON

KERN
MOSQUITO AND VECTOR CONTROL DISTRICT
DISTRICT OFFICE
4705 ALLEN RD. BAKERSFIELD, CALIFORNIA 93312
PH: (661) 589-2744 FAX: (661) 589-4913 E MAIL: kmvcd@lightspeed.net

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ALL ☐
Kern County Water Agency

August 3, 2000

Tom Clark, General Manager
Kern County Water Agency
P. O. Box 58
Bakersfield, California 93302-0058

RE: Kern River Restoration & Water Supply Project

Tom:

The District has several comments in regard to the recharge basins that would be constructed as part of this proposed project.

During years when groundwater recharge operations were being conducted, it would not be feasible to treat these basins by aircraft if they produced mosquitoes because of the proximity of residential areas and heavily-traveled roads (i.e Stockdale, Buena Vista, Allen). During the last couple of years when performing mosquito control operations, the District's airplane pilot has encountered increasing numbers of joggers, bikers, horseback riders, etc. in the "2800" and the other recharge areas west of Allen Road. These new basins will, also, attract similar attention by the public.

Ideally, vegetation in the basins would be managed in a manner that would allow the control of the aquatic stage of mosquitoes through the use of mosquitofish. Due to the size of these basins, treatment by ground rigs spraying around the perimeter would be ineffective. The use of insecticides in areas frequented by the public is a real challenge these days due to the increasingly negative reaction by people to pesticide usage in general.

Hopefully, these concerns will be considered by the Agency when the basins are constructed.

Sincerely,

Rob Quiring
Rob Quiring
District Manager

KERN COUNTY
WATER AGENCY

GROUNDWATER Kern River Program

August 29, 2000

Mr. Rob Quiring, District Manager
Kern Mosquito and Vector Control District
4705 Allen Road
Bakersfield, CA 93312

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Mr. Quiring:

Thank you for your letter dated August 3, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). The Agency has reviewed your concerns expressed in the letter and outlined below is the Agency's response.

Under the Program , two (2) recharge ponds (10 acre and 5 acre) are proposed for construction, both located just east of Allen Road and near the Kern River Stockdale Highway bridge . A proposed 40 acre to 50 acre Soccer field to be constructed may be used for groundwater recharge in the wettest years on the Kern River. This proposed field is also located east of Allen Road and north of the Kern River near the Stockdale bridge. The recharge ponds will be operated very similar to the Truxtun Lake recharge ponds owned by the City of Bakersfield, which we understand have not created a mosquito concern to the surrounding community. The Soccer field will probably be operated by the North of the River Parks and Recreation District under an arrangement with the City of Bakersfield. The two recharge ponds may be jointly managed by the Agency's Improvement District No. 4 and the City of Bakersfield's Water Resources Department. The recharge ponds and Soccer field are planned as part of a community park under a residential and commercial development proposed by Castle and Cooke California, Inc.

As with other existing recharge basins under the Agency's control, we do not anticipate any concerns with mosquitoes , however, we will comply with any applicable regulations and cooperate with your District to address any concerns you may have, should any arise at some future time. Please contact Kane Totzke at (661) 634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manger

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825

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INC ☒ RBI ☒
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JMB ☒ JWP ☐
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LWF ☒ SMR ☐
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Kern County Water Agency

IN REPLY REFER TO:
1-1-00-TA-2553

August 14, 2000

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, California 93302-0058

Subject: California Environmental Quality Act (CEQA) Compliance for the Kern River Restoration and Water Supply Program, Kern County, California

Dear Mr. Clark:

This is in response to your July 27, 2000, letter concerning the Initial Study and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program in Kern County, California. We understand from the materials enclosed with your letter that some of the property proposed for development is inside, and some is outside the boundaries of the Metropolitan Bakersfield Habitat Conservation Plan (HCP). We appreciate your efforts to provide water in the river channel for a greater part of the year, and we agree that this will enhance riparian vegetation and could provide habitat for some protected species in an area where they historically occurred, such as the least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*).

1 We expect that some parts of the project will occur within the boundaries of the Metropolitan Bakersfield HCP, and that fees will be paid into the habitat compensation fund. We think this should be mentioned in the Negative Declaration, as it is a mitigation under CEQA for effects on protected species. We are concerned about the effects of portions of the project outside the Metropolitan Bakersfield HCP on San Joaquin kit foxes (*Vulpes macrotis mutica*), Tipton kangaroo rats (*Dipodomys nitratoides nitratoides*), and blunt-nosed leopard lizards (*Gambelia silus*), which are protected under the Federal Endangered Species Act of 1973, as amended (Act). The map of the project mentions potential agricultural and urban area well sites, and installation of recharge ponds on an 80-acre parcel now belonging to Castle and Cooke. Kit fox are known to forage on, and disperse across natural land, fallow land, farmland in row crops, and grazing
2 land. Any construction of structures on farmland, fallow land, grazing land, or natural land likely will require compensation under the Act. No indication is given of the present land uses and

project footprints for portions of the project outside the MB HCP, so we cannot provide an adequate evaluation at this time.

Section 9 of the Act and its implementing regulations prohibit the "take" of federally listed fish and wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any listed wildlife species. "Harm" in this definition includes significant habitat modification or degradation where it actually kills or injures wildlife, by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures. If a Federal agency is involved with the permitting, funding, or carrying out of the project, then initiation of formal consultation between that agency and the Service pursuant to section 7 of the Act is required if it is determined that the proposed project will adversely affect a listed species. Such a consultation would result in a biological opinion that addresses the anticipated effects of the project to the listed species and may authorize a limited level of incidental take. If a Federal agency is not involved with the project, and a listed species may be taken as a result of the project, then an incidental take permit pursuant to section 10(a)(1)(B) of the Act should be obtained. The Service may issue a permit upon completion of a satisfactory HCP for the listed species that would be subject to take as a result of the project. Applicants approved by the Service and the California Department of Fish and Game, as applicable, may satisfy the Act by buying credits and obtaining incidental take authority through the Kern Water Bank HCP and Master Permit.

While the Metropolitan Bakersfield HCP is not applicable to portions of the project outside its borders, it sets a precedent in Kern County for providing endangered species compensation for conversion of farmland to buildings and other structures. For example, we worked with the Kern County Planning Department in the development of the compensation measures that were required for the Rio Bravo Tomato Company plant, which was sited on row crop farmland.

We appreciate you contacting us about your proposed project. We would appreciate receiving more detailed information about the project concerning proposed construction locations and footprints, related access roads if any, and schedule. Thank you for your interest in conserving threatened and endangered species. Please contact Susan Jones or Peter Cross at (916) 414-6600 if you have any questions about this letter.

Sincerely,

Karen J Miller

Karen J. Miller
Chief, Endangered Species Division

cc: Andy Gordus, CDFG, Fresno, California
Steve Strait, Kern County Planning Department
Cheryl Harding, Kern Water Bank Authority

KERN COUNTY
WATER AGENCY

Directors:

Fred L. Starrh
President
Division 1

Terry Rogers
Division 2

Peter Frick
Division 3

Michael Radon
Division 4

Adrienne J. Mathews
Division 5

Henry C. Garnett
Vice President
Division 6

Gene A. Lundquist
Division 7

Thomas N. Clark
General Manager

John F. Stovall
General Counsel

GROUNDWATER Kern River Program

August 29, 2000

Ms. Susan Jones
U.S. Fish and Wildlife Service
2800Cottage Way, W-2605
Sacramento, CA 95825

RE: Response to letter regarding CEQA compliance for the Kern River Restoration and Water Supply Program

Dear Ms. Jones:

Thank you for your letter dated August 21, 2000 responding to the Kern County Water Agency's (Agency) Initial Study and Proposed Negative Declaration for the Kern River Restoration and Water Supply Program (Program). We concur with the U.S. Fish and Wildlife Service's (Service) statement that the Program as proposed will provide environmental benefits to the local environment: the Agency believes the Program is an opportunity to secure environmental local benefits along the Kern River corridor for wildlife and the community of Bakersfield.

In response to the Service's concern regarding participation in the Metropolitan Bakersfield Habitat Conservation Plan (HCP), the Agency plans to comply with any regulations including those requiring participation in payment of habitat management fees, where applicable. We note however that,the Program facilities proposed for modification and/or construction taking place within the Metropolitan Bakersfield HCP are projects less than ten (10) acres in size undertaken for strictly public purposes and therefore exempt from the Habitat Management Fees, pursuant to the City of Bakersfield Ordinance 3556.

Other Program facilities, as described in the Initial Study and proposed Negative Declaration may occur on active farmland owned by the Agency, on well maintained right-of-ways owned by the Agency or other local water districts. These proposed facilities will have a very small footprint of permanently disturbed land, e.g., less than 1/10th of an acre disturbance per well site, in areas devoid of species subject to the Federal Endangered Species Act. Furthermore, since no take of threatened or endangered species will occur due to construction of facilities on farmland, fallow land, grazing land or natural land, the Agency believes no incidental take permit or compensation is required for the Program. The Agency will, of course, comply with the regulations if avoidance of impacts is not feasible.

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

The Agency hopes this letter resolves any concerns you may have with the Program. Again, we believe the overall Program will secure significant water quality, water supply, environmental and community benefits to the citizens of the greater Bakersfield area. The Program will also complement and supplement the existing the Kern River Parkway Plan adopted by the City of Bakersfield in 1988 through cooperative water exchanges and groundwater recovery to keep the Kern River wet through the center of Bakersfield during the peak recreational months of May through September. Please contact Kane Totzke at (661) 634-1468 with any questions regarding this matter.

Sincerely,

Tom Clark
General Manager

GW/KRR
Govst/RWQCB

California Regional Water Quality Control Board
Central Valley Region
Steven T. Butler, Chair

n H. Hickox
ary for
nmental
ection

Gray Davis
Governor

Fresno Branch Office
Internet Address: http //www.swrcb.ca.gov/~rwqcb5
3614 East Ashlan Avenue, Fresno, California 93726
Phone (559) 445-5116 • FAX (559) 445-5910

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AUG 25 2000
Kern County Water Agency

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xc:
Ken
Rich

23 August 2000

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P. O. Box 58
Bakersfield, CA 93302-0058

SCH # 2000081017, KERN RIVER RESTORATION AND WATER SUPPLY PROJECT, KERN COUNTY

We have reviewed the Initial Study and Proposed Negative Declaration to provide groundwater and surface water augmentations to the Kern River as it flows through the City of Bakersfield. The augmentations will occur during the summer months and be used for recreation. We understand that the project will involve construction of new agricultural and urban wells, modification of existing water exchange facilities and, possibly, construction of an interconnection in the area of the Kern River.

f more than five acres will be disturbed, the construction activities will be subject to regulation under the General Construction Activity Storm Water Permit, State Water Resources Control Board Order No. 99-08-DWQ, National Pollutant Discharge Elimination System, General Permit No. CA000002 (general permit). A copy of the permit is enclosed. Before construction begins, a Notice of Intent to comply with the permit must be submitted to the State Water Resources Control Board at the address indicated in the permit, and a Storm Water Pollution Prevention Plan must be prepared. Further information regarding the storm water program is available at the State Board web site at: http://www.swrcb.ca.gov or you may call Jarma Bennett at (559) 445-6046.

If the construction activities will involve the discharge of dredged or fill material into navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the US Army Corps of Engineers. For more information, please call Kathy Norton with the US Army Corps of Engineers at (916) 557-5260.

If a permit is needed from the US Army Corps of Engineers, certification of conformance with water quality standards pursuant to Section 401 of the Clean Water Act will be needed. Enclosed is a summary of information hat we would need to consider a request for water quality certification.

If you have any questions, please call Betty Yee of this office at (559) 445-5128.

Lonnie M. Wass

LONNIE M. WASS
Senior Engineer
RCE No. 38917

Enclosure

Distribution List – Kern River Restoration & Water Supply Program

Arvin-Edison WSD
P.O. Box 175
Arvin, CA 93203

Belridge WSD
P.O. Box 1087
Bakersfield, CA 93302

Berrenda Mesa WD
2100 "F" Street, Suite 100
Bakersfield, CA 93301

Buena Vista WSD
P.O. Box 756
Buttonwillow, CA 93206

California Water Service Company
3725 S. "H" Street
Bakersfield, CA 93304

Cawelo Water District
17207 Industrial Farm Road
Bakersfield, CA 93308

Chevron Production Company
ATT: Mr. Jim Waldron
5001 California Avenue
Bakersfield, CA 93302

City of Bakersfield
ATT: Mr. Marc Gauthier
1715 Chester Avenue
Bakersfield, CA 93301

City of Bakersfield Water Resources
ATT: Gene Bogart
1000 Buena Vista Rd
Bakersfield, CA 93311

Oildale Mutual Water Company
P.O. Box 5638
Bakersfield, CA 93388

Delano-Earlimart ID
14181 Avenue 24
Delano, CA 93215

Department of Fish and Game
ATT: Mr. Jeff Single
1234 East Shaw Avenue
Fresno, CA 93710

Division of Oil, Gas, and Geothermal
esources
800 Stockdale Hwy
Bakersfield, CA 93309

Mr. James L. Nickel
P.O. Box 60679
Bakersfield, CA 93386-0679

Dudley Ridge Water District
286 W. Cromwell Avenue
Fresno, CA 93711-6162

East Niles Community Services District
P.O. Box 6038
Bakersfield, CA 93386

Henry Miller Water District
P.O. Box 9759
Bakersfield, CA 93389-9759

Kern County Mosquito & Vector Control
District
4705 Allen Road
Bakersfield, CA 93312-3429

ern Audubon Society
ATT: Mary Griffin
604 Duke Drive
akersfield, CA 93305

Kern Water Bank Authority
P.O. Box 80607
Bakersfield, CA 93380-0607

Kern Delta WD
501 Taft Highway
Bakersfield, CA 93307

ern County Planning Department
TT: Mr. Ted James
2700 "M" Street, Suite 100
akersfield, CA 93301

Kern-Tulare WD
1820 21st Street
Bakersfield, CA 93301

Kern County Parks and Recreation
Dept
1110 Golden State Hwy
Bakersfield, CA 93301

Lost Hills Water District
008 Sillect Avenue, Suite 205
Bakersfield, CA 93308

Lower Tule River ID
ATT: Dan Vink
P.O. Box 4388
Porterville, CA 93258

North Kern WSD
P.O. Box 81435
Bakersfield, CA 93380-1435

Rag Gulch WD
820 21st Street
akersfield, CA 93301

Rosedale Rio-Bravo WSD
P.O. Box 867
Bakersfield, CA 93302-0867

Semitropic WSD
P.O. Box Z
Wasco, CA 93280

Shafter Wasco Irrigation District
P.O. Box 158
Wasco, CA 93280-0158

Tehachapi Cummings County WD
P.O. Box 326
Tehachapi, CA 93581-0326

U.S. Fish and Wildlife Service
San Joaquin Valley Branch Chief
2800 Cottage Way #W-2605
Sacramento, CA 95825-1846

West Kern WD
P.O. Box 1105
Taft, CA 93268-1105

Thomas Fallgatter
Kern River Corridor Endowment & Holding Co.
.O. Box 11172
Bakersfield, CA 93306

Carl Voss
Grimmway Farms
.O. Box 81498
Lamont, CA 93380-1498

lan Destefani
8035 Old River Road
Bakersfield, CA 93311

Sierra Club
Kern-Kaweah Chapter
2815 La Cresta Drive
Bakersfield, CA 93305-1719

Tejon-Castac WD
P.O. Box 1000
Lebec, CA 93243

U.S. Department of Agriculture
Natural Resources Conservation Service
1601 New Stine Road, Suite 270
Bakersfield, CA 93309-3698

Wheeler Ridge-Maricopa WSD
P.O. Box 9429
Bakersfield, CA 93389-9429

Carolyn Bell
Kern River Corridor Endowment & Holding Co.
5025 Panorama Drive
Bakersfield, CA 93306

Dave Russell
McCallister Ranch Irrigation District
230 Truxtun Avenue
Bakersfield, CA 93301-5312

Steve DeBranch
Castle & Cooke California Inc.
10000 Stockdale Highway
Bakersfield, CA 93311

Southern San Joaquin MUD
P.O. Box 279
Delano, CA 93216

Texaco Exploration and Production
Company, ATT: Mr. Dave Wright
Box 5197x,
Bakersfield, CA 93388

Vaughn Water Company
10014 Glen Street
Bakersfield, CA 93312

Rich O'Neill
Kern River Parkway Committee
208 Los Nietos
Bakersfield, Ca 93309

Bill Bolthouse
Wm. Bolthouse Farms Inc.
7200 East Brundage Lane
Bakersfield, CA 93307-3099

Royce Fast
17958 Kranenburg Street
Bakersfield, CA 93312

State Clearing House
15 copies

County Clerk - 2 copies

The Bakersfield Californian
1707 Eye Street
Bakersfield, CA 93301

Date: 7/31/00 2:31:40PM

To: KERN CO WATER AGENCY
Phone: 661-634-1400
Fax: 661-634-1428

From: Marie Ricks
Phone: 661-395-7314
Fax: 661-395-7540

Customer Information
KERN CO WATER AGENCY
PO BOX 58
BAKERSFIELD, CA 93302

<u>Here is a proof of your ad. Please check the ad carefully and call with any corrections.</u>

Notes:

Ad Information:

This ad will run in Classification: Legal Notices

Ad Depth in Lines: 149

Total Price: $219.03

Ad Number: 376048

This Ad will run in the following paper(s)
Non-Publishing Publication
Run Dates; 08/05/00
The Bakersfield Californian
Run Dates; 08/05/00

This Fax is Magnified: 2 X

‹ERN COUNTY WATER AGENCY
OTICE OF INTENT TO ADOPT NEGATIVE DECLARATION

[confirm CEQA Guidelines section 15072 determination]

suant to the California Envi-
onmental Quality Act and CEQA
delines, the Kern County Water
ncy hereby provides notice of
s intent to adopt a Negative Dec-
ration pursuant to CEQA Guide-
s section 15072 for the fol-
ing:
Name of Project: Kern River Res-
tion and Water Supply Pro-
n
. Project Lead Agency and Spon-
: Kern County Water Agency,
. Box 58, 3200 Rio Mirada
ve, Bakersfield CA 93302-
058. Contact person: Thomas N.
rk, General Manager, 661-634-
0.
. Project Description: Project
poses to provide significant wa-
quality, water supply, envi-
mental and community bene-
s for the metropolitan
ersfield area and a broad range
Kern County water users
hrough the coordinated imple-
tation of a number of program
ponents including: (1) acquisi-
ion of the Lower Kern River water
ght (Lower Right), i.e., Haci-
a/Garces pre-1914 water right,
uding associated Lake Isabella
Storage; (2) Purchase of land from
tle and Cooke California, Inc.,
additional recharge and recov-
ry facilities; (3) construction of
2 new water Ag recovery wells
construction of enough urban
wells to achieve a flow capac-
ty of about 60 cfs; and (4) Con-
ction of water exchange facili-
and modification of the Pool 1
portion of the Cross Valley Canal.
r more information concerning

Tile 1-2

more information concerning ne project, see the Kern County ter Agency Environmental Ini- Study Form [for CEQA Guide- nes section 15072 Determina- on] dated July 27, 2000 (the itial Study"), which is available review and copying during gular business hours at the ncy office at the above address.

Purpose and explanation of Ini- al Study: The Agency has pre- ed the Initial Study in order to ermine whether the approval implementation of the project described in the Initial Study y have a significant effect on the ironment under CEQA Guide- nes section 15063. The Kern er Restoration and Water Sup- Program is intended to provide ignificant water quality, water pply, environmental and com- nity benefits for the metropoli- Bakersfield area and a broad nge of Kern County water users. Agency has determined, in it of the record as a whole, there no substantial evidence that the oject may have a significant ef- on the environment.

Project Location: The Project is cated in the City of Bakersfield narily located along the Kern er corridor from the projected xtension of Haley Street on the t side, to the California Aque- t on the west end, and south west of Bakersfield in the un- corporated portion of the county g the Cross Valley Canal and n-Edison Canal (see maps at- ached to Initial Study);

Proposed Finding: The Agency rd of Directors has reviewed he proposed project, Initial Study, mments received on the pro- al to adopt this Negative Decla- on, and other documents and formation from Agency staff, Tile 1-3

ı the basis of this informa-
ıd the whole record before
, hereby finds and deter-
as follows: (a) The Initial
nd Negative Declaration re-
gency's independent judg-
and analysis; and (b) miti-
ıeasures have been included
ce to less than significant
tential environmental ef-
f the project and nothing
is required. This Negative
ıtion confirms this conclu-

ial Study: A copy of the Ini-
udy is either attached or
le for public review at the
y office at the above address.
ation of Background Docu-
The Initial Study, notice of
to adopt Negative Declara-
comments on the Initial
and other documents con-
g this project are on file and
le for public review at the
office at the above address.
ency Board Secretary (same
s) is the custodian of the
ents that constitute the rec-
proceedings upon which the
n in this matter is based.
blic Review: Pursuant to
Guideline section 15105,
comments on this proposal
opt a Negative Declaration
received by the Agency at
ve address beginning July
00 and ending September 1,
. The Agency Board of Direc-
expected to consider the
n of the Negative Declara-
t a public meeting scheduled
ursday, September 7, 2000
p.m., at the Agency's office
above address.
al signed on July 27, 2000
s N. Clark
l Manager
County Water Agency
5, 2000 (376048)

KERN COUNTY
WATER AGENCY

Kane

MEMORANDUM
[illegible]
GROUNDWATER Pioneer

TO: Water Management Committee
Agenda Item No. 5

FROM: John Stovall/Kane Totzke

DATE: July 27, 2000

SUBJECT: Notice of Intent to adopt a Negative Declaration for the Kern River Program, including acquisition of water rights, and discussion of a program

Issue

Consider authorizing filing and distribution of an Initial Study, Environmental Checklist/Response to Checklist and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program.

Recommended Motion:

Adopt Resolution No. 49-00 authorizing the General Manager, upon approval as to legal form by the General Counsel, to file the Initial Study and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program.

Discussion

Over the past few months, local water leaders have been working to implement the Kern River Restoration and Water Supply Program, utilizing $23 million from the "Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act" (Proposition 13). This project will generate broad local water supply, environmental and community benefits, and targeted drinking water quality benefits within the metropolitan Bakersfield area. In order to implement the proposed Project, the Kern County Water Agency (Agency) must first comply with the California Environmental Quality Act (CEQA). The Agency, as the Lead Agency under CEQA, has prepared an Initial Study and associated Environmental Checklist and Response to Checklist, and a proposed draft Negative Declaration for the Project to be filed with the County Clerk and State Clearing House, and to be distributed to interested parties and responsible agencies for comment. Staff is recommending that a Negative Declaration be prepared for this Project, since an evaluation of the environmental impacts resulting from implementing the Project are shown to be less than significant. In order to provide the required 30 day public review period, the public hearing for the Board to consider adoption of the Negative Declaration is set for Thursday at 4:00pm, on September 7, 2000 at the Agency office.

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The Project consists of the four components, generally described below.

1. Acquisition of the Kern River lower water right;
2. Construction of enough urban area wells to achieve a flow capacity of about 60 cfs;
3. Construction of water conveyance exchange facilities;
4. Construction and acquisition of local facilities to enhance groundwater recharge and recovery opportunities.

For a complete description of the Project and proposed Project Operation, see the *Initial Study* Project Description (attached). A brief description of the Project follows. Water quality and water supply benefits from the Project will be realized through the acquisition of high flow lower Kern River water right (Lower Right), i.e., Hacienda and Garces pre-1914 water right. This high flow water is estimated to be available when the river is at or above 120% of normal or in about one out of every five years. The estimated long-term average annual yield is 40,000 acre-feet. Due to the high quality nature of Kern River water, up to the maximum of 40,000 acre-feet of annual Lower Right water available will be given priority for delivery to Improvement District No. 4 Henry C. Garnett Water Purification Plant (Purification Plant) and delivered for urban use in the greater Bakersfield area. Annual Lower Right water available above the amount used by the Purification Plant will be used for groundwater recharge and provide water supply benefits to local agricultural water districts.

Environmental and community benefits are an important part of the Project. The Project plans to assure through acquisition of the Lower Right and by annual water exchanges with local water districts having Kern River water rights, that the heart of the City of Bakersfield (from Manor Street downstream to Stockdale Hwy bridge) will enjoy a re-watered Kern River, at least from May through September. This stretch of the Kern River has been dry since the mid-1950's, except in wet years.

An integral component of the program is the proposed construction of enough urban area wells along the right-of-way of the Kern Island, Carrier, Kern River and Cross Valley Canals, east of Allen Rd to achieve a capacity of about 60 cfs. In dry years, estimated to be when the supply for the SWP and the Kern River is at or below 50% of normal, these wells will be pumped as part of the exchange to keep the Kern River channel wet between Manor Street on the east end, and the Stockdale Hwy bridge at the west end of the City. Water that has previously been released down the Kern River channel and percolated will be recaptured and recirculated by these wells. The ability to recirculate water is accomplished by an exchange among ID4 and Kern Delta WD/North Kern WSD. These wells will only be pumped during the driest of years to pay back to North Kern WSD and Kern Delta WD for release of their Kern River water from Isabella into the Kern River channel. This component of the Project will serve to keep the river flowing during the peak recreational use months of May through

September, without decreasing the supplies that are needed during the critical water short years.

Also, a component of the Project includes water conveyance exchange facilities, i.e., modifications and improvements to existing surface water delivery systems to increase their integration and flexibility, thus generating both water quality and water supply benefits to local water users. These improvements will be made to facilities which provide for the exchange/delivery of high quality Kern River water to areas which currently receive water of lesser quality. They include structures on the Arvin-Edison Canal to increase water deliveries to the Kern Delta WD service area, and improvements on the Cross Valley Canal and Beardsley Canal to increase deliveries of water to Kern Delta WD and to North Kern WSD from the Cross Valley Canal, and a Cross River pipeline from the CVC near the Purification Plant to the Kern Island Canal or Carrier Canal.

Another program component is to acquire and construct facilities to enhance local groundwater recharge and recovery operations. To accomplish this goal, additional regulation/recharge basins will be constructed on approximately 80 acres of property which has been targeted for acquisition from Castle and Cooke California, Inc. The property is located along both sides of the Kern River near the Stockdale bridge. Portions of the property will be dedicated to groundwater recharge and other portions will be used for a multi-propose park facility, with groundwater recharge given a priority when the Kern River is in a high flow year, thus combining a prominent water feature into the park.

To enhance the capability of existing canals to convey recovered water, the Project proposes to interconnect the Kern River Canal with the Kern Water Bank Canal and to raise the lining of the CVC in Pool 1. The CVC would be modified to "float" off the Aqueduct to increase the operational opportunity for water exchanges. The modification will also reduce water over-topping the lining, increase flexibility to move water around the County, reduce energy costs, and reduce operations and maintenance costs. This work covers the portion of the CVC that extends from the California Aqueduct turnout near Tupman to the forebay of Pumping Plant 1.

To recover the Lower Right water that will be recharged during wet years, the Project proposes to construct 12 additional groundwater recovery wells (Ag wells). The Ag wells will be constructed on either the Agency's Pioneer property, Kern Water Bank, City of Bakersfield's Kern River Canal right-of-way, and/or on private land near the Cross Valley Canal or Kern River Canal. In dry years, these wells will be pumped and the recovered water delivered to the CVC and/or the Kern River Canal for direct delivery or by exchange to water districts to supplement deficiencies in surface water deliveries. The Ag wells will have an annual recovery capacity of approximately 36,000 acre-feet.

To address any concerns that may arise from the Agency implementing this project, the Agency proposes to incorporate a number of mitigation measures into the Negative Declaration as part of the Project. These measures include but are not limited to the following:

1. Throughout the term of the proposed Project, Project water quality, groundwater monitoring, and groundwater recharge losses will be consistent with the Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program, dated October 26, 1995, and consistent with the Operation and Monitoring Procedure for the Pioneer Project, dated May 28, 1998.
2. Project recharge and recovery well areas will be designed and located to avoid areas suspected to have hydrocarbon contamination, and to the extent practical, not to interfere with operation of oil (crude or refined) or natural gas pipelines or other sensitive oilfield facilities.
3. Project recharge and recovery well areas will be designed and located to minimize potential impacts to the Agency's Cross Valley Canal.
4. The Agency will develop agreements with Kern Delta WD and North Kern WSD to address concerns regarding the water exchanges with ID4 for the Kern River Restoration component of the Project.
5. The Agency will develop agreements to share the portion of Lower Right water available for groundwater recharge with the Member Units not required by the ID4 Water Purification Plant.
6. The Agency will develop agreements with the Member Units to share the recovery capacity of the 12 agricultural wells.
7. Improvement District No. 4 will develop agreements with the Kern River Interests to account for natural and unavoidable post-1950 Isabella Reservoir river losses when operating the urban area wells for the Kern River Restoration Project, for banking purposes.
8. Agreements with public and/or private landowners for construction and operation of Agricultural wells.

In conclusion, the Project will provide significant water quality, water supply, environmental and community benefits for the Metropolitan Bakersfield area and for a broad range of Kern County water users through the coordinated implementation and operation of the above-mentioned program components. The Project would be a cooperative arrangement among the Kern County Water Agency, Improvement District No. 4, City of Bakersfield, Kern Delta Water District, and the North Kern Water Storage District.

BEFORE THE BOARD OF DIRECTORS

OF THE

KERN COUNTY WATER AGENCY

In the Matter of:

INITIAL STUDY AND PROPOSED *
NEGATIVE DECLARATION FOR THE *
KERN COUNTY WATER AGENCY *
KERN RIVER RESTORATION AND *
WATER SUPPLY PROGRAM *

I, PAM BOSWORTH, Secretary of the Board of Directors of the Kern County Water Agency, of the County of Kern, State of California, do hereby certify that the following resolution proposed by Director ________________ and seconded by Director ________________, was duly passed and adopted by said Board of Directors at an official meeting hereof this ______ day of ____________, 2000, by the following vote to-wit:

Ayes:

Noes:

Absent:

____
Secretary of the Board of Directors
of the Kern County Water Agency

RESOLUTION 49-00

WHEREAS, with the passage in March 2000, of Proposition 13, the *Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act*, more than $1.9 billion was made available to improve California's water infrastructure; and

WHEREAS, it is estimated these funds could generate nearly 1,000,000 acre-feet of new dry-year supply, restoring a portion of the Bay-Delta water supply that have been lost to federal actions, as well as generate important water quality and flood control benefits; and

WHEREAS, Chapter 9, Article 4 of Proposition 13, the *Interim Water Reliability Supply and Water Quality Infrastructure and Management Program*, provides $180 million in competitive grants and loans to local agencies located in the Delta export service areas for programs or projects that can be completed and provide the intended benefits not later than March 8, 2009, and are designed to increase water supplies, enhance water supply reliability, or improve water quality; and

WHEREAS, Kern County water leaders and planners have been working to develop a comprehensive local program that would encompass the specific types of activities targeted for funding under Chapter 9, Article 4 portion of the bond; and

WHEREAS, the Kern County Water Agency (Agency) has been approved for a grant by the Governor for $23 million under the above described Chapter 9, Article 4 of Proposition 13 to fund the *Kern River Restoration and Water Supply Program*, (Project) which proposes to provide significant water quality, water supply, environmental and community benefits; and

WHEREAS, the Project proposes to achieve these benefits through construction and acquisition of facilities defined in four broad based components: 1) acquisition of the Lower Kern River water right (Lower Right), i.e., Hacienda/Garces pre-1914 water right, including associated Lake Isabella Storage; 2) purchase of land from Castle and Cooke California, Inc., to provide for construction of additional recharge and recovery facilities; 3) construction of 12 new water Ag recovery wells and enough Urban area wells to achieve a flow capacity of about 60cfs; 4) construction of water exchange facilities, including modifications to the Pool 1 portion of the Cross Valley Canal (CVC); and 5) interconnection of other existing canals; and

WHEREAS, all the above proposed components comprise the Project and are subject to the California Environmental Quality Act (CEQA); and

WHEREAS, the Agency's acquisition of the Lower Right will not result in any new operation or reoperation of the Kern River and as such, any environmental impacts created as a result of acquisition of the Lower Right will be less than significant; and

WHEREAS, construction of the urban area wells to achieve a flow capacity of about 60 cfs and 12 Agricultural wells will be on existing right-of-way owned by the Agency and/or the City of Bakersfield, and/or on land owned by the Agency and/or Kern Water Bank Authority, and/or on private land currently being farmed or fallowed, and as such, will have less than a significant impact on the environment; and

WHEREAS, construction of proposed water exchange facilities and CVC modifications will occur in the existing right-of-way of local water districts conveyance canals/facilities, and as such, will have a less than significant impact on the environment; and

WHEREAS, no threatened or endangered species pursuant to State and Federal Endangered Species Act will be impacted as a result of Project implementation; and

WHEREAS, the Agency has prepared an Initial Study and proposed draft Negative Declaration for the *Kern River Restoration and Water Supply Program* pursuant to CEQA; and

WHEREAS, in light of the whole record, the Agency has made an evaluation of the potential environmental effects from implementation of the Project and has found these effects, based on the Initial Study to be less than significant and therefore recommends preparation of the proposed Negative Declaration for the Project.

NOW, THEREFORE, BE IT RESOLVED by the Kern County Water Agency Board of Directors that:

1. The Board hereby finds and determines that the foregoing recitals are true and correct; and
2. Directs the General Manager to file with the State Clearinghouse and County Clerk, the Initial Study/Environmental Checklist and proposed draft Negative Declaration for the Kern County Water Agency *Kern River Restoration and Water Supply Program*, in the form shown attached hereto as Exhibit "A"; and

3. Set the hearing time, date and location for 4:00 p.m., Thursday, September 7, 2000, at the Kern County Water Agency, 3200 Rio Mirada Drive. Bakersfield, Kern County, California in order to consider adoption of the proposed Negative Declaration; and

4. Directs the Secretary of the Board to advertise a "Notice to Intent to Adopt Negative Declaration" in a local newspaper no later than one week before the public hearing.

EXHIBIT “A”

KERN COUNTY
WATER AGENCY

GROUNDWATER
Pioneer

TO: All Responsible Agencies and Interested Parties

FROM: Thomas N. Clark

DATE: July 27, 2000

SUBJECT: California Environmental Quality Act (CEQA) Compliance for the Kern River Restoration and Water Supply Program

Pursuant to the California Environmental Quality Act (CEQA), the Kern County Water Agency (Agency) will be the Lead Agency and has prepared an Initial Study, Environmental Checklist/Explanation of Responses and Proposed Draft Negative Declaration for the Kern River Restoration and Water Supply Program. We are soliciting the views of your agency as to the scope and content of the environmental information which is applicable to your agency's statutory responsibilities in connection with the proposed project.

In order to review and consider your comments during the public review period, the Agency requests that all comments be received no later than September 1, 2000. Following the review and comment period, the Initial Study and Negative Declaration will be presented for adoption by the Agency Board of Directors at a public hearing to be held at 4:00pm on Thursday, September 7, 2000, at 3200 Rio Mirada Drive, Bakersfield. Please submit comments to:

Mr. Thomas N. Clark, General Manager
Kern County Water Agency
P.O. Box 58
Bakersfield, CA 93302-0058

If you require any further information, please contact Kane Totzke at (661) 634-1468.

Sincerely,

Thomas N. Clark
General Manager

Enclosures

Mailing Address:
P.O. Box 58
Bakersfield, CA 93302-0058
Phone: 661/634-1400
Fax: 661/634-1428

CEQA Notice of Determination

COPY

RECEIVED WITH FEE
RECEIPT # DeMinimus

To: X Office of Planning and Research
1400 Tenth Street, Room 121
Sacramento, CA 95814

X County Clerk
County of Kern
1115 Truxton Ave., 2nd Floor
Bakersfield, CA 93301

From: Kern County Water Agency
P.O. Box 58
3200 Rio Mirada Drive
Bakersfield, CA 93302

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Kern County Water Agency

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6

Subject: Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code.

Project Title: Transfer of 10,000 acre-feet per year of Banked Lower Kern River Water

State Clearinghouse Number (If submitted to Clearinghouse)	Lead Agency/ Contact Person	Area Code/Telephone/Extension
SCH # 2000081017	Kern County Water Agency/ General Manager Thomas N. Clark	661-634-1400

Project Location (include county)
See attached Negative Declaration.

Project Description:
See attached Negative Declaration.

This is to advise that on November 13 , 2001 the Kern County Water Agency (as lead agency) approved the project (more particularly described in the attached Negative Declaration) and determined that no additional environmental review is required.

An Initial Study and Subsequent Negative Declaration with findings were prepared for the Agency's recent action pursuant to the provisions of CEQA Guidelines section 15162 concluding that no additional environmental review is required. The recent action will not have any significant effect on the environment that was not already addressed in the previous CEQA documents for this project. Mitigation measures and statements of overriding consideration were already adopted for the previously considered project.

This is to certify that the Initial Study with comments and responses and record of project approval is available to the general public at: Kern County Water Agency, P.O. Box 58, 3200 Rio Mirada Drive, Bakersfield, CA 93302.

Date received for filing and posting at OPR:______________________

Signature, Thomas N. Clark, General Manager, Kern County Water Agency

11/13/01
Date

Notice of Environmental Document
Posted by County Clerk on 11-16-01
and for 30 days thereafter, Pursuant to
Section 21152(c), Public Resources Code

1069

KERN COUNTY WATER AGENCY
SUBSEQUENT NEGATIVE DECLARATION
[to confirm CEQA Guidelines section 15162 determination]

Pursuant to the California Environmental Quality Act and CEQA Guidelines, the Kern County Water Agency hereby adopts this Subsequent negative declaration pursuant to CEQA Guidelines section 15162 for the following:

1. **Name of Project:** Transfer of 10,000 acre-feet per year of Banked Lower Kern River water.

2. **Project Lead Agency and Sponsor:** Kern County Water Agency, P.O. Box 58, 3200 Rio Mirada Drive, Bakersfield CA 93302-0058. Contact person: Thomas N. Clark, General Manager, 661-634-1400.

3. **Project Description:** In September 2000, the Kern County Water Agency (Agency) certified a Negative Declaration for the *Kern River Restoration and Water Supply Program* (Program). A component of the Program was acquisition of the Lower Kern River water right (Lower Right), i.e., Hacienda/Garces pre-1914 water right. Studies conducted by Agency staff showed that the controllable average annual yield from the Lower Right was approximately 40,000 acre-feet. Historically, the prior owner of the Lower Right, Nickel Family, LLC had exported at least 10,000 acre-feet per year from the basin under various terms and conditions. For example, during the period from 1992 through 2001, approximately 13,000 acre-feet of Lower River water was exported out-of-County. Subsequent to the Board certification of the Negative Declaration for the Program, the Agency detailed a proposal to continue to transfer, on an annual basis, the 10,000 acre-feet of water from the Agency's groundwater bank account. The transferred water will be recovered from the Agency's storage account in the Pioneer Groundwater Recharge and Recovery Project and/or from other local banking facilities either directly or by exchange and delivered back to the California Aqueduct either directly or by exchange, via the Kern Water Bank Canal and/or the Cross Valley Canal. For more information concerning the project, see the *Kern County Water Agency Environmental Initial Study Form [for CEQA Guidelines section 15162 Determination]* dated September 27, 2001 (the "Initial Study"), which is available for review and copying during regular business hours at the Agency office at the above address.

4. **Purpose and explanation of Initial Study:** The Agency has prepared the Initial Study in order to determine whether the approval and implementation of the project as described in the Initial Study require subsequent or additional environmental review under CEQA Guidelines section 15162. The purpose of the project is to continue to transfer the 10,000 acre-feet of water per year. The recipient entity(s) of the transferred water are unknown at this time. A portion or all of this water may be transferred outside Agency boundaries. In comparing water transfers between the prior owner and the Agency, except for which groundwater banking project the water is delivered from, the physical arrangement and potential impacts remain very much the same.

The Initial Study evaluates the incremental differences between the impacts of the transfer of the 10,000 acre-feet from the prior owner verus transfer by the Agency as the new owner of the water and use of the Agency's Pioneer groundwater bank supply and/or other local banking facilities, as previously described, analyzed and approved in the previous CEQA documents For more information concerning the purpose of the Initial Study and this Subsequent Negative Declaration, see the Initial Study. CEQA compliance for acquisition of the Lower Kern River water right and the Pioneer Groundwater Recharge and Recovery Project are available for review at the above address.

5. **Project Location:** Water storage in and transfer from Agency Pioneer Groundwater Recharge and Recovery Project and/or other local banking facilities, Kern County, California (see map attached to Initial Study); water delivery via the State Department of Water Resources California Aqueduct.

6. **Finding:** The Agency Board of Directors has reviewed the proposed project, Initial Study, comments received on the proposal to adopt this Subsequent Negative Declaration, and other documents and information from Agency staff, and on the basis of this information and the whole record before Agency,

hereby finds and determines as follows: (a) The Initial Study and Subsequent Negative Declaration reflect Agency's independent judgment and analysis; and (b) the Agency's Kern River Restoration and Water Supply Program and the Pioneer Groundwater Recharge and Recovery Project and other local banking facilities (i) have been analyzed adequately in the previous CEQA documents pursuant to applicable standards, and (ii) impacts have been avoided or mitigated pursuant to the previous negative declarations, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required. This Subsequent Negative Declaration confirms this conclusion.

7. Initial Study: A copy of the Initial Study is either attached or available for public review at the Agency office at the above address.

8. Location of Background Documents: The Initial Study, documents referenced in the Initial Study, notice of intent to adopt Subsequent Negative Declaration, comments on the Initial Study, and other documents concerning this project are on file and available for public review at the Agency office at the above address. The Agency Board Secretary (same address) is the custodian of the documents that constitute the record of proceedings upon which the decision in this matter is based.

By:________________________
President

Date: 11/13/01

CALIFORNIA DEPARTMENT OF FISH AND GAME

CERTIFICATE OF FEE EXEMPTION

De Minimis Impact Finding

Project Title: Kern County Water Agency's (Agency) Transfer of 10,000 acre-feet per year of Banked Lower Kern River Water Project

Location: California Aqueduct, Kern County

Project Description: The Project is to continue the transfer 10,000 acre-feet per year of banked Lower Kern River Water. The transferred water would come from the Agency's banked groundwater account stored in the Pioneer Groundwater Recharge and Recovery Project and/or other local banking facilities and would be recovered either directly or by exchange and conveyed back to the California Aqueduct either directly or by exchange.

Findings of Exemption:

1. The project consists of a water transfer.
2. A Subsequent Negative Declaration has been conducted by Kern County Water Agency (lead agency) which evaluates the potential for adverse environmental impacts resulting from the approval and implementation of the project.
3. The lead agency has no evidence before it, including the information in the Subsequent Negative Declaration and comments of appropriate reviewing agencies, to indicate that the proposed project could have any potential for adverse effects on fish and wildlife resources.

Certification:

I hereby certify that the public agency has made the above finding(s) and that the project will not individually or cumulatively have an adverse effect on wildlife resources, as defined in Section 71.2 of the Fish and Game Code.

Title: GeneralManager

Local Lead Agency: Kern County Water Agency

Date: November 13, 2001

The State Water Project Deliverability Reliability Report,
Public Review Draft, November 16, 2005

State of California
The Resources Agency
Department of Water Resources

The State Water Project Delivery Reliability Report 2005

Public Review Draft

November 16, 2005

Arnold Schwarzenegger	**Mike Chrisman**	**Lester A. Snow**
Governor	Secretary for Resources	Director
State of California	The Resources Agency	Department of Water Resources

If you need this report in alternate format, call the Equal Opportunity and Management Investigations Office at (916) 653-6952 or TDD (916) 653-6934.

Foreword

The Department of Water Resources (DWR) is issuing this report to update information presented in the *State Water Project Delivery Reliability Report – 2002*, which was finalized in 2003 after an extensive public review. DWR will update this information every two years or more frequently if new information significantly affecting the assessments warrants an earlier update.

The 2002 report was the first of this biennial series. It was welcomed by SWP contractors as the source of delivery estimates of their SWP supply that could be incorporated into their, or their sub-agencies', water supply plans. The information contained in this update was recommended by DWR in May 2005 for use by SWP contractors in developing their 2005 Urban Water Management Plans.

The information contained in the 2002 report and this update is based upon a computer simulation model, CalSim II. DWR believes CalSim II is the best available method for this assessment. Public criticism of the model has centered upon the ability of the model to simulate "real world" conditions and accurately estimate SWP deliveries. Following up on commitments in the 2002 report, DWR has completed an assessment of how well the model simulates a recent historical period and conducted a sensitivity analysis investigating the relative effect of assumptions used for input data upon the results of the simulation. The simulation of the historical period corresponds very well with the actual data. The sensitivity study and a study on the significance of the calculation interval (monthly) provide useful information in identifying areas important to CalSim II results. These studies are discussed in Chapter 3.

In addition, a peer review sponsored by the CALFED Science Program was conducted in 2003 to evaluate the strengths and weaknesses of CalSim II. The panel concluded the model is comparable to other state-of-the-art models and, specific to the type of information contained in this report, recommended calibration and verification of the model, as well as analyses of the sensitivity and uncertainty associated with the studies. The studies mentioned above and discussed in Chapter 3 address some of these concerns. DWR, with the support of U.C. Davis, is planning to develop a strategy for identifying and reducing the major sources of uncertainty in CalSim II studies and a procedure for quantifying the uncertainties. This effort should begin in 2006.

The next version of CalSim, CalSim III, is planned to be completed by early 2007. This version will include improvements in the land-use-based water budget calculations, which include refinements in the water budget boundaries, agricultural water use efficiencies, modeling wildlife refuges, and modeling the surface water-groundwater interaction. A new and improved graphical user interface will also be developed as part of this effort.

The updated SWP delivery estimates are summarized in Chapter 5. Chapter 6 contains examples of how to incorporate this information into a local water supply assessment. These examples are based upon examples contained in the *Draft Guidelines for Documentation and Integration of SWP Supplies,* which will soon be released by DWR for public review. These draft guidelines are designed to assist SWP urban contractors in estimating the amount of SWP supplies available to them and in integrating the SWP supply information with supply information from other sources to develop an overall assessment of each contractor's total water portfolio.

The release of the *Draft SWP Delivery Reliability Report – 2005* continues public involvement in this important topic and the evolution of the assessment tools. For additional information or questions about this report, please contact DWR's Bay-Delta Office at (916) 653-1099.

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Arnold Schwarzenegger, Governor

THE RESOURCES AGENCY
Mike Chrisman, Secretary for Resources

DEPARTMENT OF WATER RESOURCES
Lester A. Snow, Director

P. Joseph Grindstaff
Chief Deputy Director

Peter S. Garris
Deputy Director

Gerald E. Johns
Deputy Director

Ralph Torres
Deputy Director

Stephen Verigin
Deputy Director

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Assistant Director Legislative Affairs

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Chief Counsel

Susan Sims-Teixeira
Assistant Director Public Affairs

Bay-Delta Office
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Modeling Support Branch

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Sina Darabzand	Senior Engineer, Bay-Delta Office
Alan Olson	Engineer, Bay-Delta Office

Editorial review, graphics, and report production

Gretchen Goettl, Acting Supervisor of Technical Publications

Nikki Blomquist, Lead Editor
Research Writer

Marilee Talley
Research Writer

Chapter 1.
Introduction

Will there be enough water? Public officials throughout California face this question with increasing frequency as growth and competing uses strain existing resources. Water supply, however, has always been an uncertain and contentious matter in our state. For many years, the Department of Water Resources (DWR) has investigated this question. At its simplest level, the question might be, “How many wells are needed for a rural town’s water supply?” or “How many people can a 100,000 acre-foot reservoir serve?” But for most areas of the state, the evaluation of water supply adequacy is not simple. The answer requires a complex analysis, taking into account multiple sources of water, a range of water demands, the timing of water uses, hydrology, available facilities, regulatory restraints, levels of demand management (water conservation) strategies, and, of course, future weather patterns.

Most water users in California live in areas that rely on multiple sources of water supply, some local and some imported. Typically, local water providers “mix and match” their supply sources to maximize water supply and quality and to minimize cost. In addition to considering available sources of supply, local water providers are planning for ways to improve the efficiency of local water uses and the operation of their water management systems. To help with this effort, DWR presents 25 different resource management strategies available to local agencies and governments and private utilities in the *California Water Plan Update 2005* (see website at http://www.waterplan.water.ca.gov).

Purpose

The State Water Project Delivery Reliability Report 2005 presents DWR’s current information regarding the annual water delivery reliability of the State Water Project (SWP) for existing and future levels of development in the water source areas, assuming historical patterns of precipitation. This report first looks at the general subject of water delivery reliability and then discusses how DWR determines delivery reliability for the SWP. A discussion of the analysis tool, the CalSim II computer simulation model, and the analyses and peer review regarding the accuracy of CalSim II and its suitability for use in this report is included. Finally, estimates of SWP delivery reliability today and in the future are provided along with examples of how to incorporate this information into local water management plans.

This delivery reliability report also responds to public comments on how DWR administers the SWP. Comments on the Monterey Amendment Environmental Impact Report stated that local planners and public officials were relying on inflated estimates of water supply from the SWP in approving new development. This report provides local officials with a single source of the most current data available on SWP delivery reliability for use in local planning decisions.

The report does not, however, analyze how specific local water agencies integrate SWP water into their water supply equation. That topic requires extensive information about local facilities, local water resources, and local water use, which is beyond the scope of this report. Moreover, such an analysis would require decisions about water supply and use that traditionally have been made at the local level. DWR believes that local officials should continue to fill this role. The examples provided in Chapter 6 are included to help local agencies incorporate the information presented in this report into local water management assessments.

Background

The original *SWP Delivery Reliability Report* was issued as a draft in August 2002. In 2002, DWR held six public meetings throughout the state to discuss the report and receive comments upon the content. The final *SWP Delivery Reliability Report* was released in early 2003. The 2005 SWP Delivery Reliability Report is an update to the report issued in 2003. DWR intends to publish biennial update of the *SWP Delivery Reliability Report* in the future.

The SWP supplies two-thirds of the state's population with a portion of its water supply and provides water to irrigate, in part, 750,000 acres of agriculture. The SWP delivers water under long-term contracts to 29 public water agencies throughout the state. They, in turn, either deliver water to water wholesalers or retailers or deliver it directly to agricultural and urban water users.

The water delivery reliability of the SWP is of direct interest to those who use SWP supplies because it is an important element in the overall water supply in those areas. Local supply reliability is of key importance to local planners and local government officials who are responsible for planning for future growth while assuring that an adequate and affordable water supply is available for the existing population and businesses. This function is usually conducted in the course of preparing a water management plan such as the Urban Water Management Plans required by Water Code section 10610. The information in this report may be used by local agencies in preparing or amending their water management plans and identifying the new facilities or programs that may be necessary to meet future water demands.

Local agencies and governments and private utilities will also find in this report information that is useful in conducting analyses mandated by legislation authored by Senator Sheila Kuehl (SB 221) and Senator Jim Costa (SB 610). These laws require water retailers to demonstrate whether their water supplies are sufficient for certain proposed subdivisions and development projects subject to the California Environmental Quality Act.

DWR published the *Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001*, which includes suggestions on how local water suppliers can integrate supplies from various sources such as the SWP into their analyses. DWR has also published the *Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan*, which includes suggestions on how local water suppliers can integrate supplies from other sources such as the SWP in their analyses. Both documents can be found on the DWR's Office of Water Use Efficiency home page at http://www.owue.water.ca.gov.

DWR will also soon publish *Guidelines for Documentation and Integration of SWP Supplies* to assist SWP urban contractors in determining the amount of SWP supplies available to them. These guidelines, using the information in this report (*SWP Delivery Reliability Report 2005)*, explain how to integrate the SWP supply information with supply information from other sources to develop an overall reliability assessment of each contractor's total water portfolio.

Senate Bill 221

This law amends Section 11010 of the Business and Professions Code and Section 65867.5 of the Government Code. It also adds Sections 66455.3 and 66473.7 to the Government Code.

Under the Subdivision Map Act, a legislative body of a city or county is required to deny approval of a tentative map, or a parcel map for which a tentative map is not required, if it makes any of a number of findings. Under the Planning and Zoning Law, a city, county, or city and county may not approve a development agreement unless the legislative body finds that the agreement is consistent with the general plan and any applicable specific plan. [SB 221 prohibits] approval of a tentative map, or a parcel map for which a tentative map was not required, or a development agreement for a subdivision of property of more than 500 dwelling units, except as specified, including the design of the subdivision or the type of improvement, unless the legislative body of a city or county or the designated advisory agency provides written verification from the applicable public water system that a sufficient water supply is available or, in addition, a specified finding is made by the local agency that sufficient water supplies are, or will be, available prior to completion of the project.

(From Legislative Counsel's Digest of Senate Bill No. 221, 2001-2002 session, filed with Secretary of State Oct. 9, 2001, Chapter 642:88-89)

An exception is made for the County of San Diego if the Governor's Office of Planning and Research determines certain conditions are met.

Senate Bill 610

Senate Bill 610 This law amends Section 21151.9 of the Public Resources Code, and Sections 10631, 10656, 10910, 10911, 10912, and 10915 of the Water Code. It also repeals Section 10913 and adds and expires Section 10657 of the Water Code.

This [law requires] additional information be included as part of an urban water management plan if groundwater is identified as a source of water available to the supplier. [It] requires an urban water supplier to include in the plan a description of all water supply projects and programs that may be undertaken to meet total projected water use. [It prohibits] an urban water supplier that fails to prepare or submit the plan to the [California Department of Water Resources] from receiving funding made available from specified bond acts until the plan is submitted. The law, until January 1, 2006, requires the department to take into consideration whether the urban water supplier has submitted an updated plan, as specified, in determining eligibility for funds made available pursuant to any program administered by the department.

[In addition, the law] requires a city or county that determines a project is subject to the California Environmental Quality Act to identify any public water system that may supply water for the project and to request those public water systems to prepare a specified water supply assessment, except as otherwise specified. [It requires] the assessment include, among other information, an identification of existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project and water received in prior years pursuant to those entitlements, rights, and contracts. The [law requires] the city or county, if it is not able to identify any public water system that may supply water for the project, to prepare the water supply assessment after a prescribed consultation.

The [law prescribes] a timeframe within which a public water system is required to submit the assessment to the city or county and would authorize the city or county to seek a writ of mandamus to compel the public water system to comply with requirements relating to the submission of the assessment.

[It requires] the public water system, or the city or county, as applicable, if that entity concludes that water supplies are, or will be, insufficient, to submit the plans for acquiring additional water supplies. [It also requires] the city or county to include the water supply assessment and certain other information in any environmental document prepared for the project pursuant to the act.

(From Legislative Counsel’s Digest of Senate Bill No. 610, 2001-2002 session, filed with Secretary of State Oct. 9, 2001, Chapter 643:94-95.)

An exception is made for the County of San Diego if the Governor’s Office of Planning and Research determines certain conditions are met.

Chapter 2.
Delivery Reliability in General

What is Water Delivery Reliability?

"Water delivery reliability" means how much one can count on a certain amount of water being delivered to a specific place at a specific time.

Objectively, water delivery reliability indicates a particular amount of water that can be delivered with a certain numeric frequency. A delivery reliability analysis assesses such things as facilities, system operation, water demand, and weather projections.

Subjectively, water delivery reliability indicates an acceptable or desirable level of dependability of water deliveries to the people receiving the water. Usually, a local water agency in coordination with the public it serves determines the acceptable level of reliability and plans for new facilities, demand-management and conservation programs, or additional water supply sources to meet or maintain this level.

What Factors Determine Water Delivery Reliability?

In its simplest terms, water delivery reliability depends on three general factors:

1) Availability of water from the source (that is, the natural source or sources of the water from which the supplier draws—the particular watercourse or groundwater basin). Availability of water from the source depends on the amount and timing of precipitation and runoff, or "hydrology," which provides water to the stream or groundwater basin, and the anticipated patterns of use and consumption of this water within the source area, including water returned to the source after use.

2) Availability of means of conveyance (that is, the means for conveying the water from the source via pumps, diversion works, reservoirs, canals, etc. to its point of delivery). The ability to convey water from the source depends on the existence and physical capacity of the diversion, storage, and conveyance facilities and also on contractual, statutory, and regulatory limitations on the operation of the facilities.

3) The level and pattern of water demand in the delivery service area (destination). The level of water demand in the delivery service area is affected by the magnitude and types of water demands, level of water conservation strategies, local weather patterns, water costs, and other factors. Supply from a water system may be sufficiently reliable at a low level of demand but may become less reliable as the demand increases. In other cases under increased demand, the water supply system may be able to deliver more water than in the past and maintain its reliability because the system's facilities had not been fully utilized.

How is Water Delivery Reliability Determined?

Water Delivery Reliability is Defined for a Specific Point in Time

For this report, water delivery reliability is analyzed for 2005 conditions and for conditions projected to exist 20 years in the future (2025). These analyses must describe current conditions adequately and make predictions about the three factors described earlier and discussed here.

The Availability of Water at the Source

This factor depends on how much rain and snow there will be in any given year and what the level of development (that is, the use of water) will be in the source areas. No model or analytical tool can predict the actual, natural water supplies for any year or years in the future. Until we are able to better quantify the impacts of climate change on precipitation and runoff patterns in California, future weather patterns are usually assumed to be similar to those in the past, especially where there is a long historical rainfall record.

The State Water Project analyses contained in this report are based upon 73 years of historical records (1922-1994) for rainfall and runoff that have been adjusted to reflect the current and future levels of development in the source areas by analyzing land use patterns and projecting future land and water use. These series of data are then used to forecast the amount of water available to the SWP under current and future conditions.

The Ability to Convey Water from the Source to the Desired Point of Delivery

This factor describes the facilities available to capture and convey surface water or groundwater and the institutional limitations placed upon the facilities. The facilities and institutional limitations may be assumed to be those that currently exist. Alternatively, predictions may be made regarding planned new facilities. Assumptions made about the institutional limitations to operation—such as legal, contractual, or regulatory restrictions—often are based upon existing conditions. Future changes in conditions that affect the ability to convey water usually cannot be predicted with certainty, particularly the regulatory and other institutional constraints on water conveyance.

Although new facilities are planned to increase the water delivery capability of the SWP, the analyses contained in this report assume no additional facilities. The analyses also assume current regulatory and institutional limitations will exist 20 years in the future (2025).

The Level of Demand

This factor includes the amount and pattern of water demand on the water management system. Demand can have a significant effect upon the reliability of a water system. For example, if the demand occurs only three months in the summer, a water system with a sufficient annual supply but insufficient water storage may not be able to reliably meet the demand. If, however, the same total amount of demand is distributed over the year, the system could more easily meet the demand because the need for water storage is reduced.

Demand levels for the SWP are derived from historical data and information received from the SWP contractors. Demand on the SWP is nearing the maximum Table A amount. Each of the SWP contracts has a Table A, which lists the maximum annual delivery amount over the period of the contract. These annual amounts usually increase over time. Most contractors' Table A amounts reached a maximum in 1990. The total of all contractors' maximum Table A amounts is 4.173 million acre-feet (maf) per water year. Table A is used to define each contractor's portion of the available water supply that the Department will allocate and deliver to that contractor. The Table A amounts in any particular contract, accordingly, should not be read as a guarantee of that amount but rather as the tool in an allocation process that defines an individual contractor's "slice of the pie." The size of the "pie" itself is determined by the factors described in this report. (See Appendix C for additional explanation and listing of the maximum Table A amounts.)

There are 29 SWP contractors. Yuba City, Butte County, and the Plumas County Flood Control and Water Conservation District are north of the Delta. Their maximum Table A amounts total 0.040 maf. The maximum Table A amounts for the remaining 26 contractors, which receive their supply from the Delta, total 4.133 maf. This report focuses on SWP deliveries from the Delta because the amount of water pumped from the Delta by SWP facilities is the most significant component of the total amount of SWP deliveries. The results presented in this report regarding the percent of Table A deliveries applies to contractors north of the Delta in the same manner as those contractors receiving supply from the Delta.

Past Deliveries Cannot Accurately Predict Future Deliveries

It is worthwhile to note that actual, historical water deliveries cannot be used with a significant degree of certainty to predict future water deliveries. As discussed earlier, there are continual, significant changes over time in the determinants of water delivery: changes in water storage and delivery facilities, in water use in the source areas, in water demand in the receiving areas, and in the regulatory constraints on the operation of facilities for the delivery of water. Given the very significant historical changes that have occurred, past deliveries are not necessarily good predictors of current deliveries, much less of future deliveries.

For example, the demand 30 years ago for water from the SWP was not as high as it is currently or expected to be in the future. Because the need for SWP water then was relatively low, less water was transported through the SWP during normal and wet times than could have been if the demand had been higher. Simply put, less water was delivered in those past years because less water was needed. Conversely, the current or projected delivery capability of a water project would be less than the past if (1) demand for water from a water project was at its maximum level for many years, (2) no new facilities were built, and (3) the supply from one of its main sources of water was recently reduced because another entity with a prior water right increased its use of that source.

Many Assumptions Must Be Made in the Determination and Analysis of Water Delivery Reliability

As discussed earlier, to plan for the future, many assumptions must be made about the future. One of the most significant assumptions for water planning in general is how wet, dry and variable the weather will be. For many planning purposes, the assumption is that future patterns of weather will be like the past, and an effort is made to develop information on the longest historical period for which acceptable records exist.

Using the historical record, planners analyze the worst drought in the period of record to evaluate how the water management systems will respond. Precipitation information for the Central Valley used for this report begins in 1922 and records the area's worst multi-year drought (1928-1934), although the brief drought from 1976 through 1977 was more acutely dry. Whatever assumptions are made, every responsible water delivery reliability analysis should expressly state the assumptions, methods and data used to produce its results. It should always be understood that those numbers depend on, and are no better than, the assumptions upon which they must necessarily rest.

Because assumptions are the foundation upon which the estimates are made, it is helpful to know how each assumption affects study results. For example, what impact would a significant increase in water use in the source areas have upon the projected SWP water delivery reliability? Would it significantly reduce the amount of SWP supply, and if so, by how much? These types of questions can be answered by varying specific factors to see the impact upon the results. These studies are referred to as sensitivity analyses and can be helpful in assessing the importance of certain assumptions to the study results. In the 2002 Reliability Report, the Department committed to conducting a comprehensive sensitivity analysis for assumptions contained in the CalSim II model studies. This analysis is complete. Summaries of the findings of this and other studies of CalSim II as well as a peer review of the model are contained in this report and discussed in more detail in Appendix E.

Chapter 3.
Study Approach and CalSim II Follow-up Studies

This report presents information from computer simulation studies of the operation of the SWP using the CalSim II model. CalSim II is a planning model developed by the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation. It simulates the SWP and the Central Valley Project (CVP) and areas tributary to the Sacramento-San Joaquin Delta. Using historical rainfall and runoff data, which has been adjusted for changes in water and land use that have occurred or may occur in the future, the model simulates the operation of the water resources infrastructure in the Sacramento and San Joaquin river basins on a month-to-month basis. In the model, the reservoirs and pumping facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met.

The month-to-month simulations are conducted over the 73-year period (1922-1994) of the adjusted historical rainfall/runoff data. This approach incorporates the over-arching assumption that the next 73 years will have the same rainfall/snowmelt amount and pattern, both within-year and from year to year, as the period 1922 through 1994. The studies do not incorporate any modifications to account for changes related to climate change or assess the risk of future seismic or flooding events significantly disrupting SWP deliveries. As tools are developed to address these risks and the resulting studies become available, the information will be incorporated into the assessment of SWP delivery reliability. The results of the CalSim II studies conducted for this update to *The State Water Project Delivery Reliability Report 2002* (DWR 2003b) represent the best available assessment of the delivery capability of the SWP.

Since the release of the 2002 report, a peer-review and several studies have been conducted regarding CalSim II. These reports include:

- An external peer review commissioned by the California Bay-Delta Authority (CALFED);
- An analysis of an historical operations simulation;
- An analysis of the effect varying selected parameters has upon model results (sensitivity analysis study); and
- An analysis of the significance of the simulation time-step to the estimated SWP delivery amounts.

A strategic plan for improvements to CalSim II that incorporates recommendations of the peer review and on-going efforts has been developed. The conclusion of the historical simulation study is that CalSim II estimates of SWP Delta deliveries are very good. The analysis of the monthly versus daily time-step concludes it is not a significant factor in estimating SWP Delta deliveries. A more comprehensive sensitivity analysis report provides insight to the parameters with the greatest potential for affecting SWP Delta deliveries. An overview of these efforts follows.

Science Program Peer Review of CalSim II

In 2003, the CALFED Science Program commissioned an external review panel to provide an independent analysis and evaluation of the strengths and weaknesses of CalSim II. The central question put to the review panel was whether the CALFED program had adopted an appropriate approach to modeling the Central Valley Project/State Water Project (CVP/SWP) system. The panel considered a variety of CalSim II issues and addressed how future model development activities could be managed to assure quality results for current and proposed applications. The panel published its results in *A Strategic Review of CALSIM II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003).

In general, the panel concluded that the current modeling approach was comparable to other state-of-the-art models and addressed many of the complexities of the CVP/SWP system. To balance the competing needs of those who require greater detail from the model and those who require less detail, the panel recommended steps to achieve a more comprehensive, modular, and flexible approach in modeling practices and tools. To increase user confidence in model results and to provide a basis for gauging the model's ability to produce absolute predictive results of system behavior, the panel suggested calibration and verification of the model, as well as analyses in sensitivity and uncertainty.

In what was most relevant to the subject of this report on the SWP delivery reliability, the panel summarized its observation on the accuracy of the model to estimate the delivery capability of both the CVP and SWP systems in the *Strategic Review's* Appendix F "Analysis of the November 2003 CalSim II Validation Report." Appendix F is discussed in the next section.

In August 2004, DWR and the USBR jointly responded to the questions, comments, and recommendations of the review panel in a report, *Peer Review Response: A Report by DWR/Reclamation in Reply to the Peer Review of the CalSim II Model Sponsored by the CALFED Science Program in December 2003.* (*Peer Review Response*). In their report, the agencies outline current and planned work on model development and the priorities for improving CalSim II. The *Peer Review Response* also highlights the ongoing and planned efforts to establish trust in and credibility for the model by improving documentation, conducting sensitivity and uncertainty analyses of the model parameters and results. Other efforts include enhancing the level of detail in the geographic representation of the system, and improving hydrologic input and software development.

Many of the elements of model development outlined in the *Peer Review Response* are in progress and will be implemented in the updated version of the model, CalSim III. Some of the *Strategic Review's* pressing issues regarding the reliability of CalSim II as a planning tool are addressed below.

The Ability of CalSim II to Estimate Water Deliveries

The accuracy of CalSim II in simulating "real-world" conditions was one of the major issues raised by the peer review panel. The review panel focused on the system's delivery capability as a major concern to water users as well as water managers who rely on CalSim II when making planning decisions. In Appendix F of the *Strategic Review,* the panel expresses concern that CalSim II overestimates deliveries to south-of-Delta water users. This observation is based on comparing the average deliveries for the last 10 years (1993–2002) with the average annual deliveries in a 73-year model simulation (1922–1994) conducted at the 2001 level of development.

In *Peer Review Response,* DWR and USBR (2004) conclude the concern about overestimations of south-of-Delta deliveries is unwarranted because the 73-year study referenced by the panel is not designed to mimic historical conditions; rather it is intended to determine the reliability of the SWP when the demand equals the maximum Delta Table A amount (4.133 MAF) every year. The results of the referenced study are documented in *The SWP Delivery Reliability Report 2002* (DWR 2003b) as study 3 (2021B).

A more appropriate method for assessing the ability of CalSim II to accurately model SWP operations is to compare the historical SWP deliveries with the simulated deliveries of the Historical Operations Study. DWR committed to conducting this study in *The SWP Delivery Reliability Report 2002* (DWR 2003b). The study is documented in the November 2003 Technical Memorandum Report *CALSIM-II Simulation of Historical SWP/CVP Operations* (DWR 2003a). The Historical Operations Study is designed to assess CalSim II's ability to mimic historical operations of the SWP. In this study, historical input is used where reliable data are available. In situations where reliable historical record is not readily available, reasonable assumptions and estimates are made.

Comparing the average annual historical deliveries with the simulated deliveries in the Historical Operations Study for the dry period showed reasonable results: The average annual SWP south-of-Delta Table A delivery for the 6-year drought of 1987–1992 was 1,930 taf per year, compared to 2,030 taf per year for actual historical deliveries (Figure 3-1). The simulated deliveries in Figure 3-1 were adjusted for any differences between the historical and simulated carryover storage in the SWP system reservoirs, Lake Oroville and SWP's portion of San Luis Reservoir.

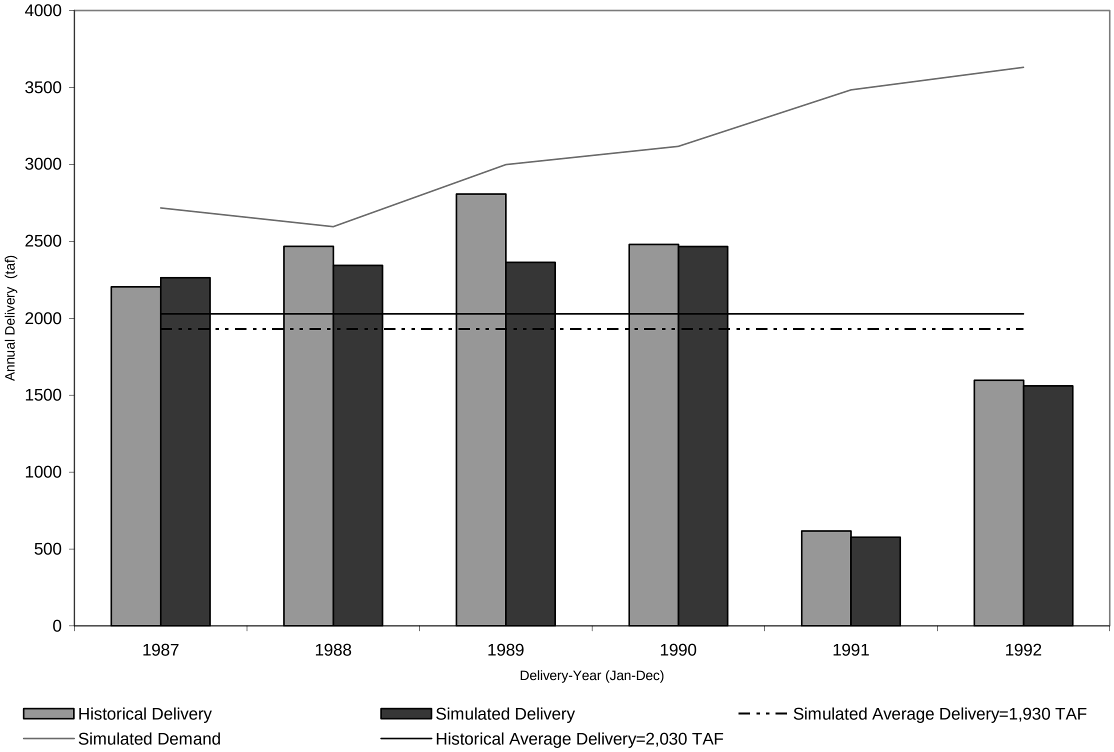

Figure 3-1 SWP south-of-Delta Table A deliveries (1987–1992 dry period)

The observed differences in the historical and simulated deliveries can be attributed to differences in the operational rules and parameters assumed in the simulation run. Some of the major operational parameters that could be different between the model run and the actual historical operations include the rule governing the amount of delivery versus the amount of storage to be carried-over into the following year (delivery-carryover storage rule), flood control rules, San Luis Reservoir operation rule, Delta outflow requirements, regulatory decisions, Delta export curtailments caused by pumping facilities outages or compliance with state and federal endangered species regulations, compliance with the provisions of the Coordinated Operations Agreement, implementation of a drought water bank, and water transfers.

In the wetter years (above-normal and wet year-types), when supply is plentiful and deliveries are mostly determined by demands, the simulated deliveries were very close to historical values. When long-term values were compared, the average annual delivery for the SWP during the 23-year period of 1975–1997 was 1,810 taf per year for the Historical Operations Study and 1,790 taf per year for the historical deliveries.

Additional details of this study are in Appendix E.

CalSim II Sensitivity Analysis Study

The sensitivity analysis is an important component of any water resources planning model evaluation. The sensitivity analysis procedures explore and quantify the impact of possible errors in input data on the model outputs and system performance measures. With a simple sensitivity analysis procedure, errors in model input parameters are generally investigated one at a time. With a more complex procedure, the investigation can be conducted by varying a set of parameters simultaneously. In the sensitivity analysis conducted in response to the recommendations in the *Strategic Review* (Close and others 2003), the simple procedure was adopted and errors in model input parameters were investigated one at a time. The objective of the analysis was twofold: (1) to examine the behavior of the model in response to variations in selected input parameters; (2) to provide a basis for CalSim II modelers for prioritizing future model development activities. The *CalSim-II Model Sensitivity Analysis* is available at website http://baydeltaoffice.water.ca.gov/index.cfm.

There are many input parameters used in the CalSim II model to define the physical characteristics of the system, as well as the regulatory environment and operational characteristics. Some input parameters are in the form of time series or monthly distribution curves, and others are simply single values. Some input parameters are estimated from the historical data, and others are values developed or calibrated by users. After consultation with model developers and project operators, 21 model input parameters in 4 major categories with reasonable ranges of variations were selected for this sensitivity analysis study. The results of the sensitivity analysis are given in more detail in Appendix E.

Examination of the results of the sensitivity analysis provides the following information on the behavior of the SWP system’s delivery capability with respect to some of the key input parameters:

- The most significant input parameters affecting SWP Table A Delta deliveries are the assumed SWP Table A demands and the monthly diversion limits imposed on Banks Pumping Plant. The results show the long-term average annual SWP Table A Delta deliveries between 3.0 maf to 3.5 maf increase by 0.54 acre-foot for every acre-foot increase in Table A demands. The increase is 0.33 acre-foot for every acre-foot of increase in Table A demands for the range between 3.5 maf per year and 3.9 maf per year.
- Also, the long-term average annual SWP Table A Delta deliveries decrease by 0.48 acre-foot for every 1 acre-foot per month decrease in Bank’s allowable monthly pumping limit during March 16 to December 14 period. This sensitivity study evaluates a 5 percent reduction in the capacity during this period.
- Inflow to Lake Oroville displays a moderate impact on the SWP Table A Delta deliveries. The long-term average annual SWP Table A Delta deliveries increase by 0.20 acre-foot for every acre-foot increase in annual Oroville inflows.
- The effect of changing contractors’ demands for Article 21 water on Article 21 deliveries is high, as expected. The results show that for every acre-foot of change in the peak monthly demands for Article 21 water in the range between 134 taf per month and 400 taf per month, the long-term average annual Article 21 deliveries increase by 0.27 acre-foot.

Examples of parameters not significantly influencing the estimates for SWP Delta deliveries include the projected land use in the source areas and inflow into Lake Shasta and Folsom Reservoir.

Impact of Model Simulation Time-step in Estimating Projects Average Deliveries

In general, the delivery reliability of the SWP is assessed using monthly time-step CalSim II simulations. Monthly time-step simulations implicitly assume that daily hydrologic variability combined with daily physical and regulatory operating constraints are not significant to the forecast of expected average annual deliveries. In other words, it is assumed that a study with monthly inflows, reservoir releases, exports, and associated constraints would produce the same long-term average annual deliveries as a study where inflows, releases, exports, and associated constraints vary on a daily basis.

To confirm the above assumption, results were examined from a recently completed, simplified, daily time-step CalSim II simulation conducted for the California Bay-Delta Authority's Surface Storage Investigations. The assumptions for the baseline monthly and daily time-step simulations are documented in the draft report "Interim Common Model Package, Modeling Protocol and Assumptions" (CALFED 2005). The daily variability appears to have only minor impacts on SWP Table A deliveries. The results show the long-term average annual SWP Table A delivery is increased by 0.3 percent and the average annual deliveries during two 6-year droughts (1929–1934 and 1987–1992) is increased by 0.8 percent in the daily simulation.

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Chapter 4.
Computer Simulation Assumptions

The selection of the assumptions and factors that go into the estimation of future water delivery reliability is very important and must be tailored to the particular water supplier. Assumptions and factors for the State Water Project focus on Sacramento and San Joaquin river basin precipitation; water rights and uses; SWP storage and conveyance facilities, including diversion facilities in the Delta; SWP service area demand; and the statutes, regulations, and contractual provisions that govern and regulate the SWP, including coordinating operations with the federal Central Valley Project (CVP). A detailed list of the study assumptions for this report is found in Appendix A.

The results of five computer simulations are included in this report. Studies 1, 2, and 3 are from the *The State Water Project Delivery Reliability Report 2002* (DWR 2003). The results of studies 1, 2 and 3 are included in this report for comparison purposes. Studies 4 and 5 are updated studies conducted specifically for this report. A significant difference between the updated studies and the earlier studies is the assumed demands for SWP Table A and Article 21. Article 21 refers to a section of the water supply contracts that allows additional water to be delivered under certain conditions (see Chapter 5 for further discussion).The assumed demands for studies 4 and 5 were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with the environmental documentation for the Monterey Agreement.

The assumptions for the studies differ in three main categories: the assumed level of water use in the source areas (the level of development), the assumed SWP Table A and Article 21 demands, and the base model assumptions. These categories are summarized in Table 4-1.

Table 4-1 Key study assumptions

Study	Study name	Level of development (year)	SWP Table A demand (maf/year)	SWP Article 21 demand (taf/month)	Model version
SWP Delivery Reliability Report (2003)					
1	2001 Study	2001	3.0–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
2	2021A Study	2021	3.3–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
3	2021B Study	2021	4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
Updated Studies					
4	2005 Study	2005	2.3–3.9	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP
5	2025 Study	2025	3.9–4.1	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP

maf = million acre-feet

OCAP = 2004 Long-Term Central Valley Project Operations Criteria and Plan

taf = thousand acre-feet

The water use estimates for the source areas for 2001 are assumed to be representative of 2005. The water use estimates for the source areas for 2020 are assumed to be representative of 2021 and 2025 conditions.

The SWP contractors' Table A and Article 21 demands for deliveries from the Delta assumed for the five studies are shown in Table 4-1. In four of the studies, a range in Table A demands is shown because the demand is assumed to vary each year with the weather in the delivery areas. In study 3 (2021), the SWP Table A demand is maximized each year, regardless of weather. Article 21 deliveries are available on an unscheduled and interruptible basis and are not counted as part of the Table A amount. (See Chapter 5 for more discussion of Article 21.) The Article 21 demand in the updated studies (4 and 5) is higher than the earlier studies for the December through March period.

Two versions of the model are used for these studies as shown in Table 4-1. Studies 1, 2 and 3 are based on the May 2002 benchmark study version. The updated studies (4 and 5) use the most recent version, which was developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP). The assumption differences between the May 2002 benchmark version and the 2004 OCAP version that affect the SWP simulation significantly are listed below. A complete list of the differences in key assumptions is included in Appendix A.

1 Addition of a minimum pumping level at Banks Pumping Plant of 300 cubic feet per second.

2 Addition of flow requirements for flow at the mouth of the Feather River for SWP Settlement Contractors.

3 Delivery-carryover relationship adjusted to reduce delivery targets and increase carryover in critically dry years.

4 Addition of Lake Oroville end-of-September carryover target storage rule.

5 Study 5 assumes the implementation of Freeport Regional Water Project, including modified East Bay Municipal Utility District operations on the Mokelumne River.

All studies assume current Banks Pumping Plant capacity, existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements.

Cited Reference

[DWR] California Department of Water Resources, Bay-Delta Office. 2003. The State Water Project Delivery Reliability Report 2002. Final.

Chapter 5.
Study Results

The five CalSim II model studies in this report are described in Chapter 4. Studies 1, 2, and 3 are from the *The State Water Project Delivery Reliability Report 2002* (DWR 2003). Studies 4 and 5 are updated studies conducted specifically for this report. The results of studies 1, 2 and 3 are included in this report for comparison purposes. This chapter contains tables summarizing the estimated delivery amounts of the studies for the entire study period (1922-1994), dry years, and wet years and presents information on the estimated probability of SWP delivery amounts currently and twenty years in the future. The annual values for SWP deliveries estimated by CalSim II for the five studies are listed in tables B-3 through B-7 of Appendix B. These tables also show the annual Table A demands assumed for each study.

The results of the updated studies (4 and 5) are compared to the results of the earlier studies (1, 2 and 3) to identify and explain any significant differences in estimated delivery values. For most values, the differences are not large enough to be significant and are generally caused by differences in the assumed demands. There are, however, significant differences between the updated and earlier studies for the estimated deliveries during 1, 2 and 4-year droughts. These differences are discussed further in “Drought Years.”

Article 21 Deliveries

The studies estimate delivery amounts for Table A and Article 21. As mentioned in Chapter 2, Table A is the contractual method for allocating available supply, and the total of all maximum Table A amounts for deliveries from the Delta is 4.133 million acre-feet (maf) per year. Article 21 refers to a provision in the contracts for delivering water that is available in addition to Table A amounts. (See appendix C for more detail about Table A and Appendix D for historical delivery amounts.) Article 21 of SWP contracts allows contractors to receive additional water deliveries only under specific conditions. These conditions are:

1 It is available only when it does not interfere with Table A allocations and SWP operations;

2 It is available only when excess water is available in the Delta;

3 It is available only when conveyance capacity is not being used for SWP purposes or scheduled SWP deliveries; and

4 It cannot be stored within the SWP system. In other words, the contractors must be able to use the Article 21 water directly or store it in their own system.

Water supply under Article 21 becomes available only during wet months of the year, generally December through March. Because an SWP contractor must have an immediate use for Article 21 supply or a place to store it outside of the SWP, not all SWP contractors can take advantage of this additional supply.

The importance of Article 21 water to local water supply is tied to how each contractor uses its SWP supply. For those SWP contractors who are able to store their wet weather supplies, Article 21 supply can be stored by being put directly into a reservoir or by offsetting other water that would have been withdrawn from storage, such as local groundwater. In the absence of storage, Article 21 water is not likely to contribute significantly to local water supply reliability. Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts, and level of water supply reliability required.

This report presents information on Article 21 water separately, so local agencies can determine whether it is appropriate to incorporate this supply into their analyses.

SWP Water Deliveries under Different Hydrologic Scenarios

Tables 5-1 and 5-2 summarize the assumed Table A demands for the updated (4 and 5) and the earlier (1, 2, and 3) studies and the resulting estimates for SWP deliveries. Table 5-3 presents information on the assumed Article 21 demand and the estimated Article 21 deliveries. Tables 5-4 through 5-8 summarize values for dry and wet hydrologic periods. The estimated probabilities for a given amount of annual SWP delivery are presented in Figures 5-1 and 5-2.

Assumed Table A Demands

The average, maximum, and minimum Table A demands from the Delta for the five studies are shown in Table 5-1. Study 4 has lower assumed demands than study 1. The average demand for study 4 is 80 percent of maximum Table A compared to 90 percent of maximum Table A for study 1. The primary reason for the lower demand in study 4 is that it includes a new set of annual Table A demands for the Metropolitan Water District of Southern California (MWDSC) prepared specifically for 2003 conditions by MWDSC. The average demand for study 5 is 99.4 percent of maximum Table A and is very similar to study 3. The annual assumed demand for study 5 is less than maximum Table A in only seven wet years due to the assumption that some Table A deliveries would be replaced by supplies from the Kern River.

As explained in Chapter 2 and Appendix C, the maximum Table A amounts for the 26 contractors which receive their supply from the Delta total 4.133 maf. The demands for studies 1 and 4 assume slightly earlier conditions when the maximum Table A amounts totaled slightly less than 4.133 maf (4.114 maf and 4.112 maf, respectively). To simplify the use of this report, the calculation of demand or delivery in percent of maximum Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies. This simplification has no significant effect on the annual delivery percentages for studies 1 and 4. Additional information can be found in Appendix B.

Table 5-1 SWP Table A demand from the Delta

Study	Average demand		Maximum demand		Minimum demand	
	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)
SWP Delivery Reliability Report (2003):						
1. 2001 Study	3,712	90%	4,114	100%	3,007	73%
2. 2021A Study	4,026	97%	4,133	100%	3,343	81%
3. 2021B Study	4,133	100%	4,133	100%	4,133	100%
Updated Studies:						
4. 2005 Study	3,290	80%	3,862	93%	2,321	56%
5. 2025 Study	4,110	99%	4,133	100%	3,898	94%

Maximum Delta Table A is 4.133 million acre-feet per year.

Table A and Article 21 Deliveries

Table 5-2 contains the average, maximum, and minimum estimates of Table A deliveries from the Delta for the five studies. Comparing the relevant updated and earlier studies shows the averages of the estimated delivery percentages and the maximum estimated deliveries do not vary significantly. Study 4 has an average delivery of 68 percent of maximum Table A compared to 72 percent for study 1. This lower delivery under current conditions is due to the lower demand level assumed for study 4. The slightly higher average delivery of 77 percent for study 5 compared to 75 percent for study 2 is attributed to the higher demand assumed for study 5 and to differences in modeling assumptions as summarized in Chapter 4 and listed in Appendix A. The average delivery for study 5 is one percentage point higher than study 3 even though study 3 has a slightly higher demand. This slightly higher value for study 5 is due to differences in modeling assumptions. Comparing the updated studies (2005 versus 2025 study levels) shows study 5 has an average delivery of 77 percent of maximum Table A compared to 68 percent for study 4, an increase of 9 percent. This average increase in delivery is due to the higher demand assumed for study 5.

The difference between the earlier studies and the updated studies for the estimated minimum Table A delivery is significant. The updated studies have a minimum delivery of 4 percent to 5 percent of maximum Table A compared to 19 to 20 percent for the studies in the *SWP Delivery Reliability Report 2002* (DWR 2003). The lower minimum delivery is primarily due to modification of the delivery-carryover storage rule. Compared to the rule used for the earlier studies, the modified rule reduces delivery by about 80 percent whenever carryover storage (sum of the end-of-September storages of Oroville Reservoir and the SWP share of San Luis Reservoir) is projected to be less than about 860 thousand acre-feet (taf). The modified rule was developed in coordination with the DWR's SWP Operations Control Office to meet the primary objective of reducing the number of years storage in Oroville Reservoir reaches a very low level. The minimum delivery occurs in 1977, the driest year in the 73-year simulation. A closer look at this estimation is done later in this chapter. It applies reasonable assumptions about the amount of Table A deliveries carried-over in San Luis Reservoir from the previous year by SWP contractors and the use of storage in San Luis Reservoir to illustrate how the estimate could be adjusted to 20% of maximum Table A while not reducing storage in Oroville Reservoir.

Table 5-2 SWP Table A delivery from the Delta

Study	Average delivery		Maximum delivery		Minimum delivery	
	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)
SWP Delivery Reliability Report (2003):						
1. 2001 Study	2,962	72%	3,845	93%	804	19%
2. 2021A Study	3,083	75%	4,128	100%	830	20%
3. 2021B Study	3,130	76%	4,133	100%	830	20%
Updated Studies:						
4. 2005 Study	2,818	68%	3,848	93%	159	4%
5. 2025 Study	3,178	77%	4,133	100%	187	5%

Maximum Delta Table A is 4.133 million acre-feet per year.

Average Article 21 demands and average, maximum, and minimum Article 21 deliveries for the five studies are shown in Table 5-3. All studies have the same Article 21 demand from April through November. The updated studies (4 and 5) assume a 200 taf increase in Article 21 demand for the period December through March compared to the earlier studies (50 taf per month).

Table 5-3 SWP Article 21 demand and delivery from the Delta (taf per year except as noted)

Study	Average Article 21 demand			Annual delivery from the Delta		
	Dec-Mar	Apr-Nov	Total	Average	Maximum	Minimum
SWP Delivery Reliability Report (2003):						
1. 2001 Study	504	607	1,111	130	510	0
2. 2021A Study	504	607	1,111	80	400	0
3. 2021B Study	504	607	1,111	70	400	0
Updated Studies:						
4. 2005 Study	704	607	1,311	260	1,110	0
5. 2025 Study	704	607	1,311	120	550	0

Delivery numbers rounded to the nearest 10,000 acre-feet.

The average Article 21 delivery for study 4 is 260 taf per year, an increase of 130 taf per year from the study 1 average delivery of 130 taf per year. This increase in delivery is a result of the increase in Article 21 demand of 200 taf per year in studies 4 and 5 and also due to the decrease in Table A demand in study 4 compared to study 1. Study 5 has an average Article 21 delivery of 120 taf per year, 40 taf per year more than study 2 and 50 taf per year more than study 3. These increases are the result of the higher assumed Article 21 demand.

Drought Years

Table 5-4 includes estimates of water deliveries under an assumed repetition of historical drought periods for the five studies. The years are identified as dry by the Eight River Index, a good indicator of the relative amount of water supply available to the SWP. The Eight River Index is the sum of the unimpaired runoff from the four rivers in the Sacramento Basin used to define water conditions in the basin plus the four rivers in the San Joaquin Basin, which correspondingly define water conditions in that basin. The eight rivers are the Sacramento, Feather, Yuba, American, Stanislaus, Tuolumne, Merced, and San Joaquin. Table 5-4 also includes the average deliveries for comparison purposes.

As discussed earlier in conjunction with the minimum deliveries shown in Table 5-2, the single-year drought deliveries for the updated studies are estimated at 4 percent to 5 percent of maximum Table A compared to 19 to 20 percent for the studies in the *SWP Delivery Reliability Report 2002* (DWR 2003). The 2-year drought average annual delivery decreases from 48 percent for study 1 to 41 percent for study 4. Similarly, study 5 delivery decreases to 40 percent as compared to 44 percent for studies 2 and 3. The results for a 4-year drought show a 5 percent decrease in delivery for study 4 compared to study 1 and a 6 percent decrease in delivery for study 5 compared to studies 2 and 3, for the same reason. The decreases in each of these cases are primarily due to modification of the delivery-carryover storage rule as discussed earlier.

Table 5-4 SWP average and dry year Table A delivery from the Delta

Study	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
SWP Delivery Reliability Report (2003):						
1. 2001 Study	72%	19%	48%	37%	41%	40%
2. 2021A Study	75%	20%	44%	39%	40%	41%
3. 2021B Study	76%	20%	44%	39%	40%	41%
Updated Studies:						
4. 2005 Study	68%	4%	41%	32%	42%	37%
5. 2025 Study	77%	5%	40%	33%	42%	38%

For the updated studies, the annual delivery for the single dry year is estimated to be about the same amount whether the dry year happens now or in twenty years. This is also true for estimated annual deliveries during the multi-year drought periods. This is projected to occur even though the amount of reservoir carryover storage resulting from the increased demand is projected to be less. This result is attributable to the operation rules governing the amount of water that must be retained for carryover storage, the fact the SWP demand between 2005 and 2025 increases only slightly, and because less water is made available under Article 21.

Table 5-5 summarizes the estimates of dry year deliveries under Article 21 for the five studies. The updated studies (4 and 5) have higher deliveries than the earlier studies (1, 2 and 3) because of assumed higher Article 21 demand. Also notice the reductions in delivery for studies 2 and 3 compared to study 1 in the years 1930, 1932, 1933, and 1976. These reductions are due to the increase in Table A deliveries. The average values for Article 21 deliveries for Study 5 is lower than study 4, primarily due to the assumed higher Table A demand in study 5.

Table 5-5 Average and dry year delivery under Article 21 (taf per year)

Study:	1	2	3	4	5
Year	Study 2001	Study 2021A	Study 2021B	Study 2005	Study 2025
1929	0	0	0	0	0
1930	90	30	30	120	140
1931	0	0	0	0	0
1932	200	40	40	240	110
1933	130	10	10	510	550
1934	0	0	0	210	240
1976	110	0	0	190	0
1977	0	0	0	0	0
1987	0	0	0	550	180
1988	0	0	0	0	0
1989	0	0	0	0	90
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	100
1922-1994 average	130	80	70	260	120

Numbers rounded to the nearest 10,000 acre-feet.

Wet Years

Tables 5-6 and 5-7 below summarize the model run results for historical wet years. As with drought years, the Eight River Index is used to identify the wet years. Because plenty of water is available for deliveries in wet years, variations in Table A delivery are due to variations in the demand assumed for each of the studies.

Table 5-6 SWP average and wet year Table A delivery from Delta

Study	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
SWP Delivery Reliability Report (2003):						
1. 2001 Study	72%	73%	79%	80%	80%	80%
2. 2021A Study	75%	82%	89%	86%	87%	84%
3. 2021B Study	76%	100%	100%	91%	91%	87%
Updated Studies:						
4. 2005 Study	68%	60%	65%	69%	75%	72%
5. 2025 Study	77%	95%	97%	93%	93%	89%

Table 5-7 contains information about Article 21 deliveries for the wet period 1978–1987. The information illustrates a significant decrease in the availability of Article 21 supply between study 5 and study 4. This is primarily due to the increase in Table A demand. Article 21 deliveries are generally higher in the updated studies (4 and 5) than the earlier studies (1, 2 and 3). This is attributed to the 200 taf per year increase in Article 21 demand assumed for studies 4 and 5. In addition, the increase in Article 21 deliveries for study 4 compared to the study 1 is partially due to the lower Table A demand assumed for study 4.

Table 5-7 Average and wet year delivery under Article 21 (taf per year)

Study:	1	2	3	4	5
Year	Study 2001	Study 2021A	Study 2021B	Study 2005	Study 2025
1978	100	100	100	300	300
1979	140	90	100	160	140
1980	100	70	80	140	90
1981	120	0	0	550	70
1982	390	100	60	800	170
1983	200	200	160	400	360
1984	410	380	370	550	490
1985	0	0	0	0	0
1986	50	50	60	120	80
1987	0	0	0	550	180
1922-1994 average	130	80	70	260	120

Numbers rounded to the nearest 10,000 acre-feet.

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for the two current condition studies (1 and 4) in Figure 5-1 and for the three future condition studies (2, 3, and 5) in Figure 5-2. The plot lines in the figures are derived from the study results listed in tables B-3 through B-7. Each line is constructed by ranking the 73 annual Table A delivery values of the relevant study from lowest to highest and calculating the percentage of values equal to or greater than the delivery value of interest. For example, for study 4 in Figure 5-1, the value of 3.3 maf is in the 30 percent position of the ranking; therefore, it is equaled or exceeded by 30 percent (about 22) of the 73 delivery values. The delivery value of 0.16 maf, the minimum value for study 4, is equaled or exceeded by all of the delivery values.

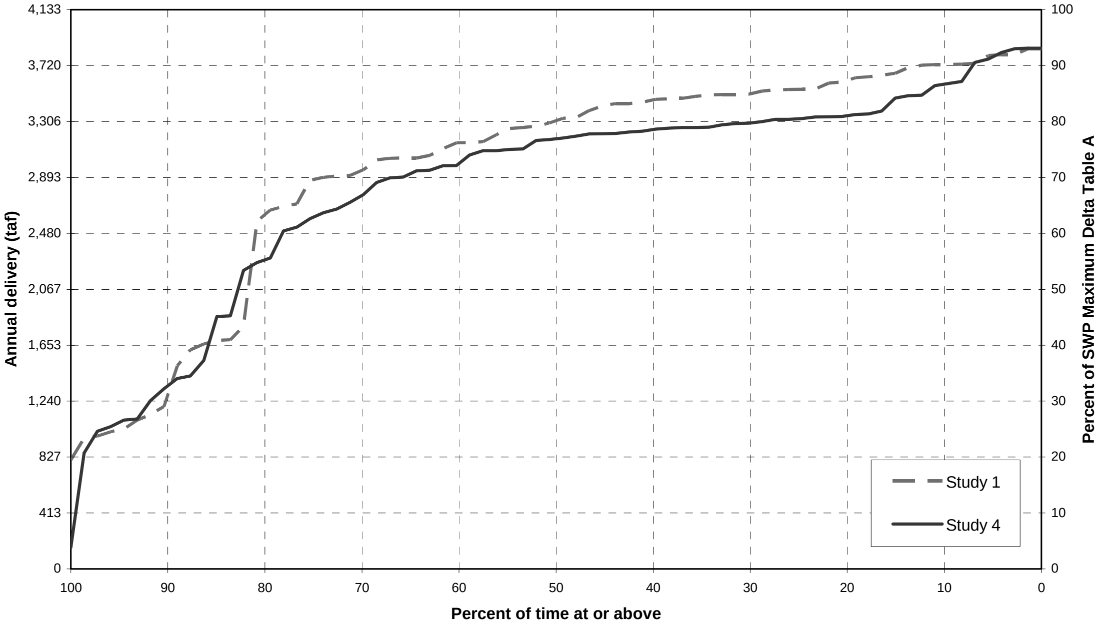

Figure 5-1 SWP Delta Table A delivery probability for year 2005

The curve for study 4 is generally lower than study 1 due to assumed lower annual demands. Neither curve reaches 100 percent because the assumed annual demands are 100 percent (99.5 percent) of the maximum Delta Table A in only two years for study 1 and the assumed maximum demand for study 4 is 93 percent of the maximum Delta Table A. In study 1, the two years with demand at 100 percent are dry years so delivery of 100 percent is not possible. The divergence of the two curves for the minimum delivery amounts (100% probability of being equaled or exceeded) is due to modification of the delivery-carryover storage rule.

Study 5 shows higher deliveries than study 3 for delivery values exceeded by up to 70 percent of the values, and mostly lower deliveries for values exceeded by 80 to 100 percent of the values. Because the assumed demands are nearly the same for these two studies, the delivery differences between study 5 and study 3 are primarily due to modification of the delivery-carryover storage relationship. The delivery-carryover relationship assumed in study 5 allows less delivery than study 3 in dry years which results in higher carryover storage and higher deliveries in normal to above normal years. Study 5 deliveries reach 100 percent 26 percent of the time, the highest percentage for the five studies.

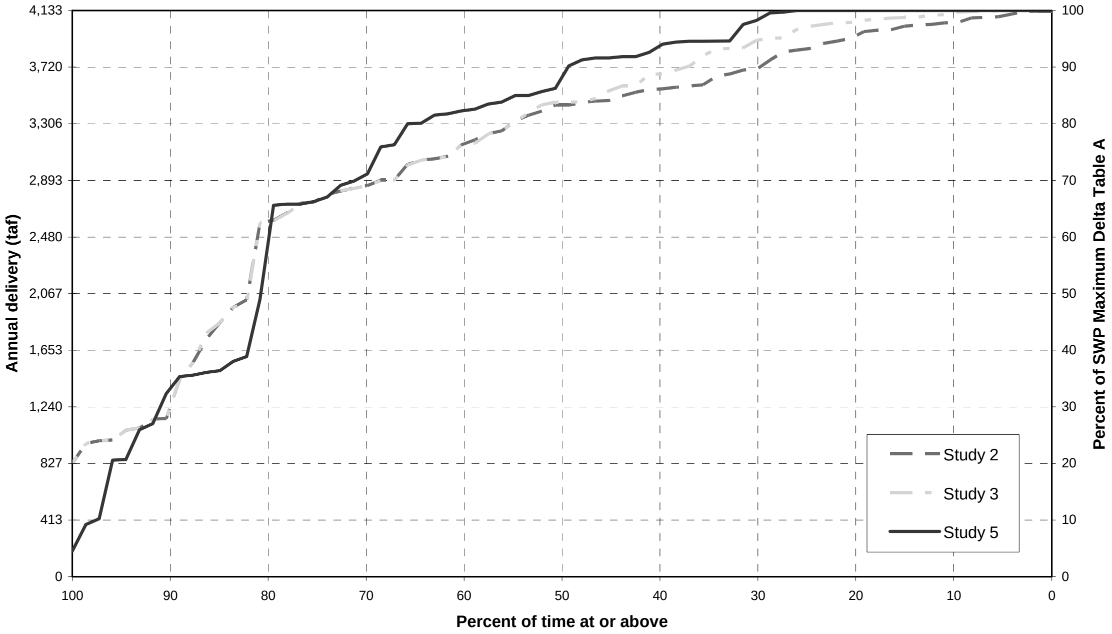

Figure 5-2 SWP Delta Table A delivery probability for year 2025

The amount of SWP Table A delivery per year, either in percent of maximum Delta Table A or in thousand acre-feet, associated with a specific degree of reliability can be estimated from Figures 5-1 and 5-2 for 2005 and 2025 conditions, respectively. The study 4 curve in Figure 5-1 is recommended to be used to represent 2005 conditions, and the study 5 curve in Figure 5-2 is recommended to be used to represent 2025 conditions. By referencing the curve for study 5 in Figure 5-2, the following can be deduced:

- In 75 percent of the years, the annual water delivery of the SWP is estimated to be at or above 2.70 maf per year (65 percent of 4.13 maf).
- In 50 percent of the years, it is estimated to be at or above 3.50 maf per year (85 percent of 4.13 maf).
- In 25 percent of the years, it is at 4.13 maf per year.

Figures 5-1 and 5-2 depict the estimated reliability for the total of SWP deliveries. Under conditions when almost all contractors are requesting their maximum Table A, like in study 5, this information can be directly applied to individual long-term water supply contracts for the SWP. For example, if a water agency has a maximum SWP Table A amount of 400 taf, at least 260 taf per year (65 percent of 400 taf) is estimated to be delivered 75 percent of the time.

Potential Adjustments to 1977 CalSim II Table A Deliveries

The CalSim II model, a planning model, is best used for estimating SWP performance over long periods of time. Considerable judgment should be applied when evaluating CalSim II results for shorter periods of time. This is especially true for estimates for a single year. The updated studies (studies 4 and 5) show that the changes in the operations criteria assumed for the SWP produce a delivery estimate of about 5 percent of maximum Delta Table A for the driest year on record (1977). This estimate is lower than the amount actually delivered from the Delta in 1977 (733 taf, 18 percent of maximum Delta Table A), as well as lower than what was shown in *SWP Delivery*

Reliability Report 2002 (DWR 2003). The discussion below presents some adjustments contractors may consider in estimating Table A deliveries under weather conditions similar to 1977.

In order to understand what led to the lower delivery estimates for 1977, it is best to start with 1975. The year 1975 is a wet year and is immediately followed by two critically dry years (1977 being the driest year on record during the last 80 years of historical hydrology). SWP Table A deliveries estimated in study 4 for 1975, 1976, and 1977 are 3.23 maf, 3.27 maf, and 159 taf, respectively. For study 5 the respective deliveries are 4.13 maf, 3.14 maf, and 187 taf. As currently practiced and allowed under the SWP water supply contracts, many of the contractors would carry over a portion of their allocated Table A water during 1975 and 1976 to succeeding years. In the case of 1977, it is reasonable to assume that up to 500 taf of 1976 allocated Table A water could be carried over to 1977. In addition, due to the slightly conservative delivery-carryover rule curve used in these studies, the minimum SWP storage in San Luis Reservoir for 1977, which occurs during the June-August period, averages about 190 taf for both studies 4 and 5. The minimum pool for the SWP share of San Luis Reservoir is just over 40 taf. In a year as critically dry as 1977, it is also reasonable to assume an additional 150 taf would be made available for deliveries bringing the SWP storage in San Luis Reservoir to minimum pool. After August, the SWP storage in San Luis Reservoir begins to rise. It is reasonable to expect additional deliveries to be made in the September-December period.

In summary, under the hydrologic conditions similar to a critically dry year like 1977, project deliveries can be expected to range from 4 or 5 to 20 percent of Table A, depending upon such factors as the delivery-carryover risk curve applied by SWP operators and the amount of allocated Table A water carried over from the previous year by SWP contractors.

Additional Analysis of Tables B-3 through B-7 in Appendix B

The information presented earlier in this chapter is helpful in analyzing the delivery reliability of a specific water system receiving a portion of its water supply from the SWP. In addition, the series of data contained in tables B-3 through B-7 are very helpful in analyzing longer periods of time that contain not only dry periods but wetter periods, which can replenish local water supplies if there is a place to store the supply. Analysis of this information can help determine if a local agency has adequate storage for capturing these supplies or if more storage could be utilized in the local water system.

Cited Reference

[DWR] California Department of Water Resources, Bay-Delta Office. 2003. The State Water Project Delivery Reliability Report 2002. Final.

Chapter 6. Examples of How to Apply Information

The following two examples illustrate how to use the information presented in this report to develop water supply assessments for a hypothetical SWP contractor. Hypothetical examples illustrating applications of the delivery probability curves and adjustments to the data for a SWP contractor that cannot convey its maximum Table A amount are provided in *The State Water Project Delivery Reliability Report 2002*. Questions regarding the use of the information contained in these reports may be directed to the Department of Water Resources' Bay-Delta Office at (916) 653-1099.

Example 1

This example uses data directly from Table 5-4 for studies 4 and 5, and employs an allocation methodology that provides a simple means of estimating supplies to each contractor. The data in the table is interpolated for 5-year increments and contained in Table 6-1. Although the percentage values are calculated using the maximum Delta Table A value, they may be directly applied to generate estimates for SWP deliveries for the entire 20-year period. This is because the Delta Table A value for 2005 is 4.114 maf/yr, 99.5 percent of the maximum Delta Table A value of 4.133 maf/yr. For comparison purposes, the percentage values for studies 1 and 4 based upon a full Table A value of 4.113 maf/yr and 4.133 maf/yr are listed in Tables B-3 and B-6. In addition, the percentages may also be used to estimate the Table A deliveries to SWP contractors in Butte and Plumas counties and Yuba City. The deliveries to these contractors would be calculated using the same method described below.

Table 6-1 shows the average percentage of maximum Delta Table A deliveries for average, single-dry year, and 2-, 4-, and 6-year multiple dry year scenarios from 2005 to 2025 in five-year increments. The maximum Table A amounts of each contractor are listed in Appendix C. Note that Table A amounts can be amended and a contractor's Table A amount over the next 20 years may be less than its maximum over some or all of this period. In this case, the contractor should use the amended Table A amounts for the corresponding years during this period. To use dry years other than those presented in Table 6-1, or to show year-to-year supplies instead of averages over a multiple-dry year period, see Example 2.

Table 6-1 SWP average and dry year Table A delivery from the Delta in five-year intervals for studies 4 and 5

Year	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005	68%	4%	41%	32%	42%	37%
2010	70%	4%	41%	32%	42%	37%
2015	73%	4%	41%	33%	42%	37%
2020	75%	4%	41%	33%	42%	37%
2025	77%	5%	40%	33%	42%	38%

How to calculate supplies:

Multiply the contractor's Table A amount for a particular year by the corresponding delivery percentages for that year from Table 6-1 to get an estimated delivery amount, for the average and drought periods, for each 5 year increment from 2005 to 2025.

The following tables show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum Table A amount of 100,000 AF, on average and for the various drought periods. For this example, the supplies shown for the multiple-dry year period are average supplies over the four-year drought from 1931-1934. Data from other year types, although not required in an urban water management plan, could also be presented this way.

Average Annual Values
(acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	68,000	70,000	73,000	75,000	77,000
State Water Project (Article 21)					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Single Dry Year (1977 conditions)
(acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	4,000	4,000	4,000	4,000	5,000
State Water Project (Article 21)					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period
1931-1934 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	32,000	32,000	33,000	33,000	33,000
State Water Project (Article 21)					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Example 2

This example is similar to Example 1 but allows a contractor to select alternative single year or multiple-dry year sequences other than those presented in Table 6-1. This option might be selected if analyzing different hydrologic year(s) makes more sense given a contractor's other supply sources, or given the locally acceptable risk level for water delivery shortages.

This example can also be used to identify supplies projected to be available in each year of a multiple-dry year period. While the Water Code does not specifically require this, the Urban Water Management Plan Guidebook suggests showing year-to-year supplies (see the UWMP Guidebook, Section 7, Step 3).

Where to find the data

Choose a single year or multiple-year sequences from Tables B-6 and B-7 to represent single-dry year and multiple-dry year scenarios. Table B-6 contains the percent of maximum Table A deliveries under all 73 hydrologic years in the updated model study for 2005. Table B-7 contains the percent of maximum Table A deliveries under all 73 hydrologic years in the updated model study for 2025.

How to calculate supplies

Multiply the contractor's Table A amount for a particular year by the percent of maximum Table A deliveries for the selected years, to get an estimated delivery amount for the years selected, for 2005 and 2025. Values for years between 2005 and 2025 can be linearly interpolated.

The following tables show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum Table A amount of 100,000 AF, in a single dry year and year-to-year over a multiple dry-year period. For this example, the single dry year selected is for 1988 conditions, and the multiple dry-year period selected is the three-year period from 1990-1992. In showing year-to-year supplies for the multiple-dry year period, these year-to-year supplies should be shown for each five year increment during the 20 year projection period.

Single Dry Year (1988 conditions)
(acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	21,000	18,000	15,000	13,000	10,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1990 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	27,000	25,000	24,000	22,000	21,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1991 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	25,000	24,000	23,000	22,000	21,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1992 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	34,000	34,000	35,000	35,000	35,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Appendices

Appendix A. 2005 Delivery Reliability Report CalSim II Modeling Assumptions

Two versions of the model are used for this report. Studies 1, 2 and 3 are based on the May 2002 benchmark study version. The updated studies (4 and 5) use the most recent version, which was developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP). The key assumption differences between the May 2002 benchmark version and the 2004 OCAP version are listed below.

1 Temperature flow below Keswick Dam was changed from a fixed time series flow to a dynamic storage dependent flow.

2 Relaxation of criteria for flow below Nimbus Dam when Folsom Lake storage drops below 300 thousand acre-feet.

3 Navigation control point flow criteria were modified from being dependent on water year type to being dependent on CVP agricultural allocation levels. Criteria were also relaxed for very low allocation years.

4 Clear Creek Tunnel target flows were modified to match the latest Trinity EIR analysis.

5 Addition of a minimum pumping level at Banks Pumping Plant of 300 cubic feet per second.

6 Addition of a minimum pumping level at Tracy Pumping Plant of 600 cubic feet per second.

7 Addition of flow requirements for flow at the mouth of the Feather River for Settlement Contractors.

8 Delivery-carryover relationship was adjusted to reduce delivery targets and increase carryover in critically dry years.

9 Addition of Lake Oroville end-of-September carryover target storage rule.

10 Five-step study setup modified to isolate (b)(2) accounting from “with Project” conditions.

11 Modification of American River demands as described in Tables A-2 and A-3.

12 Modification of Contra Costa Water District demands to include the effect of Los Vaqueros Reservoir operations.

13 The minimum flow of the Trinity River below Lewiston Dam in study 4 ranges from 369 to 453 thousand acre-feet per year depending on water year type. All other studies used in this report assume the Trinity River minimum flow has a greater range from 369 to 815 thousand acre-feet per year. This greater range of Trinity River minimum flows represents the Trinity Environmental Impact Statement Preferred Alternative.

14 Study 5 assumes the implementation of Freeport Regional Water Project, including modified East Bay Municipal Utility District operations on the Mokelumne River.

15 Implementation of May 2003 CVPIA 3406 (b)(2) decision and other changes:

    a Streamlining actions to simplify analysis of the results.

    b Anadromous Fish Restoration Program table updates to better represent management of (b)(2) water under the May 2003 (b)(2) decision.

   c Action triggering modifications to attempt to meet 200 thousand-acre feet target during October through January period.

16 Environmental Water Account (EWA) changes include:

   a Streamlining actions and coordination with (b)(2) actions.

   b EWA purchase amount increase to a maximum of 250 thousand acre-feet per year.

   c Addition of storage debt carryover accounting, including debt spill at San Luis Reservoir.

   d Addition of EWA asset takeover by SWP and CVP at San Luis Reservoir when reservoir space utilized by EWA is needed for project operations.

All studies assume current Banks Pumping Plant capacity, existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements.

The following table is a complete list of the study assumptions.

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
Period of Simulation	73 years (1922-1994)	Same	Same	Same	Same
HYDROLOGY					
Level of Development (Land Use)	2001 Level, DWR Bulletin 160-98[1]	Same as Study 1	2020 Level, DWR Bulletin 160-98	Same as Study 2	Same as Study 2
Demands					
North of Delta (except American River)					
CVP	Land Use based, limited by Full Contract	Same	Same	Same	Same
SWP (FRSA)	Land Use based, limited by Full Contract	Same	Same	Same	Same
Non-Project	Land Use based	Same	Same	Same	Same
CVP Refuges	Firm Level 2	Same	Same	Same	Same
American River Basin					
Water rights	20012	20013	20204	Same as Study 2	2020, as projected by Water Forum Analysis5
CVP	20012	20013	20206	Same as Study 2	2020, as projected by Water Forum Analysis7
San Joaquin River Basin					
Friant Unit	Regression of historical	Same	Same	Same	Same
Lower Basin	Fixed annual demands	Same	Same	Same	Same
Stanislaus River Basin	New Melones Interim Operations Plan	Same	Same	Same	Same

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1 2000 Level of Development defined by linearly interpolated values from the 1995 Level of Development and 2020 Level of Development from DWR Bulletin 160-98

2 1998 level demands defined in Sacramento Water Forum's EIR with a few updated entries.

3 Presented in attached Table 2001 American River Demand Assumptions.

4 Sacramento Water Forum 2025 level demands defined in Sacramento Water Forum's EIR.

5 Presented in attached Table 2020 American River Demand Assumptions

6 Sacramento Water Forum 2025 level demands defined in Sacramento Water Forum's EIR. Freeport Alternative defined in EBMUD Supplemental Water Supply Project REIR/SEIS.

7 Same as footnote 5 but modified with PCWA 35 TAF CVP contract supply diverted at the new American River PCWA Pump Station

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
South of Delta					
CVP	Full Contract	Same	Same	Same	Same
CCWD	143 TAF/YR[8]	124 TAF/YR[8]	151 TAF/YR[8]	Same as Study 2	158 TAF/YR[8]
SWP (w/ North Bay Aqueduct)	3.0-4.1 MAF/YR	2.3-3.9 MAF/YR	3.3-4.1 MAF/YR	4.1 MAF/YR	3.9-4.1 MAF/YR
SWP Article 21 Demand	MWDSC up to 50 TAF/month, Dec-Mar, others up to 84 TAF/month	MWDSC up to 100 TAF/month, Dec-Mar, others up to 84 TAF/month	Same as Study 1	Same as Study 1	Same as Study 4
FACILITIES					
Freeport Regional Water Project	None	Same as Study 1	Same as Study 1	Same as Study 1	Included[9]
Banks Pumping Capacity	6680 cfs	Same	Same	Same	Same
Tracy Pumping Capacity	4200 cfs + deliveries upstream of DMC constriction	Same	Same	Same	Same
REGULATORY STANDARDS					
Trinity River					
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/YR)	369-453 TAF/YR	Same as Study 1	Same as Study 1	Same as Study 1
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same	Same
Clear Creek					
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to FWS and NPS, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Upper Sacramento River					
Shasta Lake End-of-September Minimum Storage	SWRCB WR 1993 Winter-run Biological Opinion (1900 TAF)	Same	Same	Same	Same

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[8] Delta diversions include operations of Los Vaqueros Reservoir and represents average annual diversion

[9] Includes modified EBMUD operations of the Mokelumne River

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
Minimum Flow below Keswick Dam	Flows for SWRCB WR 90-5 and 1993 Winter-run Biological Opinion temperature control, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Feather River					
Minimum Flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 CFS)	Same	Same	Same	Same
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750 – 1700 CFS)	Same	Same	Same	Same
American River					
Minimum Flow below Nimbus Dam	SWRCB D-893 (see accompanying Operations Criteria), and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same	Same
Lower Sacramento River					
Minimum Flow near Rio Vista	SWRCB D-1641	Same	Same	Same	Same
Mokelumne River					
Minimum Flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100 – 325 CFS)	Same	Same	Same	Same
Minimum Flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25 – 300 CFS)	Same	Same	Same	Same
Stanislaus River					
Minimum Flow below Goodwin Dam	1987 USBR, DFG agreement , and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Minimum Dissolved Oxygen	SWRCB D-1422	Same	Same	Same	Same

	Study 1 **2001 Study, 2003 Report**	**Study 4** **2005 Study, Updated Studies**	**Study 2** **2021A Study, 2003 Report**	**Study 3** **2021B Study, 2003 Report**	**Study 5** **2025 Study, Updated Studies**
Merced River					
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180 – 220 CFS, Nov – Mar), and Cowell Agreement	Same	Same	Same	Same
Minimum Flow at Shaffer Bridge	FERC 2179 (25 – 100 CFS)	Same	Same	Same	Same
Tuolumne River					
Minimum Flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94 – 301 TAF/YR)	Same	Same	Same	Same
San Joaquin River					
Maximum Salinity near Vernalis	SWRCB D-1641	Same	Same	Same	Same
Minimum Flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Program per San Joaquin River Agreement	Same	Same	Same	Same
Sacramento River-San Joaquin River Delta					
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same	Same
Delta Cross Channel Gate Operation	SWRCB D-1641	Same	Same	Same	Same
Delta Exports	SWRCB D-1641, FWS use of CVPIA 3406(b)(2) water and CALFED Fisheries Agencies use of EWA assets	Same	Same	Same	Same
OPERATIONS CRITERIA					
Subsystem					
Upper Sacramento River					
Flow Objective for Navigation (Wilkins Slough)	3,500 – 5,000 CFS based on Lake Shasta storage condition	3,250 – 5,000 CFS based on CVP Ag	Same as Study 1	Same as Study 1	Same as Study 4
American River					
Folsom Dam Flood Control	SAFCA, Interim re-operation of	Same	Same	Same	Same

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
	Folsom Dam, Variable 400/670 (without outlet modifications)				
Flow below Nimbus Dam	Operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	Same	Same
Sacramento Water Forum Mitigation Water	None	Same as Study 1	Sacramento Water Forum (up to 47 TAF/YR in dry years)[10]	Same as Study 2	Same as Study 2
Feather River					
Flow at Mouth	No criteria	Maintain the DFG/DWR flow target above Verona or 2800 cfs for Apr– Sep dependent on Oroville inflow and FRSA allocation	Same as Study 1	Same as Study 1	Same as Study 4
Stanislaus River					
Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same	Same
San Joaquin River					
Flow near Vernalis	San Joaquin River Agreement in support of the Vernalis Adaptive Management Program	Same	Same	Same	Same
System-wide					
CVP Water Allocation					
CVP Settlement and Exchange	100% (75% in Shasta Critical years)	Same	Same	Same	Same
CVP Refuges	100% (75% in Shasta Critical years)	Same	Same	Same	Same
CVP Agriculture	100% - 0% based on supply (reduced by 3406(b)(2) allocation)	Same	Same	Same	Same
CVP Municipal & Industrial	100% - 50% based on supply (reduced by 3406(b)(2) allocation)	Same	Same	Same	Same

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[10] This is implemented only in the PCWA Middle Fork Project releases used in defining the CalSim II inflows to Folsom Lake

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
SWP Water Allocation					
North of Delta (FRSA)	Contract specific	Same	Same	Same	Same
South of Delta	Based on supply; Monterey Agreement	Same	Same	Same	Same
CVP/SWP Coordinated Operations					
Sharing of Responsibility for In-Basin-Use	1986 Coordinated Operations Agreement	Same	Same	Same	Same
Sharing of Surplus Flows	1986 Coordinated Operations Agreement	Same	Same	Same	Same
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641; use of CVPIA 3406(b)(2) only restricts CVP exports; EWA use restricts CVP and/or SWP exports as directed by CALFED Fisheries Agencies	Same	Same	Same	Same
Transfers					
Dry Year Program	None	Same	Same	Same	Same
Phase 8	None	Same	Same	Same	Same
MWDSC/CVP Settlement Contractors	None	Same	Same	Same	Same
CVP/SWP Integration					
Dedicated Conveyance at Banks	None	Same	Same	Same	Same
NOD Accounting Adjustments	None	Same	Same	Same	Same
CVPIA 3406(b)(2)	May 2002 benchmark study assumptions	Dept of Interior 2003 Decision	Same as Study 1	Same as Study 1	Same as Study 4
Allocation	800 TAF/YR (600 TAF/YR in Shasta Critical years)	800 TAF/YR, 700 TAF/YR in 40-30-30 Dry Years, and 600 TAF/YR in 40-30-30 Critical years	Same as Study 1	Same as Study 1	Same as Study 4
Actions	AFRP flow objectives (Oct-Jan), CVP export reduction (Dec-Jan), 1995 WQCP (up to 450	1995 WQCP, Fish flow objectives (Oct-Jan), VAMP (Apr 15- May 16)	Same as Study 1	Same as Study 1	Same as Study 4

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
	TAF/YR), VAMP (Apr 15- May 16) CVP export restriction, Post (May 16-31) VAMP CVP export restriction, Ramping of CVP export (Jun), Pre (Apr 1-15) VAMP CVP export restriction, CVP export reduction (Feb-Mar), Additional Upstream Releases (Feb-Sep)	CVP export restriction, 3000 CFS CVP export limit in May and June (D1485 Striped Bass continuation), Post (May 16-31) VAMP CVP export restriction, Ramping of CVP export (Jun), Upstream Releases (Feb-Sep)			
Accounting adjustments per May 2003 Interior Decision	None	No limit on responsibility for non-discretionary D1641 requirements no Reset with the Storage metric and no Offset with the Release and Export metrics	Same as Study 1	Same as Study 1	Same as Study 4
CALFED Environmental Water Account					
Actions	Total exports restricted to 4,000 cfs, 1 wk/mon, Dec-Mar (wet year: 2 wk/mon), VAMP (Apr 15- May 16) export restriction, Pre (Apr 1-15) and Post (May 16-31) VAMP export restriction, Ramping of export (Jun)	Dec-Feb reduce total exports by 50 TAF/month relative to total exports without EWA; VAMP (Apr 15- May 16) export restriction on SWP; Post (May 16-31) VAMP export restriction on SWP and potentially on CVP if B2 Post-VAMP action is not taken; Ramping of exports (Jun)	Same as Study 1	Same as Study 1	Same as Study 4
Assets	50% of use of JPOD, 50% of any CVPIA 3406(b)(2) or ERP releases pumped by SWP, flexing of Delta Export/Inflow Ratio (not explicitly modeled), dedicated 500 CFS increase of Jul – Sep Banks PP capacity, north-of-Delta (35 TAF/Yr) and south-of-Delta purchases (50 – 200 TAF/Yr), 100 TAF/Yr from south-of-Delta source shifting agreements, and 200 TAF/YR south-of-Delta groundwater	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. The purchases range from 0 TAF in Wet Years to approximately 153 TAF in Critical Years NOD, and 57 TAF in Critical Years to 250 TAF in Wet Years SOD. Variable assets include the following: used of 50% JPOD export	Same as Study 1	Same as Study 1	Same as Study 4

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
	storage capacity	capacity, acquisition of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, flexing of Delta Export/Inflow Ratio (post-processed from CalSim II results), dedicated 500 CFS pumping capacity at Banks in Jul – Sep			
Debt restrictions	No planned carryover of debt past Sep, no reset of unpaid debt, debt carried past Sep paid back by Feb	Delivery debt paid back in full upon assessment; Storage debt paid back over time based on asset/action priorities; SOD and NOD debt carryover is allowed; SOD debt carryover is explicitly managed or spilled; NOD debt carryover must be spilled; SOD and NOD asset carryover is allowed.	Same as Study 1	Same as Study 1	Same as Study 4

Table A-2 2001 American River Demand Assumptions

	ALLOCATION TYPE (MAXIMUM)					
Location / Purveyor	**CVP AG**	**CVP MI**	**CVP Settlement / Exchange**	**Water Rights / Non-CVP / No Cuts**	**CVP Refuge**	**Total**
Auburn Dam Site (D300)						
Placer County Water Agency	0	0	0	8,500	0	8,500
Total	0	0	0	8,500	0	8,500
Folsom Reservoir (D8)						
Sacramento Suburban	0	0	0	0	0	0
City of Folsom (includes P.L. 101-514)	0	0	0	20,000	0	20,000
Folsom Prison	0	0	0	2,000	0	2,000
San Juan Water District (Placer County)	0	0	0	10,000	0	10,000
San Juan Water District (Sac County) (includes P.L. 101-514)	0	11,200	0	33,000	0	44,200
El Dorado Irrigation District	0	7,550	0	0	0	7,550
El Dorado Irrigation District (P.L. 101-514)	0	0	0	0	0	0
City of Roseville	0	32,000	0	0	0	32,000
Placer County Water Agency	0	0	0	0	0	0
Total	0	50,750	0	65,000	0	115,750
Folsom South Canal (D9)						
So. Cal WC/ Arden Cordova WC	0	0	0	3,500	0	3,500
California Parks and Recreation	0	100	0	0	0	100
SMUD (export)	0	0	0	15,000	0	15,000
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	0
Canal Losses	0	0	0	1,000	0	1,000
Total	0	100	0	19,500	0	19,600

Location / Purveyor	ALLOCATION TYPE (MAXIMUM)					
	CVP AG	**CVP MI**	**CVP Settlement / Exchange**	**Water Rights / Non-CVP / No Cuts**	**CVP Refuge**	**Total**
Nimbus to Mouth (D302)						
City of Sacramento	0	0	0	63,335	0	63,335
Arcade Water District	0	0	0	2,000	0	2,000
Carmichael Water District	0	0	0	8,000	0	8,000
Total	0	0	0	73,335	0	73,335
Sacramento River (D162)						
Placer County Water Agency	0	0	0	0	0	0
Total	0	0	0	0	0	0
Sacramento River (D167/D168)						
City of Sacramento	0	0	0	38,665	0	38,665
Sacramento County Water Agency (SMUD transfer)	0	0	0	0	0	0
Sacramento County Water Agency (P.L. 101-514)	0	0	0	0	0	0
EBMUD (export)	0	0	0	0	0	0
Total	0	0	0	38,665	0	38,665
Total from the American River	0	50,850	0	166,335	0	217,185

Table A-3 2020 American River Demand Assumptions

Location / Purveyor	ALLOCATION TYPE (MAXIMUM)						Folsom Unimpaired Inflow (FUI)			Notes
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total	FUI = Total TAF (Mar – Sep) + 60 TAF			
Auburn Dam Site (D300)										
Placer County Water Agency	0	35,000	0	35,500	0	70,500	70,500	70,500	70,500	1/2/3/12
Total	**0**	**35,000**	**0**	**35,500**	**0**	**70,500**	**70,500**	**70,500**	**70,500**	
Folsom Reservoir (D8)										
Sacramento Suburban	0	0	0	29,000	0	29,000	29,000	0	0	4/5/11
City of Folsom (includes P.L. 101-514)	0	7,000	0	27,000	0	34,000	34,000	34,000	20,000	1/2/3
Folsom Prison	0	0	0	5,000	0	5,000	5,000	5,000	5,000	
San Juan Water District (Placer County)	0	0	0	25,000	0	25,000	25,000	25,000	10,000	1/2/3/11
San Juan Water District (Sac County) (includes P.L. 101-514)	0	24,200	0	33,000	0	57,200	57,200	57,200	44,200	1/2/3
El Dorado Irrigation District	0	7,550	0	17,000	0	24,550	24,550	24,550	22,550	1/2/3
El Dorado Irrigation District (P.L. 101-514)	0	7,500	0	0	0	7,500	7,500	7,500	0	1/2/3
City of Roseville	0	32,000	0	30,000	0	62,000	54,900	54,900	39,800	1/2/3/11/12
Placer County Water Agency	0	0	0	0	0	0	0	0	0	11
Total	**0**	**78,250**	**0**	**166,000**	**0**	**244,250**	**237,150**	**208,150**	**141,550**	
Folsom South Canal (D9)										
So. Cal WC/ Arden Cordova WC	0	0	0	5,000	0	5,000	5,000	5,000	5,000	
California Parks and Recreation	0	5,000	0	0	0	5,000	5,000	5,000	5,000	
SMUD (export)	0	15,000	0	15,000	0	30,000	30,000	30,000	15,000	1/2/3
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	0	0	0	0	1/2/3
Canal Losses	0	0	0	1,000	0	1,000	1,000	1,000	1,000	
Total	**0**	**20,000**	**0**	**21,000**	**0**	**41,000**	**41,000**	**41,000**	**26,000**	
Nimbus to Mouth (D302)										
City of Sacramento	0	0	0	96,300	0	96,300	96,300	96,300	50,000	6/7/8
Arcade Water District	0	0	0	11,200	0	11,200	11,200	11,200	3,500	13

	ALLOCATION TYPE (MAXIMUM)						**Folsom Unimpaired Inflow (FUI)**			
Location / Purveyor	**CVP AG**	**CVP MI**	**CVP Settlement / Exchange**	**Water Rights / Non-CVP / No Cuts**	**CVP Refuge**	**Total**	**FUI = Total TAF (Mar – Sep) + 60 TAF**			**Notes**
Carmichael Water District	0	0	0	12,000	0	12,000	12,000	12,000	12,000	
Total	**0**	**0**	**0**	**119,500**	**0**	**119,500**	**119,500**	**119,500**	**65,500**	
Sacramento River (D162)										
Placer County Water Agency	0	0	0	0	0	0	0	0	0	
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Sacramento River (D167/D168)										
City of Sacramento	0	0	0	34,300	0	34,300	34,300	34,300	80,600	8
Sacramento County Water Agency (SMUD transfer)	0	30,000	0	0	0	30,000				10
Sacramento County Water Agency (P.L. 101-514)	0	15,000	0	0	0	15,000				10
EBMUD (export)	0	133,000	0	0	0	133,000				
Total	**0**	**178,000**	**0**	**34,300**	**0**	**212,300**	**34,300**	**34,300**	**80,600**	
Total demands from the American River	**0**	**133,250**	**0**	**342,000**	**0**	**475,250**	**468,150**	**439,150**	**303,550**	

Notes

1/ Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 950,000 af.

2/ Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 950,000 af but greater than 400,000 af.

3/ Driest years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 400,000 af.

4/ Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 1,600,000 af.

5/ Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 1,600,000 af.

6/ Wet/average years as it applies to the City of Sacramento are time periods when the flows bypassing the E. A. Fairbairn Water Treatment Plant diversion exceed the "Hodge flows."

7/ Drier years are time periods when the flows bypassing the City's E.A. Fairbairn Water Treatment Plant diversion do not exceed the "Hodge flows."

8/ For modeling purposes, it is assumed that the City of Sacramento's total annual diversions from the American and Sacramento River in year 2030 would be 130,600 af.

10/ The total demand for Sacramento County Water Agency would be up to 78,000 af. The 45,000 af represents firm entitlements; the additional 33,000 af of demand is expected to be met by intermittent surplus supply. The intermittent supply is subject to Reclamation reduction (50%) in dry years.

11/ Water Rights Water provided by releases from PCWA's Middle Fork Project; inputs into upper American River model must be consistent with these assumptions.

12/ Demand requires "Replacement Water" as indicated below

13/ Arcade WD demand modeled as step function: one demand when FUI > 400, another demand when FUI < 400.

Appendix B. Results of Report Studies

A study to estimate the supply reliability of the State Water Project is done using a computer program that simulates the operation of the SWP on a monthly basis over a 73-year historical record of rainfall and runoff (1922–1994). The simulation model integrates all the relevant water resource components and calculates key water management parameters, such as:

- the amount of water released from reservoirs in the Sacramento-San Joaquin valleys,
- the amount of water required to maintain Delta water quality standards,
- the amount of water to be pumped from the Delta by the SWP and the Central Valley Project (CVP), and
- the amount of water that can be delivered by each of these projects.

The information required to run the simulation is referred to as the "model input." The most significant categories of input are:

- the physical description of the water system facilities (maximum pumping or release capacity, maximum reservoir storages, etc.);
- institutional requirements (delivery contract requirements, Delta water quality standards, the operations agreement between the SWP and CVP, endangered species requirements, and other requirements of federal and state laws, etc);
- hydrology (river and stream flows adjusted for water use in the source areas); and
- the level of SWP water demand.

CalSim II is the current version of the computer simulation model used to estimate SWP delivery reliability. All versions of CalSim employ commercially available linear programming software as a solution device. The application of the software, graphical user interface, and input/output devices are discussed in the documentation for CalSim.[11]

The model studies selected for this report answer two questions.

1 "What is the estimated current delivery reliability of the SWP?" and

2 "What is the estimate for SWP deliveries in the year 2025, if there were no new facilities or improvements to existing facilities, SWP water demand increased, and the institutional requirements existing today were in place?"

Depending upon a person's expectation of what the future holds, this estimate of SWP delivery capability could be viewed as either too low or too high. The estimate could be viewed as too low because the Department of Water Resources (DWR) is planning to have facilities in place by 2025 that will increase the reliability of the SWP. The estimate could be viewed as too high because there is the potential for exports to be required to be reduced to protect endangered Delta fish species.

The key study assumptions are shown in Table B-1 and listed in more detail in Chapter 4 and Appendix A. Additional discussions of these studies are on DWR's Modeling Branch's Website for the *SWP Delivery Reliability Report 2002* (DWR 2003) studies and on the US Bureau of Reclamation's Website for Operations Criteria and Plan (OCAP) studies

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[11] CalSim documentation may be obtained through the DWR Modeling Branch's website: http://modeling.water.ca.gov.

(http://modeling.water.ca.gov/hydro/studies/SWPReliability/index.html and http://www.usbr.gov/mp/cvo/ocap_page.html, respectively).

Table B-1 Key study assumptions

Study	Study name	Level of development (year)	SWP Table A demand (maf/year)	SWP Article 21 demand (taf/month)	Model version
SWP Delivery Reliability Report (2003)					
1	2001 Study	2001	3.0–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
2	2021A Study	2021	3.3–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
3	2021B Study	2021	4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
Updated Studies					
4	2005 Study	2005	2.3–3.9	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP
5	2025 Study	2025	3.9–4.1	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP

maf = million acre-feet

OCAP = 2004 Long-Term Central Valley Project Operations Criteria and Plan

taf = thousand acre-feet

Study Results

The annual delivery amounts calculated by the supply reliability studies are contained in Tables B-3 through B-7 at the back of this appendix. The tables show the demand level in thousand acre-feet (taf), the amount of delivery from the Delta, and percent of full Delta Table A calculated for each year of simulation for the five studies. Delta Table A refers to the total of the Table A amounts for each of the SWP contractors receiving water from the Delta. Of the 29 SWP contractors, 26 receive their deliveries from the Delta. The total maximum Table A amount for all SWP contractors is 4.173 maf/year. Of this amount, 4.133 maf/yr is the maximum Delta Table A amount.

To simplify the use of this report, the calculation of delivery in percent of full Delta Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies. The demands for studies 1 and 4 were developed assuming slightly earlier conditions when the maximum Delta Table A amounts totaled slightly less than 4.133 maf (4.114 maf and 4.112 maf, respectively). To show the effect of these minor differences in Table A totals, the annual deliveries in percent of full Delta Table A for study 1 (Table B-3) are calculated with the earlier Delta Table A total of 4.114 maf and also with the maximum Delta Table A total of 4.133 maf. Similarly, study 4 results in Table B-6 are calculated with the earlier and maximum Delta Table A totals. The tables show that most years have the same delivery percentage for both Table A totals.

These values must be interpreted within the confines of the assumptions upon which they are calculated. For example, for the year 1958 in study 5, the annual delivery is calculated to be 4,133 taf or 100 percent of maximum Delta Table A (see Table B-7). This result should be stated as follows:

> If the rainfall were the same as it was in 1958 but (1) the level of water use in the source area was increased to the level it would be in 2025; (2) SWP facilities and operation requirements were the same as they are today; and (3) SWP contractor demands were at their maximum Delta Table A level, the SWP would deliver approximately 4,133 taf or 100 percent of the maximum Delta Table A.

Actually, the conditional statement associated with the result for any particular year is even more complicated than this because the result is also dependent upon the rainfall that has occurred in previous years. For example, if the previous year (1957) were wet, runoff for 1958 for the same amount of rainfall would be greater than if 1957 were dry. In addition, reservoir storage for the beginning of 1958 would vary depending upon the weather conditions in 1957. This linkage makes each year's simulation dependent on the previous year's and, hence, links the entire historical series.

Table B-2 contains a summary of the delivery estimates for the SWP for important dry periods in history computed by the studies. Studies 4 and 5 were selected to represent the estimated 2005 and 2025 deliveries, respectively. This information can be helpful in analyzing the delivery reliability of a specific water system that receives a portion of its water supply from the SWP. The series of data contained in Tables B-3 through B-7 are also helpful in analyzing longer periods of time that contain not only dry periods but wetter periods, which can replenish water supplies.

Finally, to help analyze the chance of receiving a given level of delivery in any particular year, a probability distribution curve is useful. It simply shows the percent of the years the annual delivery estimate is at or above a given value. The probability distribution curves for the five studies are included as figures B-1 and B-2. For example, for study 5 (Figure B-2), the curve indicates that in 75 percent of the years, the annual delivery reliability is estimated to be at or above 65 percent of the maximum Delta Table A amount or 2.70 maf. Similarly, annual delivery reliability during 50 percent of the years is estimated to be at or above 85 percent of the maximum Delta Table A or 3.50 maf. The curve also shows that in 25 percent of the years, annual delivery reliability is estimated to be at 100 percent of the maximum Delta Table A.

Table B-2 SWP average and dry year Table A delivery from the Delta for studies 4 and 5

Year	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005	68%	4%	41%	32%	42%	37%
2025	77%	5%	40%	33%	42%	38%

Table B-3 SWP Water Delivery from the Delta for Study 1 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.114 maf	Percent of future maximum Table A - 4.133 maf	Model Article 21 supply
1922	3,407	3,389	82%	82%	175
1923	3,717	3,727	91%	90%	143
1924	3,961	1,014	25%	25%	0
1925	3,940	1,502	36%	36%	0
1926	3,777	2,951	72%	71%	0
1927	3,543	3,504	85%	85%	220
1928	3,897	3,337	81%	81%	155
1929	3,952	1,037	25%	25%	0
1930	3,922	2,697	66%	65%	92
1931	3,971	1,141	28%	28%	0
1932	3,673	1,620	39%	39%	199
1933	3,939	1,663	40%	40%	134
1934	3,981	1,689	41%	41%	0
1935	3,697	3,439	84%	83%	81
1936	3,769	3,638	88%	88%	0
1937	3,451	3,297	80%	80%	87
1938	3,418	3,439	84%	83%	470
1939	3,673	3,475	84%	84%	227
1940	3,713	3,544	86%	86%	102
1941	3,013	3,036	74%	73%	100
1942	3,583	3,599	87%	87%	513
1943	3,632	3,545	86%	86%	447
1944	3,563	3,449	84%	83%	0
1945	3,613	3,479	85%	84%	136
1946	3,710	3,724	91%	90%	3
1947	3,954	2,653	64%	64%	0
1948	3,959	2,681	65%	65%	2
1949	3,864	2,568	62%	62%	2
1950	3,812	2,909	71%	70%	0
1951	3,779	3,794	92%	92%	311
1952	3,078	3,108	76%	75%	103
1953	3,790	3,801	92%	92%	272
1954	3,833	3,803	92%	92%	98
1955	3,761	1,694	41%	41%	0
1956	3,639	3,649	89%	88%	261
1957	3,759	3,331	81%	81%	96
1958	3,481	3,492	85%	84%	441
1959	4,055	3,506	85%	85%	265
1960	4,114	1,795	44%	43%	0
1961	4,114	2,873	70%	70%	0
1962	3,689	3,158	77%	76%	21
1963	3,634	3,630	88%	88%	223
1964	3,907	3,262	79%	79%	5
1965	3,586	3,256	79%	79%	98
1966	3,722	3,731	91%	90%	147
1967	3,439	3,424	83%	83%	497
1968	3,792	3,548	86%	86%	402
1969	3,157	3,151	77%	76%	100
1970	3,714	3,727	91%	90%	406
1971	3,837	3,845	93%	93%	0
1972	4,012	3,057	74%	74%	2
1973	3,611	3,592	87%	87%	261
1974	3,650	3,664	89%	89%	297
1975	3,720	3,737	91%	90%	415
1976	4,014	3,150	77%	76%	110
1977	3,948	804	20%	19%	0
1978	3,126	3,036	74%	73%	100
1979	3,527	3,509	85%	85%	140
1980	3,197	3,208	78%	78%	100
1981	3,834	3,532	86%	85%	124
1982	3,451	3,471	84%	84%	386
1983	3,007	3,036	74%	73%	200
1984	3,692	3,706	90%	90%	408
1985	3,753	3,540	86%	86%	0
1986	3,345	3,023	73%	73%	51
1987	3,905	2,894	70%	70%	0
1988	4,026	968	24%	23%	0
1989	4,097	2,903	71%	70%	0
1990	3,961	1,101	27%	27%	0
1991	3,957	983	24%	24%	0
1992	3,880	1,199	29%	29%	0
1993	3,559	3,505	85%	85%	133
1994	3,739	3,272	80%	79%	9
Average	3,712	2,962	72%	72%	134
Maximum	4,114	3,845	93%	93%	513
Minimum	3,007	804	20%	19%	0

Table B-4 SWP Water Delivery from the Delta for Study 2 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.133 maf	Model Article 21 supply
1922	4,133	4,043	98%	0
1923	4,133	3,670	89%	0
1924	3,980	972	24%	0
1925	4,133	1,445	35%	0
1926	4,133	2,856	69%	113
1927	4,133	4,032	98%	124
1928	4,133	3,255	79%	3
1929	3,971	1,070	26%	0
1930	4,133	2,734	66%	27
1931	4,133	1,086	26%	0
1932	4,116	1,855	45%	39
1933	4,133	1,966	48%	6
1934	4,133	1,564	38%	0
1935	3,907	3,562	86%	59
1936	4,133	3,655	88%	5
1937	4,133	3,189	77%	65
1938	4,133	4,128	100%	192
1939	3,948	3,443	83%	1
1940	4,133	3,856	93%	22
1941	3,481	3,472	84%	0
1942	3,881	3,894	94%	378
1943	4,120	3,591	87%	375
1944	3,711	3,443	83%	2
1945	3,948	3,574	86%	123
1946	3,969	3,772	91%	0
1947	3,973	2,602	63%	0
1948	4,133	2,587	63%	2
1949	3,996	2,656	64%	0
1950	4,133	2,895	70%	0
1951	4,094	3,994	97%	230
1952	3,510	3,538	86%	100
1953	4,063	3,989	97%	236
1954	4,133	3,830	93%	6
1955	3,995	1,735	42%	0
1956	4,133	4,127	100%	129
1957	4,029	3,069	74%	3
1958	3,942	3,910	95%	335
1959	4,133	3,477	84%	167
1960	4,133	2,021	49%	0
1961	4,133	2,815	68%	0
1962	3,933	3,153	76%	2
1963	4,133	4,046	98%	134
1964	4,030	3,050	74%	0
1965	3,966	3,234	78%	3
1966	4,046	3,844	93%	61
1967	4,033	3,979	96%	167
1968	4,128	3,583	87%	398
1969	3,583	3,556	86%	93
1970	4,004	3,929	95%	398
1971	4,133	4,082	99%	0
1972	4,133	2,727	66%	0
1973	4,119	3,699	89%	211
1974	4,090	4,107	99%	147
1975	4,113	4,088	99%	209
1976	4,032	2,789	67%	0
1977	4,133	830	20%	0
1978	3,898	3,706	90%	100
1979	4,133	3,512	85%	89
1980	3,751	3,462	84%	74
1981	4,133	3,400	82%	0
1982	4,009	4,027	97%	101
1983	3,343	3,370	82%	200
1984	4,061	4,079	99%	379
1985	3,905	3,326	80%	0
1986	3,898	3,011	73%	52
1987	3,923	2,837	69%	0
1988	4,045	992	24%	0
1989	4,133	2,895	70%	0
1990	4,133	1,151	28%	0
1991	4,133	999	24%	0
1992	4,133	1,155	28%	0
1993	4,133	4,018	97%	156
1994	4,133	3,042	74%	0
Average	4,026	3,083	75%	78
Maximum	4,133	4,128	100%	398
Minimum	3,343	830	20%	0

Table B-5 SWP Water Delivery from the Delta for Study 3 (taf)

Year	Model fixed Table A demand	Model Table A delivery	Percent of maximum Table A - 4.133 maf	Model Article 21 supply
1922	4,133	4,043	98%	0
1923	4,133	3,670	89%	0
1924	4,133	972	24%	0
1925	4,133	1,446	35%	0
1926	4,133	2,856	69%	113
1927	4,133	4,031	98%	124
1928	4,133	3,255	79%	3
1929	4,133	1,070	26%	0
1930	4,133	2,734	66%	27
1931	4,133	1,086	26%	0
1932	4,133	1,855	45%	39
1933	4,133	1,967	48%	6
1934	4,133	1,564	38%	0
1935	4,133	3,729	90%	59
1936	4,133	3,669	89%	0
1937	4,133	3,165	77%	71
1938	4,133	4,129	100%	197
1939	4,133	3,444	83%	1
1940	4,133	3,856	93%	22
1941	4,133	4,084	99%	0
1942	4,133	4,122	100%	75
1943	4,133	3,584	87%	318
1944	4,133	3,465	84%	3
1945	4,133	3,547	86%	123
1946	4,133	3,801	92%	0
1947	4,133	2,597	63%	0
1948	4,133	2,586	63%	2
1949	4,133	2,654	64%	0
1950	4,133	2,893	70%	0
1951	4,133	3,996	97%	222
1952	4,133	4,133	100%	14
1953	4,133	3,931	95%	244
1954	4,133	3,860	93%	33
1955	4,133	1,779	43%	0
1956	4,133	4,126	100%	111
1957	4,133	3,067	74%	3
1958	4,133	4,063	98%	306
1959	4,133	3,467	84%	97
1960	4,133	2,007	49%	0
1961	4,133	2,818	68%	0
1962	4,133	3,153	76%	2
1963	4,133	4,046	98%	134
1964	4,133	3,050	74%	0
1965	4,133	3,233	78%	3
1966	4,133	3,853	93%	56
1967	4,133	4,069	98%	115
1968	4,133	3,584	87%	398
1969	4,133	4,078	99%	13
1970	4,133	3,933	95%	358
1971	4,133	4,082	99%	0
1972	4,133	2,725	66%	0
1973	4,133	3,699	89%	211
1974	4,133	4,133	100%	143
1975	4,133	4,102	99%	211
1976	4,133	2,775	67%	0
1977	4,133	830	20%	0
1978	4,133	3,915	95%	100
1979	4,133	3,493	85%	98
1980	4,133	3,465	84%	75
1981	4,133	3,387	82%	0
1982	4,133	4,133	100%	63
1983	4,133	4,133	100%	160
1984	4,133	4,101	99%	369
1985	4,133	3,322	80%	0
1986	4,133	3,006	73%	62
1987	4,133	2,835	69%	0
1988	4,133	993	24%	0
1989	4,133	2,895	70%	0
1990	4,133	1,151	28%	0
1991	4,133	999	24%	0
1992	4,133	1,155	28%	0
1993	4,133	4,018	97%	156
1994	4,133	3,042	74%	0
Average	4,133	3,130	76%	68
Maximum	4,133	4,133	100%	398
Minimum	4,133	830	20%	0

Table B-6 SWP water delivery from the Delta for Study 4 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.112 maf	Percent of future maximum Table A - 4.133 maf	Model Article 21 supply
1922	3,750	3,743	91%	91%	104
1923	3,251	3,251	79%	79%	106
1924	3,489	1,244	30%	30%	0
1925	3,353	1,870	45%	45%	0
1926	3,393	2,981	72%	72%	54
1927	3,860	3,845	93%	93%	213
1928	3,458	3,384	82%	82%	134
1929	2,907	1,108	27%	27%	0
1930	3,326	2,855	69%	69%	117
1931	2,933	1,018	25%	25%	0
1932	3,139	1,406	34%	34%	242
1933	3,427	1,330	32%	32%	512
1934	3,470	1,541	37%	37%	206
1935	3,798	3,769	92%	91%	229
1936	3,596	3,573	87%	86%	0
1937	3,492	3,362	82%	81%	80
1938	3,344	3,344	81%	81%	714
1939	3,262	3,262	79%	79%	349
1940	3,239	3,219	78%	78%	154
1941	2,526	2,527	61%	61%	246
1942	3,167	3,167	77%	77%	918
1943	3,104	3,104	75%	75%	623
1944	3,090	3,091	75%	75%	0
1945	3,112	3,101	75%	75%	359
1946	3,215	3,215	78%	78%	249
1947	3,422	3,292	80%	80%	0
1948	3,395	2,942	72%	71%	0
1949	3,313	2,264	55%	55%	0
1950	3,465	3,199	78%	77%	0
1951	3,497	3,497	85%	85%	388
1952	2,585	2,588	63%	63%	275
1953	3,323	3,323	81%	80%	513
1954	3,294	3,294	80%	80%	523
1955	3,228	2,207	54%	53%	0
1956	3,581	3,586	87%	87%	324
1957	3,235	3,235	79%	78%	257
1958	2,980	2,980	72%	72%	1,106
1959	3,547	3,480	85%	84%	366
1960	3,555	1,865	45%	45%	0
1961	3,580	2,659	65%	64%	97
1962	3,690	3,262	79%	79%	0
1963	3,823	3,818	93%	92%	202
1964	3,492	3,323	81%	80%	0
1965	3,059	3,059	74%	74%	177
1966	3,282	3,282	80%	79%	518
1967	2,950	2,946	72%	71%	923
1968	3,324	3,329	81%	81%	552
1969	2,636	2,632	64%	64%	275
1970	3,257	3,257	79%	79%	552
1971	3,341	3,341	81%	81%	0
1972	3,457	3,342	81%	81%	414
1973	3,097	3,092	75%	75%	384
1974	3,184	3,184	77%	77%	854
1975	3,229	3,229	79%	78%	903
1976	3,471	3,265	79%	79%	189
1977	3,421	159	4%	4%	0
1978	3,623	3,603	88%	87%	300
1979	3,512	3,501	85%	85%	160
1980	2,715	2,709	66%	66%	138
1981	3,358	3,358	82%	81%	546
1982	2,890	2,890	70%	70%	801
1983	2,497	2,498	61%	60%	400
1984	3,227	2,766	67%	67%	552
1985	3,214	3,214	78%	78%	0
1986	2,321	2,297	56%	56%	120
1987	2,896	2,896	70%	70%	546
1988	2,967	856	21%	21%	0
1989	3,551	3,174	77%	77%	0
1990	3,628	1,099	27%	27%	0
1991	3,425	1,052	26%	25%	0
1992	3,366	1,426	35%	34%	0
1993	3,862	3,848	94%	93%	159
1994	3,689	3,306	80%	80%	0
Average	3,290	2,818	69%	68%	262
Maximum	3,862	3,848	94%	93%	1,106
Minimum	2,321	159	4%	4%	0

Table B-7 SWP water delivery from the Delta for Study 5 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A -4.133 maf	Model Article 21 supply
1922	4,133	4,133	100%	21
1923	4,133	4,133	100%	0
1924	4,133	382	9%	0
1925	4,133	1,491	36%	190
1926	4,133	2,721	66%	279
1927	4,133	4,133	100%	301
1928	4,133	3,379	82%	0
1929	4,133	1,118	27%	0
1930	4,133	2,738	66%	141
1931	4,133	1,072	26%	0
1932	4,133	1,572	38%	112
1933	4,133	1,337	32%	547
1934	4,133	1,471	36%	242
1935	4,133	4,061	98%	218
1936	4,133	3,729	90%	0
1937	4,133	3,369	82%	70
1938	4,133	4,133	100%	200
1939	4,133	3,450	83%	0
1940	4,133	4,116	100%	114
1941	3,898	3,908	95%	0
1942	4,133	4,133	100%	123
1943	4,133	3,787	92%	487
1944	4,133	3,542	86%	0
1945	4,133	3,889	94%	118
1946	4,133	3,828	93%	0
1947	4,133	2,771	67%	0
1948	4,133	2,940	71%	0
1949	4,133	2,025	49%	0
1950	4,133	3,400	82%	0
1951	4,133	4,133	100%	252
1952	3,898	3,912	95%	0
1953	4,133	4,133	100%	296
1954	4,133	4,133	100%	0
1955	4,133	1,505	36%	0
1956	4,133	4,133	100%	352
1957	4,133	3,565	86%	0
1958	4,133	4,133	100%	229
1959	4,133	3,787	92%	107
1960	4,133	1,607	39%	0
1961	4,133	2,712	66%	299
1962	4,133	3,311	80%	1
1963	4,133	4,133	100%	161
1964	4,133	2,889	70%	0
1965	4,133	3,465	84%	47
1966	4,133	4,133	100%	178
1967	4,133	4,133	100%	157
1968	4,133	3,797	92%	465
1969	3,898	3,910	95%	63
1970	4,133	4,122	100%	493
1971	4,133	4,133	100%	0
1972	4,133	2,721	66%	0
1973	4,133	4,032	98%	259
1974	4,133	4,133	100%	69
1975	4,133	4,133	100%	134
1976	4,133	3,137	76%	0
1977	4,133	187	5%	0
1978	3,898	3,902	94%	300
1979	4,133	3,773	91%	144
1980	3,898	3,513	85%	86
1981	4,133	3,797	92%	71
1982	4,133	4,133	100%	171
1983	3,898	3,909	95%	357
1984	4,133	4,133	100%	490
1985	4,133	3,413	83%	0
1986	3,898	2,857	69%	83
1987	4,133	3,307	80%	183
1988	4,133	423	10%	0
1989	4,133	3,513	85%	91
1990	4,133	855	21%	0
1991	4,133	850	21%	0
1992	4,133	1,461	35%	102
1993	4,133	4,133	100%	255
1994	4,133	3,153	76%	0
Average	4,110	3,178	77%	124
Maximum	4,133	4,133	100%	547
Minimum	3,898	187	5%	0

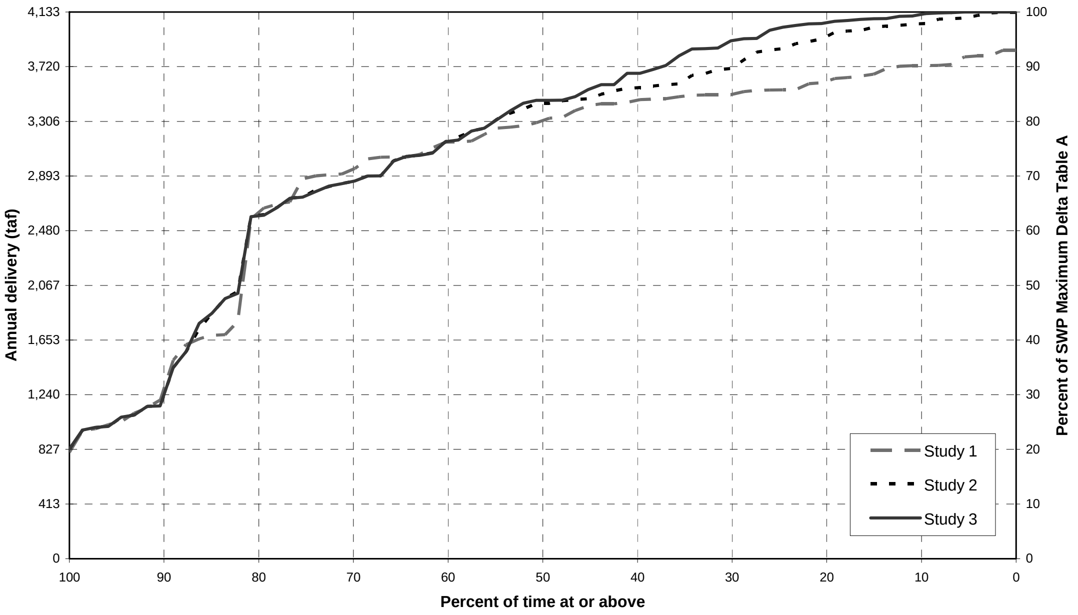


Figure B-1 SWP Delta Table A delivery probability for studies 1, 2 and 3

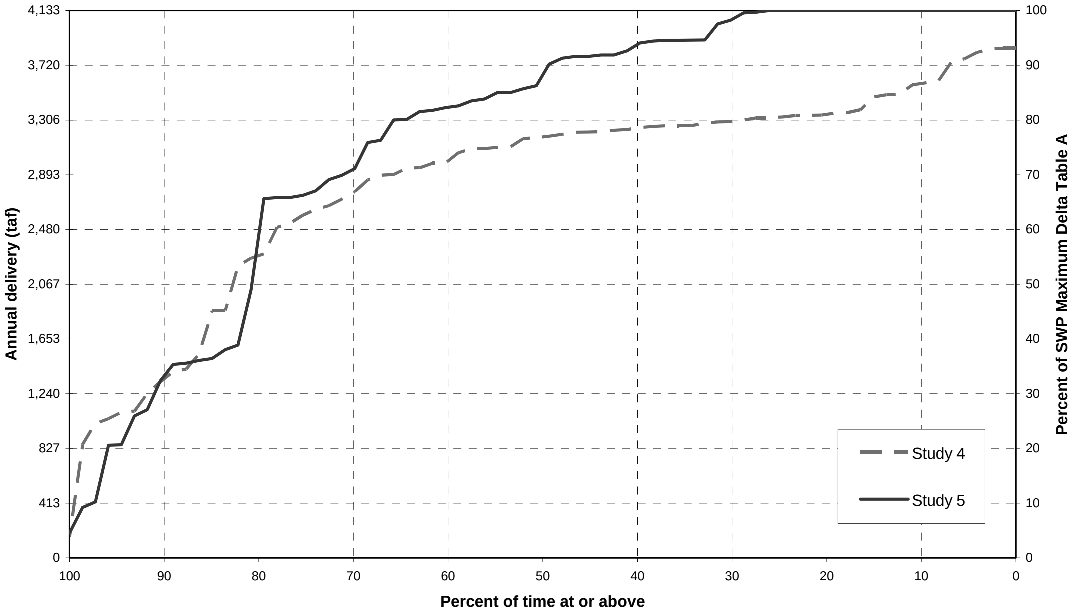


Figure B-2 SWP Delta Table A delivery probability for studies 4 and 5

Appendix C. State Water Project Table A Amounts

What is State Water Project Table A?

The contracts between the Department of Water Resources and the 29 State Water Project water contractors define the terms and conditions governing the water delivery and cost repayment for the SWP. Table A is an exhibit to these contracts. Comprehension of Table A is important in understanding the information in this report. To understand the table, it is necessary to understand how the contracts work.

All water-supply related costs of the SWP are paid by the contractors, and Table A serves as a basis for allocating some of the costs among the contractors. In addition, Table A plays a key role in the annual allocation of available supply among contractors. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4.2 million acre-feet (maf) per year. This was referred to as the minimum project yield, and it was recognized that in some years the project would be unable to deliver that amount and in other years project supply could exceed that amount. The 4.2 maf number was used as the basis for apportioning available supply to each contractor and as a factor in calculating each contractor's share of the project's costs. This apportionment is accomplished by Table A in each contract. Table A lists by year and acre-feet the portion of the 4.2 maf deliverable to each contractor. Other contract provisions permit changes to an individual contractor's Table A under special circumstances. The total of the maximums in all the contracts now equals 4.173 maf.

A copy of the consolidated Table A from all the contracts follows this explanation. The amounts listed in Table A cannot be viewed as an indication of the SWP water delivery reliability, nor should these amounts be used to support an expectation that a certain amount of water will be delivered to a contractor in any particular time span. Table A is simply a tool for apportioning available supply and cost obligations under the contract. In this report, reference to "Table A amounts" means the amounts listed in Table A. Contractors also receive other classifications of water from the project, as distinguished from Table A (for example, Article 21 water, and turnback pool water). These other contract provisions are discussed in Appendix D.

Table C-1 Maximum Annual SWP Table A Amounts

SWP Contractors	Maximum Table A
DELIVERED FROM THE DELTA	
North Bay	
Napa County FC&WCD	29,025
Solano County WA	47,756
Subtotal	**76,781**
South Bay	
Alameda County FC&WCD, Zone 7	80,619
Alameda County WD	42,000
Santa Clara Valley WD	100,000
Subtotal	**222,619**
San Joaquin Valley	
Oak Flat WD	5,700
County of Kings	9,305
Dudley Ridge WD	57,343
Empire West Side ID	3,000
Kern County WA	998,730
Tulare Lake Basin WSD	95,922
Subtotal	**1,170,000**
Central Coastal	
San Luis Obispo County FC&WCD	25,000
Santa Barbara County FC&WCD	45,486
Subtotal	**70,486**
Southern California	
Antelope Valley-East Kern WA	141,400
Castaic Lake WA	95,200
Coachella Valley WD	121,100
Crestline-Lake Arrowhead WA	5,800
Desert WA	50,000
Littlerock Creek ID	2,300
Mojave WA	75,800
Metropolitan WDSC	1,911,500
Palmdale WD	21,300
San Bernardino Valley MWD	102,600
San Gabriel Valley MWD	28,800
San Gorgonio Pass WA	17,300
Ventura County FCD	20,000
Subtotal	**2,593,100**
DELTA SUBTOTAL	**4,132,986**
Feather River	
County of Butte	27,500
Plumas County FC&WCD	2,700
City of Yuba City	9,600
Subtotal	**39,800**
GRAND TOTAL	**4,172,786**

Appendix D. Recent State Water Project Deliveries

SWP Contract Water Types

The State Water Project contracts define several classifications of water available for delivery to contractors under specific circumstances. All classifications are considered “project” water. Many contractors make frequent use of these additional water types to increase or decrease the amount available to them under Table A.

Table A Water

Each contract’s Table A is the amount in acre-feet that is used to determine the portion of available supply to be delivered to that contractor. Table A water is water delivered according to this apportionment methodology and is given first priority for delivery.

Article 21 Water

Article 21 of the contracts permits delivery of water excess to delivery of Table A and some other water types to those contractors requesting it. It is available under specific conditions discussed in Chapter 5. Article 21 water is apportioned to those contractors requesting it in the same proportion as their Table A.

Turnback Pool Water

Contractors may choose to offer their allocated Table A water excess to their needs to other contractors through two pools in February and March. Contributing contractors receive a reduction in charges, and taking contractors pay extra.

Carryover Water

Pursuant to the long-term water supply contracts, the Department of Water Resources (DWR) has offered contractors the opportunity to carry over a portion of their allocated water approved for delivery in the current year for delivery during the next year. The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The water supply contracts state the criteria of carrying over Table A water from one year to the next. Normally, carryover water is water that has been exported during the year, has not been delivered to the contractor during that year, and has remained stored in the SWP share of San Luis Reservoir to be delivered during the following year. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs.

Updated Historical Deliveries

The tables in this appendix list annual historical deliveries by various water classifications for each contractor for 1995 through 2004. Similar delivery tables for years 1995 through 2002 are included in the *State Water Project Delivery Reliability Report 2002*. Amounts listed for these years are slightly different due to accounting adjustments made by DWR’s State Water Project Analysis Office.

1995

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	203				203
Plumas County FC&WCD	308				308
City of Yuba City	910				910
Napa County FC&WCD	5,182				5,182
Solano County WA	21,345				21,345
Alameda County FC&WCD, Zone 7	30,091				30,091
Alameda County WD	17,793				17,793
Santa Clara Valley WD	28,756				28,756
Oak Flat WD	5,169				5,169
County of Kings	4,000				4,000
Dudley Ridge WD	57,700			2,986	60,686
Empire West Side ID	957	106		568	1,631
Kern County WA	1,089,063	59,671		2,795	1,151,529
Tulare Lake Basin WSD	71,679	4,553		25,637	101,869
Antelope Valley-East Kern WA	47,286				47,286
Castaic Lake WA (+Rch 31A, 5 & 7)	25,660			1,573	27,233
Coachella Valley WD	23,100				23,100
Crestline-Lake Arrowhead WA	409				409
Desert WA	38,100				38,100
Littlerock Creek ID	480				480
Mojave WA	3,722				3,722
Metropolitan WDSC	396,600			19,442	416,042
Palmdale WD	6,961				6,961
San Bernardino Valley MWD	696				696
San Gabriel Valley MWD	12,922				12,922
Totals	**1,889,092**	**64,330**	**0**	**53,001**	**2,006,423**
Total South of Delta	**1,887,671**	**64,330**	**0**	**53,001**	**2,005,002**

1996

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	257				257
Plumas County FC&WCD	360				360
City of Yuba City	820				820
Napa County FC&WCD	4,893				4,893
Solano County WA	29,144			855	29,999
Alameda County FC&WCD, Zone 7	18,903				18,903
Alameda County WD	19,662				19,662
Santa Clara Valley WD	88,829			1,021	89,850
Oak Flat WD	4,904				4,904
County of Kings	4,000				4,000
Dudley Ridge WD	52,491	4,457			56,948
Empire West Side ID	1,371			497	1,868
Kern County WA	1,117,060	15,653		52,350	1,185,063
Tulare Lake Basin WSD	118,500	8,537	71,268	38,570	236,875
San Luis Obispo County FC&WCD	100				100
Antelope Valley-East Kern WA	56,356				56,356
Castaic Lake WA (+Rch 31A, 5 & 7)	32,500				32,500
Coachella Valley WD	23,100		39,119		62,219
Crestline-Lake Arrowhead WA	485				485
Desert WA	38,100		64,522		102,622
Littlerock Creek ID	494				494
Mojave WA	7,427				7,427
Metropolitan WDSC	553,259			40,121	593,380
Palmdale WD	11,434				11,434
San Bernardino Valley MWD	6,064				6,064
San Gabriel Valley MWD	15,989				15,989
Totals	**2,206,502**	**28,647**	**174,909**	**133,414**	**2,543,472**
Total South of Delta	**2,205,065**	**28,647**	**174,909**	**133,414**	**2,542,035**

1997

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	185				185
Plumas County FC&WCD	231				231
City of Yuba City	1,005				1,005
Napa County FC&WCD	4,341				4,341
Solano County WA	35,530				35,530
Alameda County FC&WCD, Zone 7	27,522				27,522
Alameda County WD	24,063				24,063
Santa Clara Valley WD	95,601				95,601
Oak Flat WD	5,238				5,238
Dudley Ridge WD	51,623	7,141	12,544		71,308
Kern County WA	1,092,543	10,264			1,102,807
Tulare Lake Basin WSD	21,156	1,213			22,369
San Luis Obispo County FC&WCD	1,199				1,199
Santa Barbara County FC&WCD	7,439				7,439
Antelope Valley-East Kern WA	61,752	641			62,393
Castaic Lake WA (+Rch 31A, 5 & 7)	27,712				27,712
Coachella Valley WD	23,100		35,000		58,100
Crestline-Lake Arrowhead WA	651				651
Desert WA	38,100		15,000		53,100
Littlerock Creek ID	444				444
Mojave WA	10,374				10,374
Metropolitan WDSC	738,990				738,990
Palmdale WD	11,861				11,861
San Bernardino Valley MWD	9,654				9,654
San Gabriel Valley MWD	16,002	2,173			18,175
Ventura County FCD	1,850				1,850
Totals	**2,308,166**	**21,432**	**62,544**	**0**	**2,392,142**
Total South of Delta	**2,306,745**	**21,432**	**62,544**	**0**	**2,390,721**

1998

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	527				527
City of Yuba City	1,054				1,054
Napa County FC&WCD	5,359				5,359
Solano County WA	21,377	9,982		407	31,766
Alameda County FC&WCD, Zone 7	17,941				17,941
Alameda County WD	19,075				19,075
Santa Clara Valley WD	62,526			884	63,410
Oak Flat WD	4,401				4,401
County of Kings	3	12			15
Dudley Ridge WD	52,919	984		1,747	55,650
Empire West Side ID				542	542
Kern County WA	856,906			1,684	858,590
Tulare Lake Basin WSD	11,367	9,310			20,677
San Luis Obispo County FC&WCD	3,592				3,592
Santa Barbara County FC&WCD	18,618				18,618
Antelope Valley-East Kern WA	52,926				52,926
Castaic Lake WA (+Rch 31A, 5 & 7)	20,093				20,093
Coachella Valley WD	23,100		55,000		78,100
Crestline-Lake Arrowhead WA	187				187
Desert WA	38,100		20,000		58,100
Littlerock Creek ID	404				404
Mojave WA	3,925				3,925
Metropolitan WDSC	359,213			33,672	392,885
Palmdale WD	8,752				8,752
San Bernardino Valley MWD	1,878				1,878
San Gabriel Valley MWD	9,310				9,310
Ventura County FCD	1,850				1,850
Totals	**1,595,403**	**20,288**	**75,000**	**38,936**	**1,729,627**
Total South of Delta	**1,593,822**	**20,288**	**75,000**	**38,936**	**1,728,046**

1999

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	286				286
City of Yuba City	1,096				1,096
Napa County FC&WCD	4,550	754			5,304
Solano County WA	37,753				37,753
Alameda County FC&WCD, Zone 7	46,000	2,910			48,910
Alameda County WD	34,871	2,781			37,652
Santa Clara Valley WD	67,465	15,480			82,945
Oak Flat WD	4,871				4,871
County of Kings	4,000				4,000
Dudley Ridge WD	51,870	4,990	6,566		63,426
Empire West Side ID	3,000	176			3,176
Kern County WA	1,077,755	58,241	42,154		1,178,150
Tulare Lake Basin WSD	118,500	49,898	121,337		289,735
San Luis Obispo County FC&WCD	3,743				3,743
Santa Barbara County FC&WCD	20,137				20,137
Antelope Valley-East Kern WA	69,073				69,073
Castaic Lake WA (+Rch 31A, 5 & 7)	32,899				32,899
Coachella Valley WD	23,100		27,380		50,480
Crestline-Lake Arrowhead WA	1,132				1,132
Desert WA	38,100		20,000		58,100
Littlerock Creek ID	342				342
Mojave WA	5,144				5,144
Metropolitan WDSC	829,777	22,840			852,617
Palmdale WD	13,278				13,278
San Bernardino Valley MWD	12,874				12,874
San Gabriel Valley MWD	18,000				18,000
Ventura County FCD	1,850				1,850
Totals	**2,521,466**	**158,070**	**217,437**	**0**	**2,896,973**
Total South of Delta	**2,520,084**	**158,070**	**217,437**	**0**	**2,895,591**

2000

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	586				586
City of Yuba City	901				901
Napa County FC&WCD	3,136	297		1,525	4,958
Solano County WA	32,882	1,040		1,417	35,339
Alameda County FC&WCD, Zone 7	53,877	3,740			57,617
Alameda County WD	33,598	2,380			35,978
Santa Clara Valley WD	70,433	18,381		13,174	101,988
Oak Flat WD	4,494			14	4,508
County of Kings	3,600				3,600
Dudley Ridge WD	38,673	7,454	12,193	2,884	61,204
Empire West Side ID	1,271	528			1,799
Kern County WA	825,856	78,908	233,202	13,193	1,151,159
Tulare Lake Basin WSD	98,595	56,818	27,073	15,827	198,313
San Luis Obispo County FC&WCD	3,962				3,962
Santa Barbara County FC&WCD	22,741				22,741
Antelope Valley-East Kern WA	83,577				83,577
Castaic Lake WA (+Rch 31A, 5 & 7)	40,680				40,680
Coachella Valley WD	20,790	17,820	3,713		42,323
Crestline-Lake Arrowhead WA	1,194				1,194
Desert WA	34,290	17,820	6,124		58,234
Mojave WA	9,135				9,135
Metropolitan WDSC	1,273,729	103,124		169,529	1,546,382
Palmdale WD	8,221			839	9,060
San Bernardino Valley MWD	18,399				18,399
San Gabriel Valley MWD	14,000	475			14,475
Ventura County FCD	4,050				4,050
Totals	**2,702,670**	**308,785**	**282,305**	**218,402**	**3,512,162**
Total South of Delta	**2,701,183**	**308,785**	**282,305**	**218,402**	**3,510,675**

2001

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	513				513
City of Yuba City	1,065				1,065
Napa County FC&WCD	4,293	996	82	1,723	7,094
Solano County WA	17,756	2,304		1,021	21,081
Alameda County FC&WCD, Zone 7	22,307		308	5,990	28,605
Alameda County WD	13,695	10	107	4,192	18,004
Santa Clara Valley WD	35,689			12,233	47,922
Oak Flat WD	2,089		22	101	2,212
County of Kings	1,560				1,560
Dudley Ridge WD	18,467	933	347	6,815	26,562
Empire West Side ID		253		1,107	1,360
Kern County WA	363,204	23,233	6,502	92,052	484,991
Tulare Lake Basin WSD	40,830	8,755	769	7,889	58,243
San Luis Obispo County FC&WCD	4,184		99		4,283
Santa Barbara County FC&WCD	14,285	396	296		14,977
Antelope Valley-East Kern WA	45,071		899		45,970
Castaic Lake WA (+Rch 31A, 5 & 7)	30,471	850	618		31,939
Coachella Valley WD	9,009		91		9,100
Crestline-Lake Arrowhead WA	1,057				1,057
Desert WA	14,859		151		15,010
Mojave WA	4,433				4,433
Metropolitan WDSC	686,545	10,415	7,949	200,000	904,909
Palmdale WD	8,170			2,257	10,427
San Bernardino Valley MWD	26,488				26,488
San Gabriel Valley MWD	6,534				6,534
Ventura County FCD	1,850				1,850
Totals	**1,374,424**	**48,145**	**18,240**	**335,380**	**1,776,189**
Total South of Delta	**1,372,846**	**48,145**	**18,240**	**335,380**	**1,774,611**

2002

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	419				419
City of Yuba City	1,181				1,181
Napa County FC&WCD	2,022	827	283	3,743	6,875
Solano County WA	28,223	2,242			30,465
Alameda County FC&WCD, Zone 7	40,707	1,484	556	8,113	50,860
Alameda County WD	24,250	83	862	2,331	27,526
Santa Clara Valley WD	55,896	202	2,053	3,311	61,462
Oak Flat WD	3,841	50	76	134	4,101
County of Kings	2,800		54		2,854
Dudley Ridge WD	38,688	1,861	1,177	1,994	43,720
Empire West Side ID	1,278	26		101	1,405
Kern County WA	670,884	21,951	20,543	15,680	729,058
Tulare Lake Basin WSD	73,785	3,749	2,289	5,385	85,208
San Luis Obispo County FC&WCD	4,355				4,355
Santa Barbara County FC&WCD	24,166	436	324	3,455	28,381
Antelope Valley-East Kern WA	53,907		1,008	3,256	58,171
Castaic Lake WA (+Rch 31A, 5 & 7)	61,880	280		6,657	68,817
Coachella Valley WD	16,170	111	474		16,755
Crestline-Lake Arrowhead WA	2,189				2,189
Desert WA	26,670	189	781		27,640
Mojave WA	4,346				4,346
Metropolitan WDSC	1,273,205	9,624	14,335	97,940	1,395,104
Palmdale WD	8,359		437		8,796
San Bernardino Valley MWD	68,268			3,801	72,069
San Gabriel Valley MWD	18,353			4,698	23,051
Ventura County FCD	4,998				4,998
Totals	**2,510,840**	**43,115**	**45,252**	**160,599**	**2,759,806**
Total South of Delta	**2,509,240**	**43,115**	**45,252**	**160,599**	**2,758,206**

2003

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	551				551
City of Yuba City	1,324				1,324
Napa County FC&WCD	6,026	376	180	1,055	7,637
Solano County WA	25,135	2,280		1,918	29,333
Alameda County FC&WCD, Zone 7	30,695		656	13,099	44,450
Alameda County WD	31,086		354	5,150	36,590
Santa Clara Valley WD	90,620	936	841	14,104	106,501
Oak Flat WD	4,059	19	48	140	4,266
County of Kings	3,600	58	34		3,692
Dudley Ridge WD	49,723	1,928	482	1,452	53,585
Empire West Side ID	1,074	175		187	1,436
Kern County WA	841,697	27,891	8,419	22,380	900,387
Tulare Lake Basin WSD	94,376	6,243	938	4,284	105,841
San Luis Obispo County FC&WCD	4,417	36			4,453
Santa Barbara County FC&WCD	24,312	339	43	2,274	26,968
Antelope Valley-East Kern WA	52,730		250	7,049	60,029
Castaic Lake WA (+Rch 31A, 5 & 7)	49,895	991	90	4,760	55,736
Coachella Valley WD	14,045	204	194		14,443
Crestline-Lake Arrowhead WA	1,563				1,563
Desert WA	23,168	330	321		23,819
Mojave WA	10,907			3,528	14,435
Metropolitan WDSC	1,550,356	17,622	16,920	134,845	1,719,743
Palmdale WD	9,701			1,846	11,547
San Bernardino Valley MWD	25,371	200		1,844	27,415
San Gabriel Valley MWD	13,034	200			13,234
San Gorgonio Pass WA	116				116
Ventura County FCD	5,000				5,000
Totals	**2,964,581**	**59,828**	**29,770**	**219,915**	**3,274,094**
Total South of Delta	**2,962,706**	**59,828**	**29,770**	**219,915**	**3,272,219**

2004

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	1,440				1,440
City of Yuba City	1,434				1,434
Napa County FC&WCD	5,030	1,450	52	1,602	8,134
Solano County WA	15,991	7,787		47	23,825
Alameda County FC&WCD, Zone 7	38,895			11,466	50,361
Alameda County WD	20,959		214	6,714	27,887
Santa Clara Valley WD	52,867	2,983	508		56,358
Oak Flat WD	4,324		29	276	4,629
County of Kings	5,850	3,157	46		9,053
Dudley Ridge WD	36,676	7,393	291	1,886	46,246
Empire West Side ID	1,310	626		1,626	3,562
Kern County WA	641,368	86,513	5,075	38,729	771,685
Tulare Lake Basin WSD	58,125	15,299	489	5,638	79,551
San Luis Obispo County FC&WCD	4,096	69			4,165
Santa Barbara County FC&WCD	29,358		122		29,480
Antelope Valley-East Kern WA	50,532			9,199	59,731
Castaic Lake WA (+Rch 31A, 5 & 7)	46,358	1,618		35,785	83,761
Coachella Valley WD	8,631		89	6,745	15,465
Crestline-Lake Arrowhead WA	2,006				2,006
Desert WA	9,966		102	11,122	21,190
Mojave WA	13,176				13,176
Metropolitan WDSC	1,195,807	91,601	10,223	215,000	1,512,631
Palmdale WD	10,549			1,613	12,162
San Bernardino Valley MWD	35,523			20,631	56,154
San Gabriel Valley MWD	15,600				15,600
San Gorgonio Pass WA	837				837
Ventura County FCD	5,250				5,250
Totals	**2,311,958**	**218,496**	**17,240**	**368,079**	**2,915,773**
Total South of Delta	**2,309,084**	**218,496**	**17,240**	**368,079**	**2,912,899**

Appendix E. Technical Memorandum Report Summaries: Historical SWP/CVP Operations Simulation and CalSim II Model Sensitivity Analysis

Study

This appendix presents summaries of the findings of the *CalSim II Simulation of Historical SWP/CVP Operations* and a *CalSim II Model Sensitivity Analysis Study*. The entire reports are available at the websites listed at the end of this appendix.

1. CalSim II Simulation of Historical SWP/CVP Operations Technical Memorandum Report

Objective of Study

The purpose of the Historical Operations Study is to evaluate the ability of CalSim II to represent CVP and SWP operations, in general, and the delivery capability of the projects, in particular, through the monthly simulation of recent historical conditions.

Study Description

The period of simulation for the Historical Operations Study is water years 1975 to 1998. This 24-year period includes the 1976-77 and 1987-92 droughts, as well as the driest (1977) and the wettest (1983) years on record. The version of CalSim II used for this study is the benchmark study dated 30 September 2002, but with some inputs changed to reflect the historically changing conditions rather than a fixed level of development. Model inflows correspond to the historical flow from gage records, or are estimated from a hydrologic mass balance, or stream-flow correlation. Land use-based demands are calculated for annual varying land use, as determined from DWR’s land surveys and county commissioners’ reports. The operational logic has been revised to reflect the changing regulatory environment. The historical regulations have been simplified into three periods:

- October 1974 – September 1992: represented by State Water Resources Control Board (SWRCB) Water Right Decision 1485 (D-1485),
- October 1992 – September 1994: represented by D-1485 and the 1993 National Marine Fisheries Service (NMFS) winter-run Chinook salmon biological opinion (minimum carryover storage in Lake Shasta, and temperature related minimum instream flows downstream of Keswick Reservoir),
- October 1994 – September 1998: represented by SWRCB Water Right Decision 1641 (D-1641) and the 1993 winter-run biological opinion.

The Historical Operations Study is limited in geographical scope to a dynamic operation of the Sacramento Valley, the Delta, and the CVP-SWP facilities south of the Delta. Delta inflows from the San Joaquin Valley and East Side streams are constrained to their historical values. Imports from the Trinity River system are similarly constrained.

Results and Discussion

The key performance measures in evaluating CalSim II are considered to be SWP and CVP deliveries, project storage operations, and stream flows. During the study period of water years 1975-1998, SWP demands were historically much lower than current or projected level of demands. Simulation of historically wet years, when the system was not supply constrained, may therefore be a poor indicator of the model's ability to accurately simulate future levels of development. Particular attention is therefore placed on model results during the six-year drought of 1987-1992. Results for four key performance parameters are summarized in the table below.

The table below shows that simulated SWP Table A and CVP south-of-Delta deliveries during the drought are less than historical values. Differences are, however, within 5 percent. Comparison of Sacramento Valley inflow to the Delta (flow at Freeport) is a good measure of how well the Sacramento Valley hydrology is simulated by CalSim II. Simulated Delta inflows are 0.3 percent greater than historical. Comparison of the Net Delta Outflow Index, a measure of how well the Sacramento-San Joaquin Delta is represented by CalSim II, appears favorable. Simulated values are 3.5 percent greater than historical during the 1987-1992 period. The table also shows that simulated long-term (1975-1998) average deliveries compare quite well and are within 7 percent of historical values.

	Dry-period average 1987-1992				Long-term average			
	Simulated	Historical	Difference		Simulated	Historical	Difference	
Performance parameter		taf/yr		%		taf/yr		%
SWP south-of-Delta Table A deliveries	1,930	2,030	-100	-4.9	1,810	1,790	20	1.1
CVP south-of-Delta deliveries	2,230	2,320	-90	-3.9	2,650	2,490	160	6.4
Sacramento Valley inflow to the Delta	9,700	9,670	30	0.3	19,830	19,920	-90	-0.5
Net Delta Outflow Index	5,270	5,090	180	3.5	19,070	19,690	-620	-3.1

The total volume of surface water to be held in storage or routed through the model network is the same as historical. Model inflows to the Delta can deviate from historical due to three reasons: storage regulation, groundwater pumping to supplement surface water diversions, and stream-aquifer interaction.

Differences in Delta inflows are primarily caused by differences in project storage regulation (i.e. Lake Shasta, Lake Oroville and Folsom Lake). Storage operations in CalSim II are driven by two sets of rule curves. The first set of rule curves determines how much of the available project water will be held as carryover storage and how much will be delivered to meet contractors' current-year demands. The second set of rule curves determines when and how-much water will be transferred from north of Delta storage to San Luis Reservoir. These two sets of rule curves are fixed throughout the period of simulation. The rule curves have been determined in prior simulations of CalSim II. They are subjective in nature, but balance the conflicting objectives to maximize long-term average annual deliveries, to maintain water deliveries during the critically dry period 1928-34, and to keep water levels in project reservoirs above minimum levels while meeting minimum flow requirements. Secondly, differences in Delta inflows are due to differences in upstream surface water diversions and return flows. The historical consumptive water demand must be met by the model. Differences in Delta inflow, after accounting for differences in upstream storage regulation, therefore reveal how well CalSim II matches the historical mix of surface water and groundwater to meet demands. Lastly inflows to the Delta are influenced by the stream-aquifer interaction.

For a given south-of-Delta demand and a given Delta inflow, differences in model and historical project exports are indicative of how well the model represents the regulatory operating constraints to which the projects must comply, and how the model simulates storage operations in the San Luis Reservoir.

Conclusions from the study can be framed in the form of answers to some frequently asked questions about CalSim II.

Does CalSim II overestimate the projects' ability to export water from the Delta?

For the supply constrained years 1987-1992, model exports from the Delta average 4,450 taf/yr compared to a historical six-year average of 4,460 taf/yr. This suggests that CalSim II's simulation of the Delta operations is representative of actual historical conditions.

Does CalSim II overestimate the availability of surface water in the Delta by meeting Sacramento Valley in-basin use through excessive groundwater pumping?

The mix of surface water and groundwater used by the model to meet Sacramento Valley consumptive demands depends primarily on project water allocation decisions and levels of minimum groundwater pumping that are specified in the model. Over the 24-year period average annual net groundwater extraction in CalSim II as compared to estimates based on the Central Valley Groundwater Surface water Model (CVGSM) is lower by 378 taf. The average annual net stream inflow from groundwater in CalSim II is 190 taf greater than estimated by the CVGSM for the same period. The combined effect of dynamically modeling groundwater operations in CalSim II (pumping, recharge and stream-aquifer interaction) leads to 188 taf/yr less water being available to the Delta. For the 1987-1992 period the combined effect results in 46 taf/yr additional water being available to the Delta.

How well does CalSim II represent stream flows?

Differences in long-term average annual flows at key stream locations are typically 1.2 percent or less. It is noted that differences are larger for the Sacramento River at the Ord Ferry gage. At this location a proportion of the water diverted upstream returns downstream so that simulated river flows are sensitive to assumed model water use efficiencies.

How well does CalSim II simulate the Sacramento Valley system?

The net Sacramento Valley accretion is calculated as the Sacramento Valley Delta inflow less releases from Whiskeytown Reservoir, Keswick Reservoir, Lake Oroville and Folsom Lake. The historical 24-year average annual net accretion is 5,950 taf/yr compared with a model value of 5,920 taf/yr.

Do different reservoir operating rules in CalSim II translate into differences in project deliveries?

Simulated month-to-month and year-to-year model results can vary significantly from historical operations. This is primarily due to differences in storage operations. However when averaged over a longer period, model operations (stream flows and deliveries) are very close to historical.

2. CalSim II Model Sensitivity Analysis Study Technical Memorandum Report

Background

The sensitivity analysis is an important component of any water resources planning model evaluation. It enhances understanding of the model, builds greater public confidence, and expands public acceptance of the model. The sensitivity analysis explores and quantifies the effects of various inputs on the model outputs. With a simple sensitivity analysis procedure, variations of model input parameters are generally investigated one at a time. With a more complex procedure, the investigation is conducted by changing a set of input parameters simultaneously. For this study, the simple sensitivity study procedure is used.

The *Sensitivity Analysis Study* responds to the commitment in *The State Water Project Delivery Reliability Report 2002* to conduct such a study and to issues raised during the public review of that report. The sensitivity analysis study is also one of the recommendations by the CalSim II peer review sponsored by the CALFED Science Program in December 2003. The review panel recommended such a study would help identify key input parameters that have significant effects on the model output, and to provide a systematic way to measure the sensitivity of the model output to variations of key input parameters.

Study Objectives

There are three objectives of the CalSim II Sensitivity Analysis Study:

- to examine the behavior of the SWP-CVP system performance in response to variations in selected input parameters within CalSim-II
- to help SWP contractors and others understand the impact of key assumptions within CalSim II on the SWP delivery capability
- to aid CalSim II modelers for prioritizing future model development activities on the basis of sensitivities of input parameters

Study Description

The development of the CalSim II model is an ongoing effort. DWR and Reclamation periodically release updated versions of the model. This study uses the modified benchmark study of September 30, 2002, under the D-1641 regulatory environment as the base study.

The CalSim II model uses many input parameters to define the physical characteristics of the system, as well as the regulatory environment and operational parameters. Input parameters include time series, single dimensionless coefficients, or monthly distribution curves. Some input parameters are estimated from the historical data and others are user-input or calibrated values. After discussions with model developers and project operators, 21 model input parameters in four major categories and their reasonable ranges of variations were selected for this study. Similarly, there are many output variables in different categories, including reservoir storage, flows at key locations, Delta outflows, project exports and deliveries that characterize the overall outcome of any particular simulation run. After discussions with model users, project operators, and model developers, 22 key output variables that cover various aspects of the SWP-CVP system performance were selected.

In this study, two performance measures – Sensitivity Index (SI) and Elasticity Index (EI) – are used to quantify the model output sensitivity with respect to a certain model input parameter. The SI is a first-order derivative of a model output variable with respect to an input parameter. It can be used to measure the magnitude of change in an output variable per unit change in the magnitude of an input parameter from its base value. The EI is a dimensionless expression of sensitivity that measures the relative change in an output variable to a relative change in an input parameter. As an example, assuming SI = 0.5 and EI = 0.25 for the output variable of total Delta outflow with respect to the input parameter of Oroville inflow, means that for one thousand acre-feet (taf) increase in Oroville inflow, total Delta outflow increases by 0.5 taf; and for 1 percent increase in Oroville inflow, total Delta outflow increases by 0.25 percent, respectively.

Study Results and Discussions

The complete results of the study showing sensitivity and elasticity indices for each one of the selected output variables are listed in terms of their long-term (1922–1994) averages with respect to variations of input parameters. Table E-1 highlights the behavior of some of the key output variables that define the important aspects of SWP–CVP system performance. In Table E-1, the top row is the list of model input parameters and the left-most column is the list of model output variables. In general, each cell in the table contains two numbers except cells in Columns 8 and 9.

The number inside parentheses is the SI value and the number outside parentheses is the EI value. Signs in front of SI and EI values can be either positive or negative. In general, the positive sign indicates that the output variable changes in the same direction as the input parameter. For example, as shown in the Row 1 of Column 1 in the table, when SWP Table A demand increases, SWP total delivery, which is the sum of SWP Delta delivery and FRSA delivery, increases as well (SI = +0.39). SWP Delta Delivery is defined as SWP Table A deliveries to South-of-Delta plus deliveries to North Bay (Solano and Napa Counties) contractors. FRSA delivery is defined as the sum of deliveries to the Settlement Contractors in Feather River Service Area (FRSA) and Table A deliveries to Butte and Yuba Counties. The negative sign indicates that the output variable changes in the opposite direction as the input parameter. For example, as shown in the Row 5 of Column 1 in the table, when SWP Table A demand increases, Article 21 delivery decreases (SI = -0.13). In order to highlight relative sensitivity of the various input parameters, a color coded cell background has been used. A red color cell background represents a relatively higher sensitivity or (SI >= 0.2); yellow background represents a moderate sensitivity or (0.1 <= SI <= 0.2); and white background shows a lower sensitivity or (SI <= 0.1).

An examination of Row 3 of Table E-1 highlights the behavior of SWP Delta delivery with respect to changes in some of the key input parameters. It shows that the SWP Table A demand, the Banks pumping limit, and the Oroville inflow affect SWP Delta delivery the most. Folsom inflow and historical land use display moderate effects on the SWP Delta delivery. A positive SI of 0.52 for the SWP Table A demand indicates that the SWP Delta delivery will increase by an average of 0.52 taf if the SWP Table A demand increases by 1 taf; and a positive EI of 0.55 for the SWP Table A demand indicates that the SWP Delta delivery will increase by an average of 0.55 percent if the SWP Table A demand increases by one percent. Similarly, a positive SI of 0.20 for the Oroville inflow indicates that the SWP Delta delivery will increase by an average of 0.20 taf if the Oroville inflow increases by 1 taf; and a positive EI of 0.26 for the Oroville inflow indicates that the SWP Delta delivery will increase by an average of 0.26 percent if the Oroville inflow increases by one percent.

No SI values are computed for input parameters of the SWP Delivery-Carryover Curve and the SWP San Luis Rule-curve (see Columns 8 and 9) because the equivalent changes in the commensurate units of taf are difficult to define for these two parameters. A more detailed discussion of their impact on the SWP Delta delivery is presented in the Memorandum Report.

Table E-1 Summary Excerpt of Elasticity Index (EI) and Sensitivity Index (SI) for Selected Variables

Model Output Response		Model Input Parameters											
		SWP Table A Demand	Article 21 Demand	Banks Pumping Limit	Historical Land Use	Projected Land Use	Crop ET	Basin Efficiency	SWP Delivery-Carryover Curve	SWP San Luis Rule Curve	Shasta Inflow	Oroville Inflow	Folsom Inflow
		1	2	3	4	5	6	7	8	9	10	11	12
1	SWP Total Delivery	0.31 (0.39)(1)	0.01 (0.16)	0.15 (1.45)	0.09 (-0.13)	-0.05 (-0.03)		-0.15 (0.10)	-0.01	0.02	0.07 (0.05)	0.18 (0.19)	0.05 (0.14)
2	CVP total Delivery	-0.01 (-0.01)	(2)	-0.01 (-0.12)	0.10 (-0.18)	0.14 (0.11)	0.16 (0.09)	-0.32 (0.26)			0.25 (0.22)	0.05 (0.07)	0.03 (0.09)
3	SWP Delta Delivery	0.55 (0.52)	0.00 (-0.01)	0.07 (0.48)	0.12 (-0.13)	-0.09 (-0.04)	-0.21 (-0.08)	-0.17 (0.08)	-0.02		0.08 (0.04)	0.26 (0.20)	0.05 (0.12)
4	FRSA Delivery	-0.01 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.17 (0.02)	0.78 (0.08)	-0.17 (0.02)	0.00		0.00 (0.00)	0.01 (0.00)	0.00 (0.00)
5	Article 21 Delivery	-2.62 (-0.13)	0.15 (0.17)	2.63 (0.96)		-0.45 (-0.01)		0.30 (-0.01)	0.08	0.46	0.34 (0.01)	-0.51 (-0.02)	0.16 (0.02)
6	CVP SOD Delivery	-0.01 (-0.01)		-0.02 (-0.10)	0.15 (-0.15)	-0.25 (-0.11)	-0.27 (-0.09)	-0.10 (0.04)			0.38 (0.18)	0.08 (0.06)	0.04 (0.08)
7	CVP NOD Delivery	0.00 (0.00)		0.00 (-0.02)	0.03 (-0.03)	0.59 (0.21)	0.66 (0.18)	-0.59 (0.22)			0.10 (0.04)	0.02 (0.01)	0.01 (0.01)
8	Total Delta Outflow	-0.08 (-0.35)	0.00 (-0.16)	-0.04 (-1.48)	0.07 (-0.36)	-0.09 (-0.22)	-0.18 (-0.30)	-0.07 (0.15)	0.00	0.00	0.27 (0.69)	0.20 (0.74)	0.07 (0.75)
9	Banks Export	0.35 (0.37)	0.01 (0.16)	0.20 (1.63)	0.11 (-0.14)	-0.11 (-0.06)	-0.20 (-0.08)	-0.14 (0.08)	-0.01	0.02	0.10 (0.06)	0.21 (0.18)	0.05 (0.14)
10	Tracy Export	-0.01 (-0.01)		-0.02 (-0.10)	0.16 (-0.15)	-0.25 (-0.10)	-0.28 (-0.09)	-0.10 (0.04)			0.39 (0.18)	0.09 (0.06)	0.04 (0.08)
11	Banks SWP Export	0.37 (0.38)	0.01 (0.16)	0.18 (1.46)	0.11 (-0.13)	-0.10 (-0.05)	-0.20 (-0.08)	-0.14 (0.07)	-0.01	0.02	0.08 (0.05)	0.22 (0.18)	0.06 (0.14)
12	Banks CVP Export	-0.53 (-0.02)	0.00 (0.00)	0.79 (0.17)	0.42 (-0.01)	-0.37 (-0.01)	-0.43 (0.00)	-0.31 (0.00)	0.00	0.02	0.86 (0.01)	0.04 (0.00)	

Note: (1) Values inside parentheses are SI and outside are EI.
(2) Blank cells indicate that SI and EI are non-monotonic functions of the input parameters and their averages are not meaningful. See Chapters 2 and 4 for details.

High Sensitivity	0.2 < |SI|
Moderate Sensitivity	0.1 <= |SI| <= 0.2
Low Sensitivity	|SI| < 0.1

Future Work

This sensitivity study is mainly focused on Sacramento Valley hydrology, Sacramento-San Joaquin Delta water quality, and SWP operations. Additional sensitivity studies focused on San Joaquin Valley hydrology and CVP operations may be done in the near future by Reclamation.

A simple sensitivity analysis procedure has been used for this study. In order to evaluate the combined effect of varying two or more input parameters on the model outputs, future studies with a more complex sensitivity analysis procedure, which investigates changes in a set of input parameters simultaneously, may be needed.

Linear programming solution methodology used in the CalSim II model has the potential to produce an array of sensitivity analyses as a by-product of the linear programming analysis automatically. Discussion of these results will provide a degree of transparency to model users and an internal diagnostic tool that the current CalSim II does not provide. Studying these by-products of the linear programming solution procedure will be considered during the development of the next generation of the CalSim II model.

The CALFED report, *A Strategic Review of CalSim-II and its Use for Water Planning, Management, and Operations in Central California* (December 2003), recommends a model uncertainty analysis be conducted. An uncertainty analysis is not the same as a sensitivity analysis. It takes a set of randomly chosen input values (that can include parameter values), passes them through a model to obtain the probability distributions (or statistical measures of the probability distributions) of the resulting outputs, while a sensitivity analysis attempts to determine the relative change in model output values given modest changes in model input values. The uncertainty analysis would help users of the model understand better the risks of various decisions and the confidence they can have in various model predictions. DWR is currently working on a contract with University of California, Davis to develop a strategy for the identification and reduction of the major sources of uncertainty in CalSim II modeling studies, and implement a recommended procedure for the quantification of uncertainties in a CalSim II study.

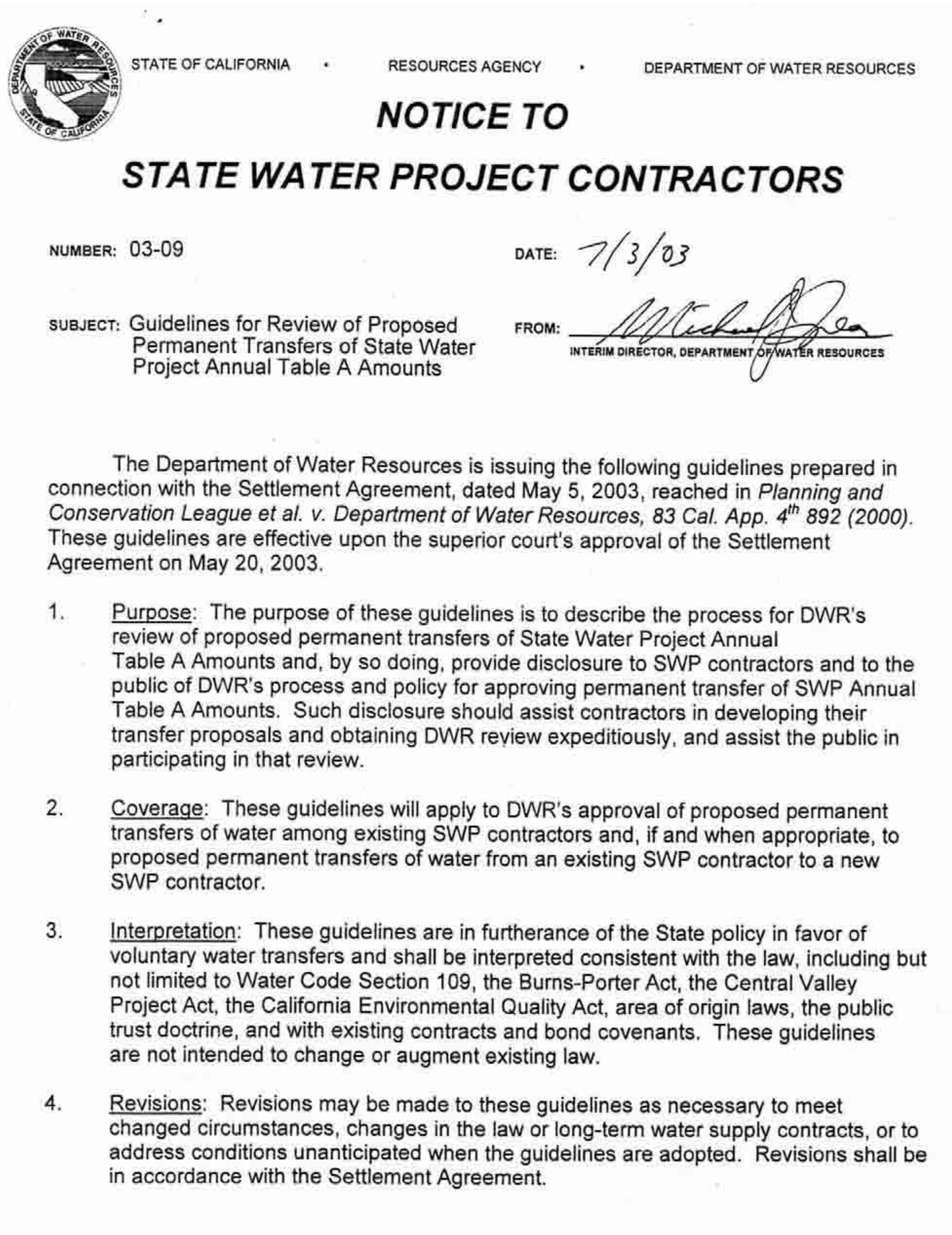
Websites for the Memorandum Reports:

1. [DWR] California Department of Water Resources, Bay-Delta Office. 2003. CalSim II Simulation of Historical SWP/CVP Operations. Technical Memorandum Report. Availability: http://science.calwater.ca.gov/pdf/CalSimII_Simulation.pdf

2. [DWR] California Department of Resources, Bay-Delta Office. 2005. CalSim II Model Sensitivity Analysis Study. Technical Memorandum Report. Availability: http://baydeltaoffice.water.ca.gov/

Appendix F. Guidelines for Review of Proposed Permanent Transfers of SWP Annual Table A Amounts

A copy of Notice to State Water Project Contractors Number 03-09 entitled “Guidelines for Review of Proposed Permanent Transfers of State Water Project Annual Table A Amounts” is shown below. These guidelines are being included per the Settlement Agreement, dated May 5, 2003, reached in the *Planning and Conservation League et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000).*



STATE OF CALIFORNIA • RESOURCES AGENCY • DEPARTMENT OF WATER RESOURCES

NOTICE TO
STATE WATER PROJECT CONTRACTORS

NUMBER: 03-09

DATE: 7/3/03

SUBJECT: Guidelines for Review of Proposed Permanent Transfers of State Water Project Annual Table A Amounts

FROM: INTERIM DIRECTOR, DEPARTMENT OF WATER RESOURCES

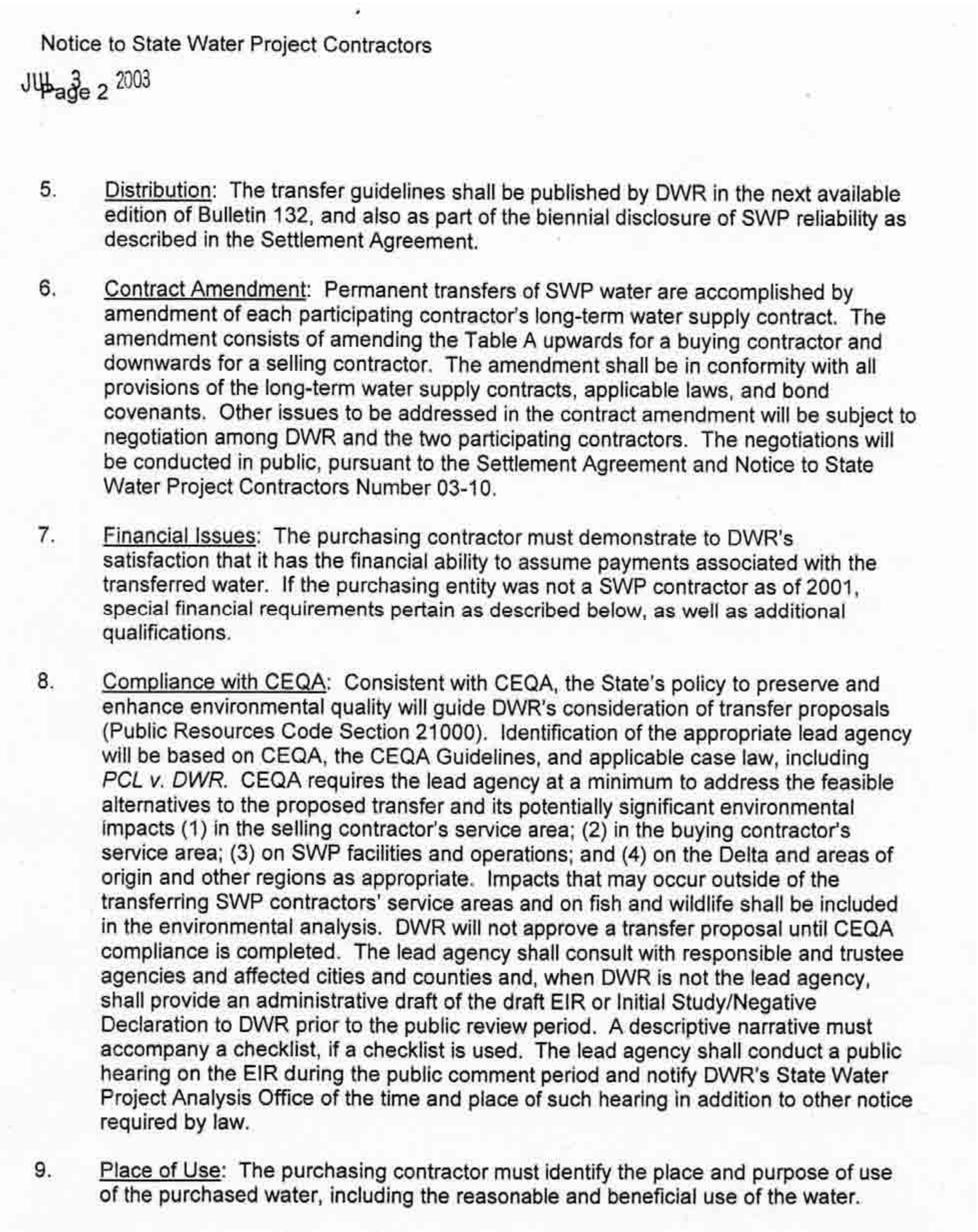
The Department of Water Resources is issuing the following guidelines prepared in connection with the Settlement Agreement, dated May 5, 2003, reached in *Planning and Conservation League et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000).* These guidelines are effective upon the superior court's approval of the Settlement Agreement on May 20, 2003.

1. Purpose: The purpose of these guidelines is to describe the process for DWR's review of proposed permanent transfers of State Water Project Annual Table A Amounts and, by so doing, provide disclosure to SWP contractors and to the public of DWR's process and policy for approving permanent transfer of SWP Annual Table A Amounts. Such disclosure should assist contractors in developing their transfer proposals and obtaining DWR review expeditiously, and assist the public in participating in that review.

2. Coverage: These guidelines will apply to DWR's approval of proposed permanent transfers of water among existing SWP contractors and, if and when appropriate, to proposed permanent transfers of water from an existing SWP contractor to a new SWP contractor.

3. Interpretation: These guidelines are in furtherance of the State policy in favor of voluntary water transfers and shall be interpreted consistent with the law, including but not limited to Water Code Section 109, the Burns-Porter Act, the Central Valley Project Act, the California Environmental Quality Act, area of origin laws, the public trust doctrine, and with existing contracts and bond covenants. These guidelines are not intended to change or augment existing law.

4. Revisions: Revisions may be made to these guidelines as necessary to meet changed circumstances, changes in the law or long-term water supply contracts, or to address conditions unanticipated when the guidelines are adopted. Revisions shall be in accordance with the Settlement Agreement.



Notice to State Water Project Contractors

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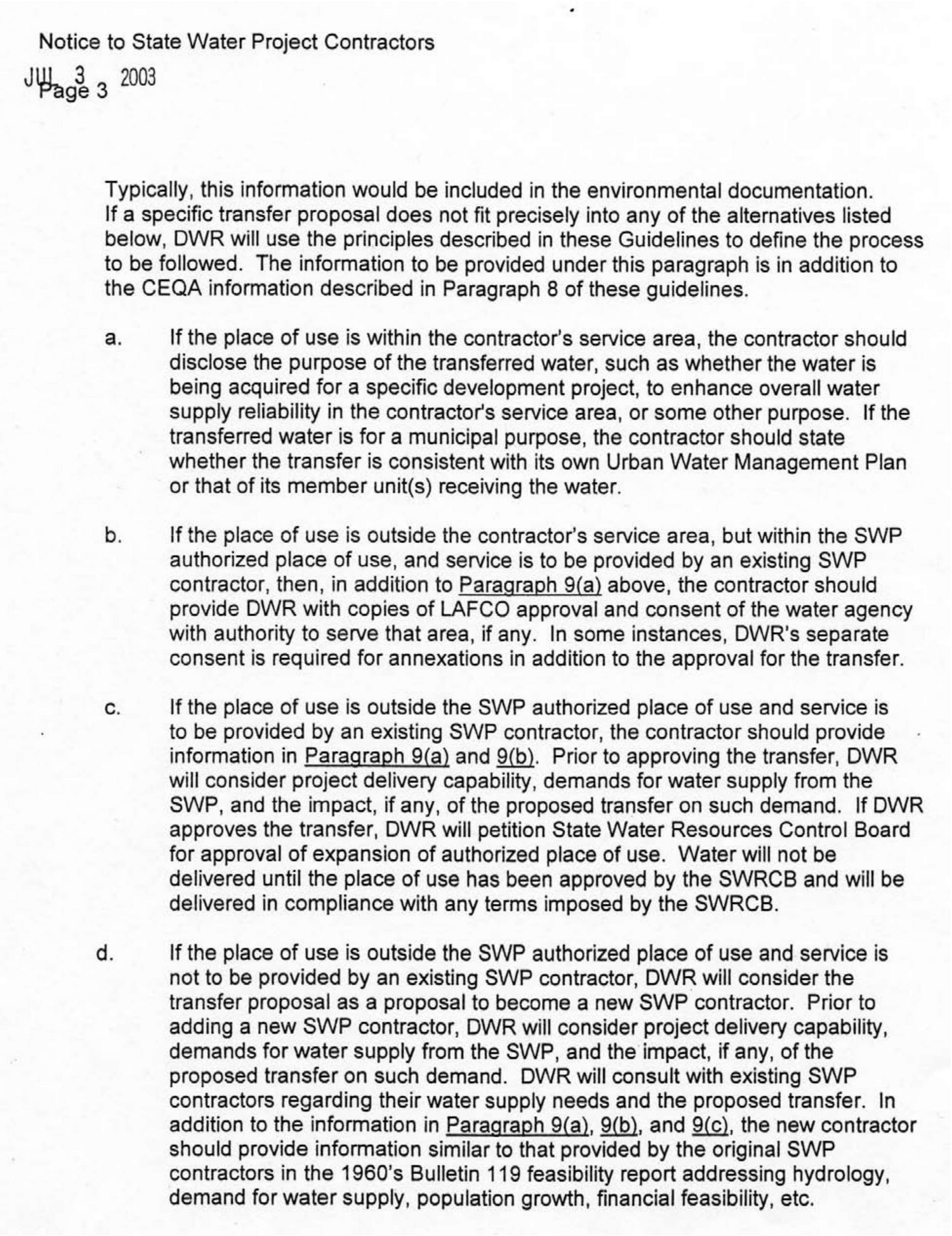
5. Distribution: The transfer guidelines shall be published by DWR in the next available edition of Bulletin 132, and also as part of the biennial disclosure of SWP reliability as described in the Settlement Agreement.

6. Contract Amendment: Permanent transfers of SWP water are accomplished by amendment of each participating contractor's long-term water supply contract. The amendment consists of amending the Table A upwards for a buying contractor and downwards for a selling contractor. The amendment shall be in conformity with all provisions of the long-term water supply contracts, applicable laws, and bond covenants. Other issues to be addressed in the contract amendment will be subject to negotiation among DWR and the two participating contractors. The negotiations will be conducted in public, pursuant to the Settlement Agreement and Notice to State Water Project Contractors Number 03-10.

7. Financial Issues: The purchasing contractor must demonstrate to DWR's satisfaction that it has the financial ability to assume payments associated with the transferred water. If the purchasing entity was not a SWP contractor as of 2001, special financial requirements pertain as described below, as well as additional qualifications.

8. Compliance with CEQA: Consistent with CEQA, the State's policy to preserve and enhance environmental quality will guide DWR's consideration of transfer proposals (Public Resources Code Section 21000). Identification of the appropriate lead agency will be based on CEQA, the CEQA Guidelines, and applicable case law, including *PCL v. DWR*. CEQA requires the lead agency at a minimum to address the feasible alternatives to the proposed transfer and its potentially significant environmental impacts (1) in the selling contractor's service area; (2) in the buying contractor's service area; (3) on SWP facilities and operations; and (4) on the Delta and areas of origin and other regions as appropriate. Impacts that may occur outside of the transferring SWP contractors' service areas and on fish and wildlife shall be included in the environmental analysis. DWR will not approve a transfer proposal until CEQA compliance is completed. The lead agency shall consult with responsible and trustee agencies and affected cities and counties and, when DWR is not the lead agency, shall provide an administrative draft of the draft EIR or Initial Study/Negative Declaration to DWR prior to the public review period. A descriptive narrative must accompany a checklist, if a checklist is used. The lead agency shall conduct a public hearing on the EIR during the public comment period and notify DWR's State Water Project Analysis Office of the time and place of such hearing in addition to other notice required by law.

9. Place of Use: The purchasing contractor must identify the place and purpose of use of the purchased water, including the reasonable and beneficial use of the water.



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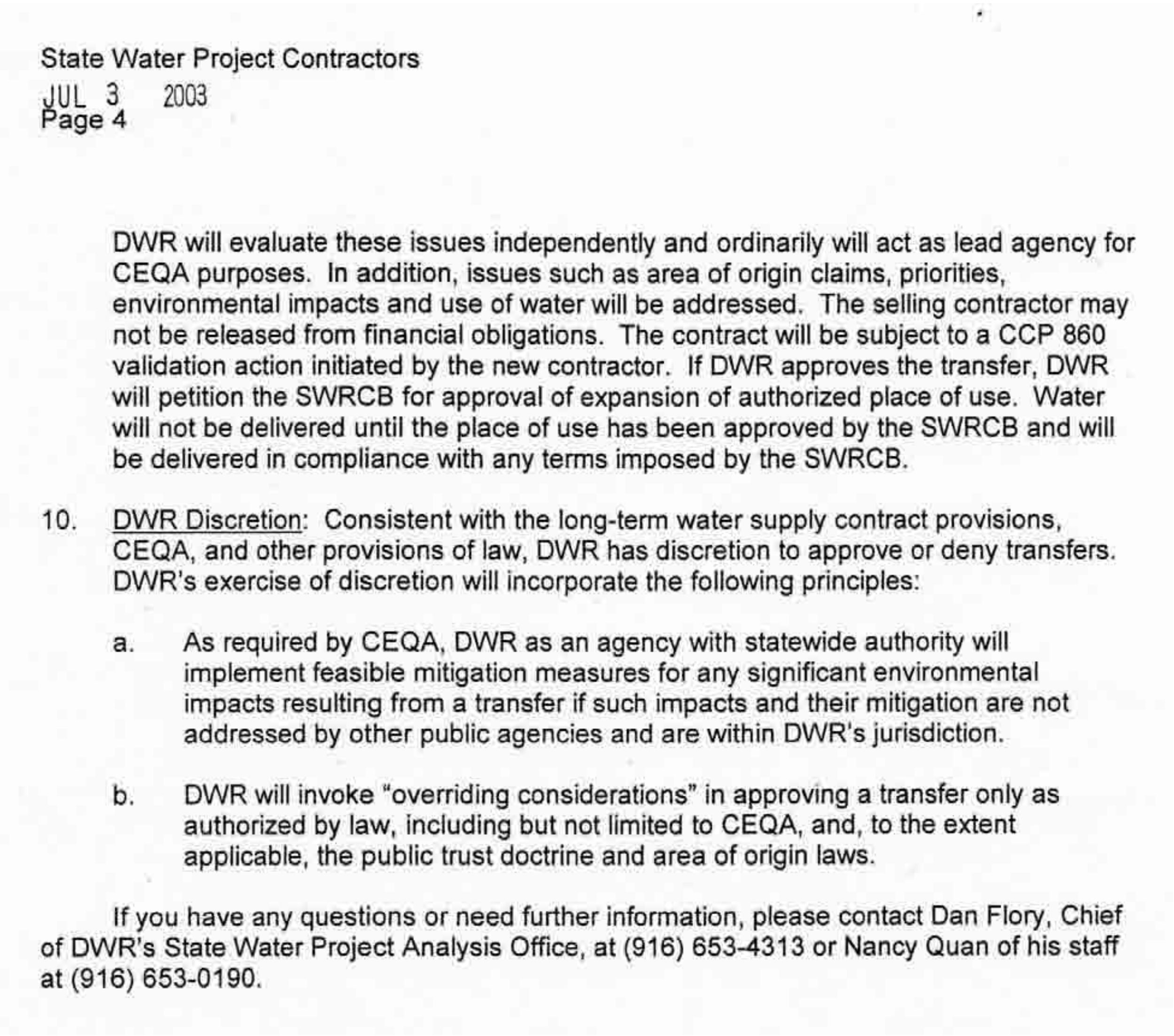
Typically, this information would be included in the environmental documentation. If a specific transfer proposal does not fit precisely into any of the alternatives listed below, DWR will use the principles described in these Guidelines to define the process to be followed. The information to be provided under this paragraph is in addition to the CEQA information described in Paragraph 8 of these guidelines.

a. If the place of use is within the contractor's service area, the contractor should disclose the purpose of the transferred water, such as whether the water is being acquired for a specific development project, to enhance overall water supply reliability in the contractor's service area, or some other purpose. If the transferred water is for a municipal purpose, the contractor should state whether the transfer is consistent with its own Urban Water Management Plan or that of its member unit(s) receiving the water.

b. If the place of use is outside the contractor's service area, but within the SWP authorized place of use, and service is to be provided by an existing SWP contractor, then, in addition to Paragraph 9(a) above, the contractor should provide DWR with copies of LAFCO approval and consent of the water agency with authority to serve that area, if any. In some instances, DWR's separate consent is required for annexations in addition to the approval for the transfer.

c. If the place of use is outside the SWP authorized place of use and service is to be provided by an existing SWP contractor, the contractor should provide information in Paragraph 9(a) and 9(b). Prior to approving the transfer, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

d. If the place of use is outside the SWP authorized place of use and service is not to be provided by an existing SWP contractor, DWR will consider the transfer proposal as a proposal to become a new SWP contractor. Prior to adding a new SWP contractor, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. DWR will consult with existing SWP contractors regarding their water supply needs and the proposed transfer. In addition to the information in Paragraph 9(a), 9(b), and 9(c), the new contractor should provide information similar to that provided by the original SWP contractors in the 1960's Bulletin 119 feasibility report addressing hydrology, demand for water supply, population growth, financial feasibility, etc.



DWR will evaluate these issues independently and ordinarily will act as lead agency for CEQA purposes. In addition, issues such as area of origin claims, priorities, environmental impacts and use of water will be addressed. The selling contractor may not be released from financial obligations. The contract will be subject to a CCP 860 validation action initiated by the new contractor. If DWR approves the transfer, DWR will petition the SWRCB for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

10. <u>DWR Discretion</u>: Consistent with the long-term water supply contract provisions, CEQA, and other provisions of law, DWR has discretion to approve or deny transfers. DWR's exercise of discretion will incorporate the following principles:

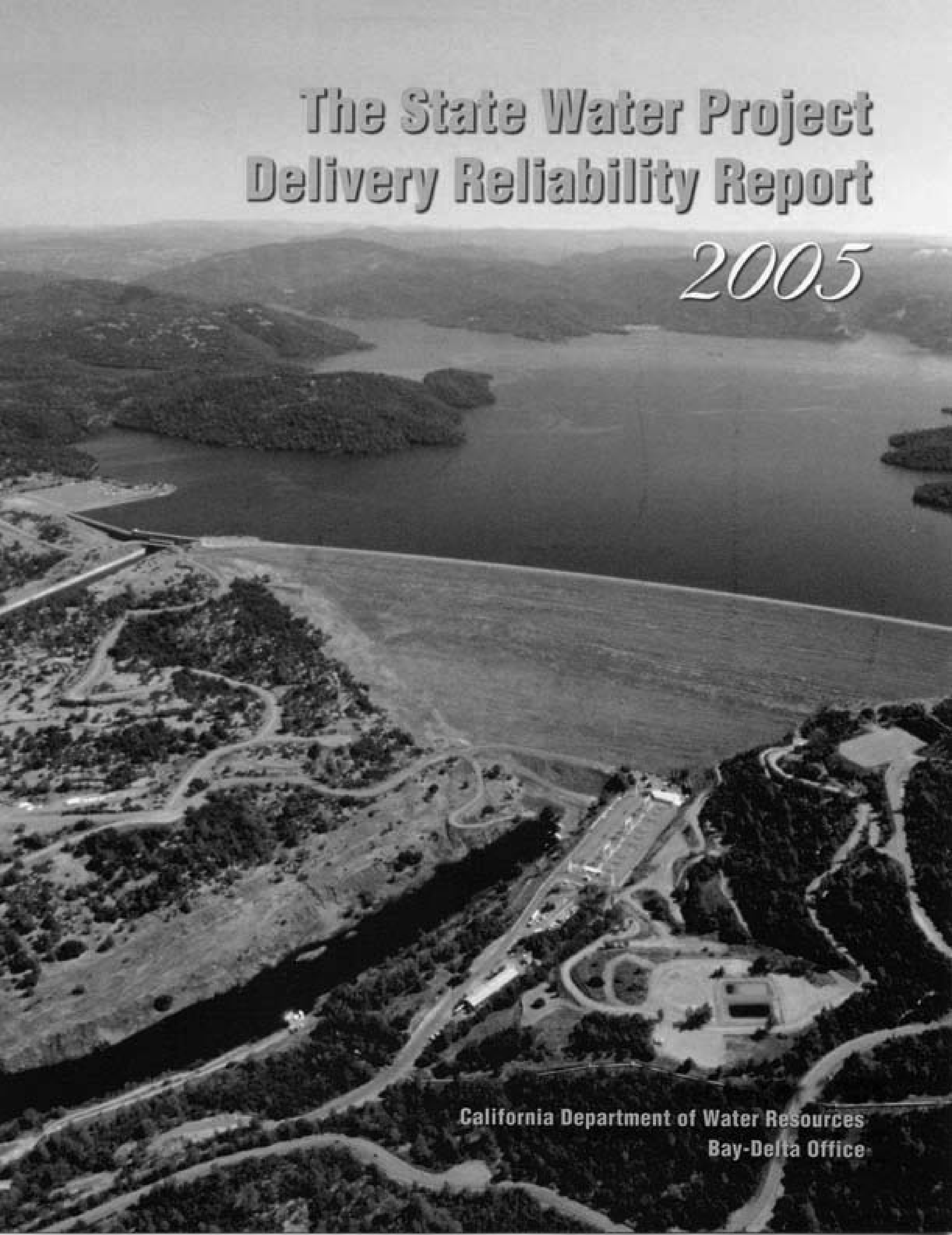
    a. As required by CEQA, DWR as an agency with statewide authority will implement feasible mitigation measures for any significant environmental impacts resulting from a transfer if such impacts and their mitigation are not addressed by other public agencies and are within DWR's jurisdiction.

    b. DWR will invoke "overriding considerations" in approving a transfer only as authorized by law, including but not limited to CEQA, and, to the extent applicable, the public trust doctrine and area of origin laws.

If you have any questions or need further information, please contact Dan Flory, Chief of DWR's State Water Project Analysis Office, at (916) 653-4313 or Nancy Quan of his staff at (916) 653-0190.

The State Water Project Delivery Reliability Report

2005



California Department of Water Resources
Bay-Delta Office

State of California
The Resources Agency
Department of Water Resources

The State Water Project Delivery Reliability Report 2005

Final

April 2006

Arnold Schwarzenegger
Governor
State of California

Mike Chrisman
Secretary for Resources
The Resources Agency

Lester A. Snow
Director
Department of Water Resources

If you need this report in alternate format, call the Office of Workforce Equality at (916) 653-6952 or TDD (916) 653-6934.

Foreword

The Department of Water Resources (DWR) is issuing this report to update information presented in the first report of this series, *The State Water Project Delivery Reliability Report 2002*, which was finalized in 2003 after an extensive public review. A draft of the *The State Water Project Delivery Reliability Report 2005* underwent a 30-day public review during November and December 2005. The information contained in this update was recommended by DWR in May 2005 for use by SWP water supply contractors in developing their 2005 Urban Water Management Plans.

The SWP Delivery Reliability Report 2002 and *The SWP Delivery Reliability Report 2005* are based upon analyses using a computer simulation model, CalSim II. Public criticism of this analytical approach centers on two areas: the ability of CalSim II to simulate "real world" conditions and accurately estimate SWP deliveries; and the inability of the approach to account for future uncertainties such as changes in the climate pattern or levee failure in the Delta due to flooding or an earthquake. While no model is perfect, DWR is satisfied with the degree to which CalSim II simulates actual, real-world operations of the SWP. When professional judgment is used with the knowledge of the limitations of CalSim II and the assumptions used in the studies, CalSim II is a useful tool in assessing the delivery reliability of the SWP. The studies and peer review related to CalSim II are discussed in Chapter 3 and Appendix E of this update.

Although the estimates contained in *The SWP Delivery Reliability Report 2005* are the best quantifications available of the delivery ability of the SWP, these estimates are limited because of the uncertainty of future conditions. DWR will continue to use the CalSim II model and its updates as appropriate for analyses, but other information is being developed that will help us analyze, understand, and prepare for our uncertain future. Per the Governor's directive (Executive Order S-3-05), the potential impacts of climate change on the State's resources, including water supply, are being evaluated. Using CalSim II, preliminary estimates have been done of the potential impact upon the SWP 50 to 100 years in the future if no additional conveyance facilities or upstream reservoirs are built. As these estimates become more refined, they will be helpful in guiding strategies for the management and development of the State's water resources, including improvements to the SWP.

In addition, DWR is working on three projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These include: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. Although none of these efforts will be completed before release of the next Reliability Report, some preliminary results and conclusions may be completed. Subsequent Reliability Reports will fully incorporate this information.

The updated SWP delivery estimates are summarized in Chapter 5. Chapter 6 contains examples of how to incorporate this information into a local water supply assessment. These examples are based upon examples contained in the *Draft Guidelines for Documentation and Integration of SWP Supplies with UWMPs*, which will soon be released by DWR for public review. These draft guidelines are designed to assist SWP urban contractors in estimating the amount of SWP supplies available to them and in integrating the SWP supply information with information from other sources of supply to develop an overall assessment of each contractor's total water portfolio. For additional information on the *Draft Guidelines*, contact the Office of Water Use Efficiency and Transfers at (916) 651-7027. DWR's Bay-Delta Office may be contacted at (916) 653-1099 with questions about other aspects of *The SWP Delivery Reliability Report 2005*.

Lester A. Snow
Director
California Department of Water Resources

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Chapter 1.
Introduction

Will there be enough water? Public officials throughout California face this question with increasing frequency as growth and competing uses strain existing resources. Water supply, however, has always been an uncertain and contentious matter in our state. For many years, the Department of Water Resources (DWR) has investigated this question. At its simplest level, the question might be, "How many wells are needed for a rural town's water supply?" or "How many people can a 100,000 acre-foot reservoir serve?" But for most areas of the state, the evaluation of water supply adequacy is not simple. The answer requires a complex analysis, taking into account multiple sources of water, a range of water demands, the timing of water uses, hydrology, available facilities, regulatory restraints, levels of demand management (water conservation) strategies, and, of course, future weather patterns.

Most water users in California live in areas that rely on multiple sources of water supply, some local and some imported. Typically, local water providers "mix and match" their supply sources to maximize water supply and quality and to minimize cost. In addition to considering available sources of supply, local water providers are planning for ways to improve the efficiency of local water uses and the operation of their water management systems. To help with this effort, DWR presents 25 different resource management strategies available to local agencies and governments and private utilities in the *California Water Plan Update 2005* (see website at http://www.waterplan.water.ca.gov).

Purpose

The State Water Project Delivery Reliability Report 2005 presents DWR's current information regarding the annual water delivery reliability of the State Water Project (SWP) for existing and future levels of development in the water source areas, assuming historical patterns of precipitation. This report first looks at the general subject of water delivery reliability and then discusses how DWR determines delivery reliability for the SWP. A discussion of the analysis tool (the CalSim II computer simulation model), the analyses, and peer review regarding the accuracy of CalSim II and its suitability for use in this report is included. Finally, estimates of SWP delivery reliability today and in the future are provided along with examples of how to incorporate this information into local water management plans.

This report responds to a requirement in the settlement agreement[1] with the Planning and Conservation League to provide an assessment of the existing delivery capability of the SWP over a range of hydrologic conditions. The range of conditions is to include the historic extended dry cycle and the long-term average. In addition, the biennial report is to include the total amount of project water delivered and the amount of project water delivered to each contractor for each of the 10 years immediately preceding the report (see Appendix D, Recent SWP Deliveries).

The State Water Project Delivery Reliability Report 2005 does not include analyses of how specific water agencies should integrate SWP water supply into their water supply equation. That topic requires extensive information about local facilities, local water resources, and local water use, which is beyond the scope of this report. Moreover, such an analysis would require decisions about water supply and use that traditionally have been made at the local level. DWR believes that local officials should continue to fill this role. The examples provided in Chapter 6 are included to help local agencies incorporate the information presented in this report into local water management assessments.

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[1] *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892

Background

The original *SWP Delivery Reliability Report* was issued as a draft in August 2002. In 2002, DWR held six public meetings throughout the state to discuss the report and receive comments upon the content. The final *SWP Delivery Reliability Report* was released in early 2003. *The State Water Project Delivery Reliability Report 2005* is an update to the report issued in 2003. DWR intends to publish biennial updates of the *SWP Delivery Reliability Report* in the future.

The SWP supplies two-thirds of the state's population with a portion of its water supply and provides water to irrigate, in part, 750,000 acres of agriculture. The SWP delivers water under long-term contracts to 29 public water agencies throughout the state. They, in turn, either deliver water to water wholesalers or retailers or deliver it directly to agricultural and urban water users.

The water delivery reliability of the SWP is of direct interest to those who use SWP supplies because it is an important element of the overall water supply in those areas. Local supply reliability is of key importance to local planners and local government officials who are responsible for planning for future growth while assuring that an adequate and affordable water supply is available for the existing population and businesses. This function is usually conducted in the course of preparing a water management plan such as the Urban Water Management Plans required by Water Code section 10610. The information in this report may be used by local agencies in preparing or amending their water management plans and identifying the new facilities or programs that may be necessary to meet future water demands.

Local agencies and governments and private utilities will also find in this report information that is useful in conducting analyses mandated by laws requiring water retailers to demonstrate whether their water supplies are sufficient for certain proposed subdivisions and development projects subject to the California Environmental Quality Act. DWR published the *Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001*, which includes suggestions on how local water suppliers can integrate supplies from various sources, such as the SWP, into their analyses. DWR has also published the *Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan*, which includes suggestions on how local water suppliers can integrate supplies from other sources such as the SWP in their analyses. Both documents can be found on the DWR's Office of Water Use Efficiency home page at http://www.owue.water.ca.gov.

The *Draft Guidelines for Documentation and Integration of SWP Supplies with UWMPs* will soon be released for public review. These guidelines are designed to assist SWP urban contractors in determining the amount of SWP supplies available to them. Using the information in this report (*SWP Delivery Reliability Report 2005)*, these guidelines explain how to integrate the SWP supply information with supply information from other sources to develop an overall reliability assessment of each contractor's total water portfolio.

Chapter 2.
Water Delivery Reliability

What is Water Delivery Reliability?

"Water delivery reliability" means how much one can count on a certain amount of water being delivered to a specific place at a specific time.

Objectively, water delivery reliability indicates a particular amount of water that can be delivered with a certain numeric frequency. A delivery reliability analysis assesses such things as facilities, system operation, water demand, and weather projections.

Subjectively, water delivery reliability indicates an acceptable or desirable level of dependability of water deliveries to the people receiving the water. Usually, a local water agency in coordination with the public it serves determines the acceptable level of reliability and plans for new facilities, demand-management and conservation programs, or additional water supply sources to meet or maintain this level.

What Factors Determine Water Delivery Reliability?

In its simplest terms, water delivery reliability depends on three general factors:

1. Availability of water from the source (that is, the natural source or sources of the water from which the supplier draws, such as a particular watercourse or groundwater basin). Availability of water from the source depends on the amount and timing of precipitation and runoff, or "hydrology," which provides water to the stream or groundwater basin, and the anticipated patterns of use and consumption of this water within the source area, including water returned to the source after use.
2. Availability of means of conveyance (that is, the means for conveying the water from the source via pumps, diversion works, reservoirs, canals, etc. to its point of delivery). The ability to convey water from the source depends on the existence and physical capacity of the diversion, storage, and conveyance facilities and also on contractual, statutory, and regulatory limitations on the operation of the facilities.
3. The level and pattern of water demand in the delivery service area (destination). The level of water demand in the delivery service area is affected by the magnitude and types of water demands, level of water conservation strategies, local weather patterns, water costs, and other factors. Supply from a water system may be sufficiently reliable at a low level of demand but become less reliable as the demand increases. In other cases, the reliability of a water supply system to meet a higher demand may be maintained at its past level because new facilities have been added or the operation of the system has been changed.

How is Water Delivery Reliability Determined?

Water Delivery Reliability is Defined for a Specific Point in Time

For this report, water delivery reliability is analyzed for 2005 conditions and for conditions projected to exist 20 years in the future (2025). These analyses must describe current conditions adequately and make predictions about the three factors described earlier and discussed here.

The Availability of Water at the Source

This factor depends on how much rain and snow there will be in any given year and what the level of development (that is, the use of water) will be in the source areas. No model or analytical tool can predict the actual, natural water supplies for any year or years in the future. Until the impacts of climate change on precipitation and runoff patterns in California are better quantified, future weather patterns are usually assumed to be similar to those in the past, especially where there is a significant historical rainfall record.

The State Water Project analyses contained in this report are based upon 73 years of historical records (1922-1994) for rainfall and runoff that have been adjusted to reflect the current and future levels of development in the source areas by analyzing land use patterns and projecting future land and water use. These series of data are then used to forecast the amount of water available to the SWP under current and future conditions.

The assumption that past rainfall-runoff patterns will be repeated in the future has an inherent uncertainty, especially given the evolving information on the potential effects of global climate change. The *California Water Plan Update 2005* (December 2005) states:

> California's water systems have been designed and operated based on data from a relatively short hydrologic record. Mounting scientific evidence suggests that forecasted climate changes could significantly change California's precipitation pattern and amount from that shown by the record. Less snowpack would mean less natural water storage. More variability in rainfall, wetter at times and drier at times, would place more stress on the reliability of existing flood management and water systems. California's high dependence on reservoir storage and snowpack for water supply and flood management makes us particularly vulnerable to these types of projected hydrologic changes. (See Chapter 4 in this volume and articles in Volume 4 Reference Guide under Global Climate Change for further discussion.)
> (*California Water Plan Update*, December 2005, Vol. 1, page 3-15)

Potential changes in climate patterns are becoming better defined and attempts to quantify the resulting impacts to SWP water supply are underway. Broad brush estimates are being developed of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. As this information becomes more refined, it will be helpful in guiding the development of statewide strategies for the future management and development of water resources facilities, including the SWP.

The Ability to Convey Water from the Source to the Desired Point of Delivery

This factor describes the facilities available to capture and convey surface water or groundwater and the institutional limitations placed upon the facilities. The facilities and institutional limitations may be assumed to be those that currently exist. Alternatively, predictions may be made regarding planned new facilities. Assumptions made about the institutional limitations to operation—such as legal, contractual, or regulatory restrictions—often are based upon existing conditions. Future changes in conditions that affect the ability to convey water usually cannot be predicted with certainty, particularly the regulatory and other institutional constraints on water conveyance.

The analyses in this report include the assumptions that current regulatory and institutional limitations regarding water quality, fish protection, and flows will exist 20 years in the future (2025); no facility improvements, expansions, or additions will be made to the SWP; and conveying water through the Sacramento-San Joaquin Delta will not be significantly interrupted.

Most of the Delta's levees do not meet modern engineering standards and are highly susceptible to failure. Levees are subject to failure at any time of the year due to seepage or the piping of water through the levee, slippage or sloughing of levee material, or sudden failure due to an earthquake. DWR is working on three projects that will improve the ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These include: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. Information developed through these efforts will be incorporated into subsequent Reliability Reports.

The Level of Demand

This factor includes the amount and pattern of water demand on the water management system. Demand can have a significant effect upon the reliability of a water system. For example, if the demand occurs only three months in the summer, a water system with a sufficient annual supply but insufficient water storage may not be able to reliably meet the demand. If, however, the same total amount of demand is distributed over the year, the system could more easily meet the demand because the need for water storage is reduced.

Demand levels for the SWP are derived from historical data and information received from the SWP contractors. Demand on the SWP is nearing the maximum Table A amount. Each of the SWP contracts has a Table A, which lists the maximum annual delivery amount over the period of the contract. These annual amounts usually increase over time. Most contractors' Table A amounts reached a maximum in 1990. The total of all contractors' maximum Table A amounts is 4.173 million acre-feet (maf) per water year. Table A is used to define each contractor's portion of the available water supply that DWR will allocate and deliver to that contractor. The Table A amounts in any particular contract, accordingly, should not be read as a guarantee of that amount but rather as the tool in an allocation process that defines an individual contractor's "slice of the pie." The size of the "pie" itself is determined by the factors described in this report. (See Appendix C for additional explanation and listing of the maximum Table A amounts.)

There are 29 SWP contractors. Yuba City, Butte County, and the Plumas County Flood Control and Water Conservation District are north of the Delta. Their maximum Table A amounts total 0.040 maf. The maximum Table A amounts for the remaining 26 contractors, which receive their supply from the Delta, total 4.133 maf. This report focuses on SWP deliveries from the Delta because the amount of water pumped from the Delta by SWP facilities is the most significant component of the total amount of SWP deliveries. The results presented in this report regarding the percent of Table A deliveries applies to contractors north of the Delta in the same manner as those contractors receiving supply from the Delta.

Past Deliveries May Not Accurately Predict Future Deliveries

It is worthwhile to note that in some situations, actual, historical water deliveries cannot be used with a significant degree of certainty to predict future water deliveries. As discussed earlier, there are continual, significant changes over time in the determinants of water delivery for a specific water supply system: changes in water storage and delivery facilities, in water use in the source areas, in water demand in the receiving areas, and in the regulatory constraints on the operation of facilities for the delivery of water. Given the very significant changes that have occurred for the SWP over the past 40 years, past deliveries are not a good predictor of current deliveries, much less of future deliveries.

For example, the demand 30 years ago for water from the SWP was not as high as it is currently or expected to be in the future. Because the demand for SWP water then was low, less water was transported through the SWP during normal and wet times than could have been if the demand had been higher. Simply put, less water was delivered in those past years because less water was needed. Conversely, the projected deliveries of a water project would be less than the past if the water project had been operated at its maximum ability for many years, no new facilities were planned to be built, and the annual supply from one of its main sources of water was recently reduced and would remain at the reduced level.

Many Assumptions Must Be Made in the Determination and Analysis of Water Delivery Reliability

As discussed earlier, to plan for the future, many assumptions must be made about the future. One of the most significant assumptions for water planning in general is how wet, dry and variable the weather will be. For many planning purposes and until the potential effects of climate change are better defined, the assumption is that future patterns of weather will be like the past, and an effort is made to develop information on the longest historical period for which acceptable records exist.

Using the historical record, planners analyze the worst drought in the period of record to evaluate how the water management systems will respond. Precipitation information for the Central Valley used for this report begins in 1922 and records the area's worst multi-year drought (1928-1934), although the brief drought from 1976 through 1977 was more acutely dry. Whatever assumptions are made, every responsible water delivery reliability analysis should expressly state the assumptions, methods and data used to produce its results. It should be understood that those numbers depend on, and are no better than, the assumptions upon which they must necessarily rest.

Because assumptions are the foundation upon which the estimates are made, it is helpful to know how each assumption affects study results. For example, what impact would a significant increase in water use in the source areas have upon the projected SWP water delivery reliability? Would it significantly reduce the amount of SWP supply, and if so, by how much? These types of questions can be answered by varying specific factors to see the impact upon the results. These studies are referred to as sensitivity analyses and can be helpful in assessing the importance of certain assumptions to the study results. Per a commitment in the 2002 Reliability Report, DWR has conducted a sensitivity analysis for assumptions contained in the CalSim II model studies. The results of this study are discussed in Appendix E. In the future, the results of this study will be analyzed to develop more detailed findings regarding SWP Delta deliveries. Summaries of the findings of other studies of CalSim II, as well as a peer review of the model, are contained in this report and discussed in more detail in Appendix E.

Chapter 3.
Study Approach and CalSim II Follow-up Studies

This report presents information from computer simulation studies of the operation of the SWP using the CalSim II model. CalSim II is a planning model developed by the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR). It simulates the SWP and the Central Valley Project (CVP) and areas tributary to the Sacramento-San Joaquin Delta. Using historical rainfall and runoff data, which has been adjusted for changes in water and land use that have occurred or may occur in the future, the model simulates the operation of the water resources infrastructure in the Sacramento and San Joaquin river basins on a month-to-month basis. In the model, the reservoirs and pumping facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met.

The month-to-month simulations are conducted over the 73-year period (1922-1994) of the adjusted historical rainfall/runoff data. This approach incorporates the over-arching assumption that the next 73 years will have the same rainfall/snowmelt amount and pattern, both within-year and from year to year, as the period 1922 through 1994. The studies do not incorporate any modifications to account for changes related to climate patterns or assess the risk of future seismic or flooding events significantly disrupting SWP deliveries. The results of the CalSim II studies conducted for this update to *The State Water Project Delivery Reliability Report 2002* (DWR 2003a) represent the best available assessment of the delivery capability of the SWP.

Since the release of the 2002 report, a peer-review and several studies have been conducted regarding CalSim II. These reports include:

- An external peer review commissioned by the California Bay-Delta Authority (CALFED);
- An analysis of an historical operations simulation;
- An analysis of the effect varying selected parameters has upon model results (sensitivity analysis study); and
- An analysis of the significance of the simulation time-step to the estimated SWP delivery amounts.

An overview of these efforts follows.

Science Program Peer Review of CalSim II

In 2003, the CALFED Science Program commissioned an external review panel to provide an independent analysis and evaluation of the strengths and weaknesses of CalSim II. The central question put to the review panel was whether the CALFED program had adopted an appropriate approach to modeling the Central Valley Project/State Water Project (CVP/SWP) system. The panel considered a variety of CalSim II issues and addressed how future model development activities could be managed to assure quality results for current and proposed applications. The panel published its results in *A Strategic Review of CALSIM II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003).

In general, the panel concluded that the current modeling approach was comparable to other state-of-the-art models and addressed many of the complexities of the CVP/SWP system. To balance the competing needs of those who require greater detail from the model and those who require less detail, the panel recommended steps to achieve a more comprehensive, modular, and flexible approach in modeling practices and tools. To increase user confidence in model results and to provide a basis for gauging the model's ability to produce absolute predictive results of system behavior, the panel suggested calibration and verification of the model, as well as analyses in sensitivity and uncertainty.

In what was most relevant to the subject of this report on the SWP delivery reliability, the panel summarized its observation on the accuracy of the model to estimate the delivery capability of both the CVP and SWP systems in the *Strategic Review's* Appendix F "Analysis of the November 2003 CalSim II Validation Report." Appendix F is discussed in the next section.

In August 2004, DWR and the USBR jointly responded to the questions, comments, and recommendations of the review panel in a report, *Peer Review Response: A Report by DWR/Reclamation in Reply to the Peer Review of the CalSim II Model Sponsored by the CALFED Science Program in December 2003.* (*Peer Review Response*). In their report, the agencies outline current and planned work on model development and the priorities for improving CalSim II. The *Peer Review Response* also highlights the ongoing and planned efforts to establish trust in and credibility for the model by improving documentation, conducting sensitivity and uncertainty analyses of the model parameters and results. Other efforts include enhancing the level of detail in the geographic representation of the system, and improving hydrologic input and software development.

Many of the elements of model development outlined in the *Peer Review Response* are in progress and will be implemented in the updated version of the model, CalSim III. Some of the *Strategic Review's* pressing issues regarding the reliability of CalSim II as a planning tool are addressed below.

The Ability of CalSim II to Estimate Water Deliveries

The accuracy of CalSim II in simulating "real-world" conditions was one of the major issues raised by the peer review panel. The review panel focused on the system's delivery capability as a major concern to water users as well as water managers who rely on CalSim II when making planning decisions. In Appendix F of the *Strategic Review,* the panel expresses concern that CalSim II overestimates deliveries to south-of-Delta water users. This observation is based on comparing the average deliveries for the last 10 years (1993-2002) with the average annual deliveries in a 73-year model simulation (1922-1994) conducted at the 2001 level of development.

In *Peer Review Response,* DWR and USBR (2004) conclude the concern about overestimations of south-of-Delta deliveries is unwarranted because the 73-year study referenced by the panel is not designed to mimic historical conditions; rather it is intended to determine the reliability of the SWP when the demand equals the maximum Delta Table A amount (4.133 maf) every year. The results of the referenced study are documented in *The SWP Delivery Reliability Report 2002* (DWR 2003a) as study 3 (2021B).

A more appropriate method for assessing the ability of CalSim II to accurately model SWP operations is to compare the historical SWP deliveries with the simulated deliveries of the Historical Operations Study. DWR committed to conducting this study in *The SWP Delivery Reliability Report 2002* (DWR 2003a). The study is documented in the November 2003 Technical Memorandum Report *CALSIM-II Simulation of Historical SWP/CVP Operations* (DWR 2003b). The Historical Operations Study is designed to assess the ability of CalSim II to mimic historical operations of the SWP. In this study, historical input is used where reliable data are available. In situations where reliable historical record is not readily available, reasonable assumptions and estimates are made.

Comparing the average annual historical deliveries with the simulated deliveries in the Historical Operations Study for the dry period shows reasonable results: The average annual SWP south-of-Delta Table A delivery for the 6-year drought of 1987-1992 is 1,930 taf per year, compared to 2,030 taf per year for actual historical deliveries (Figure 3-1). Figure 3-1 compares the simulated Table A deliveries with the actual Table A deliveries for calendar years 1987 through 1992. Although the averages are close, the annual differences between the simulated and actual values can be large. This illustrates that the results of CalSim II analyses are best used for estimating SWP performance over longer periods of time and that considerable judgment must be used when analyzing a specific year. Figure 3-1 replaces the figure contained in the draft of this report which showed the calculated annual delivery amounts would be very close to the

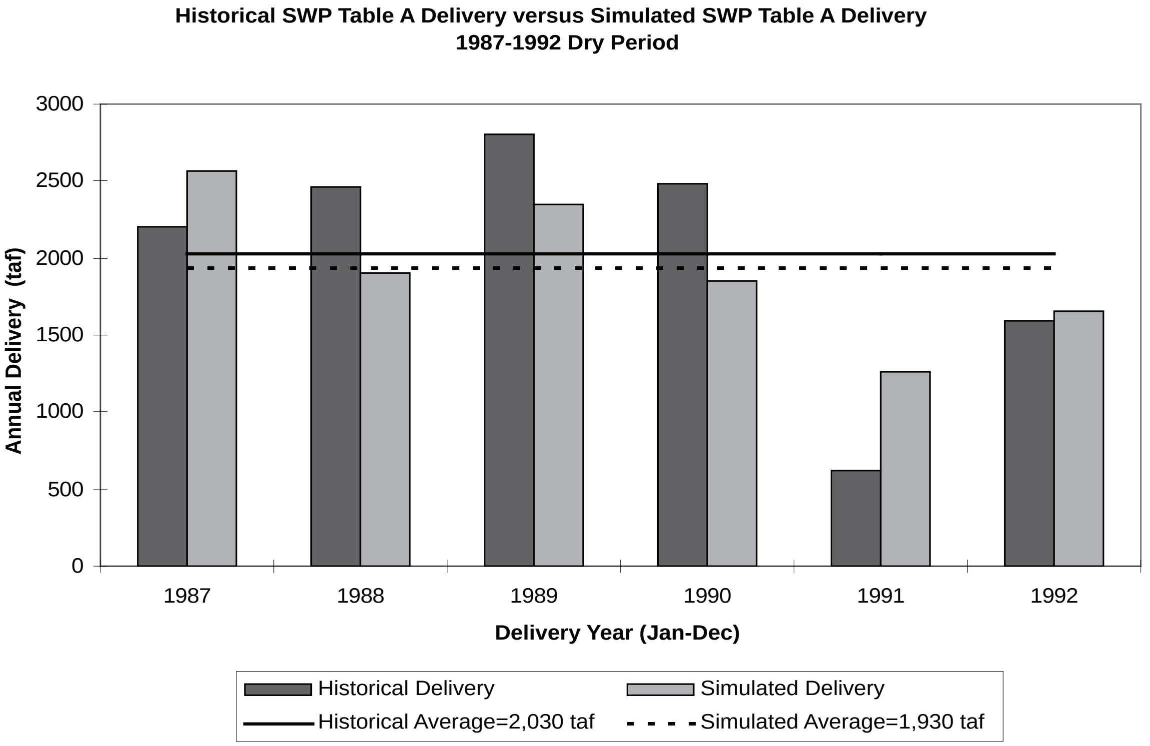

Figure 3-1 SWP south-of-Delta Table A deliveries (1987-1992 dry period)

actual annual delivery amounts, if SWP reservoir storages were adjusted to match the historical values. Additional discussion on this subject is contained in the response to the comment letter from the Planning and Conservation League (Appendix G, Comment Letters on the Draft Report and the Department's Responses).

The observed differences in the annual historical and simulated deliveries can be attributed to differences in the operational rules and parameters assumed in the simulation run. Some of the major operational parameters that could be different between the model run and the actual historical operations include the rule governing the amount of delivery versus the amount of storage to be carried-over into the following year (delivery-carryover storage rule), flood control rules, San Luis Reservoir operation rule, Delta outflow requirements, regulatory decisions, Delta export curtailments caused by pumping facilities outages or compliance with state and federal endangered species regulations, compliance with the provisions of the Coordinated Operations Agreement, implementation of a drought water bank, and water transfers.

In the wetter years (above-normal and wet year-types), when supply is plentiful and deliveries are mostly determined by demands, the simulated deliveries are very close to historical values. When long-term values are compared, the average annual delivery for the SWP during the 23-year period of 1975-1997 is 1,810 taf per year for the Historical Operations Study and 1,790 taf per year for the historical deliveries.

Additional details of this study are in Appendix E.

CalSim II Sensitivity Analysis Study

The sensitivity analysis is an important component of any water resources planning model evaluation. The sensitivity analysis procedures explore and quantify the impact of possible errors in input data on the model outputs and system performance measures. With a simple sensitivity analysis procedure, errors in model input parameters are generally investigated one at a time. With a more complex procedure, the investigation can be conducted by varying a set of parameters simultaneously. In the sensitivity analysis conducted in response to the recommendations in the *Strategic Review* (Close and others 2003), the simple procedure was adopted and errors in model input parameters were investigated one at a time. The objective of the analysis was twofold: (1) to examine the behavior of the model in response to variations in selected input parameters; (2) to provide a basis for CalSim II modelers for prioritizing future model development activities. The *CalSim-II Model Sensitivity Analysis* is available at website http://baydeltaoffice.water.ca.gov/index.cfm.

There are many input parameters used in the CalSim II model to define the physical characteristics of the system, as well as the regulatory environment and operational characteristics. Some input parameters are in the form of time series or monthly distribution curves, and others are simply single values. Some input parameters are estimated from the historical data, and others are values developed or calibrated by users. After consultation with model developers and project operators, 21 model input parameters in four major categories with reasonable ranges of variations were selected for this sensitivity analysis study. The results of the sensitivity analysis are given in more detail in Appendix E.

Examination of the results of the sensitivity analysis provides the following information on the behavior of the SWP system's delivery capability with respect to some of the key input parameters:

- The most significant input parameters affecting SWP Table A Delta deliveries are the assumed SWP Table A demands and the monthly Delta diversion limits applied to Banks Pumping Plant. The results show the long-term average annual SWP Table A Delta deliveries between 3.0 maf to 3.5 maf increase by 0.54 acre-foot for every acre-foot increase in Table A demands. The increase is 0.33 acre-foot for every acre-foot of increase in Table A demands for the range between 3.5 maf per year and 3.9 maf per year.
- Also, the long-term average annual SWP Table A Delta deliveries decrease by 0.48 acre-foot for every 1 acre-foot per month decrease in the monthly Delta diversion limits applied to Banks Pumping Plant during the March 16 to December 14 period. This sensitivity study evaluates a 5 percent reduction in the capacity during this period.
- Inflow to Lake Oroville displays a moderate impact on the SWP Table A Delta deliveries. The long-term average annual SWP Table A Delta deliveries increase by 0.20 acre-foot for every acre-foot increase in annual Oroville inflows.
- The effect of changing SWP contractors' demands for Article 21 water on Article 21 deliveries is high, as expected. The results show that for every acre-foot of change in the peak monthly demands for Article 21 water in the range between 134 taf per month and 400 taf per month, the long-term average annual Article 21 deliveries increase by 0.27 acre-foot.

Examples of parameters not significantly influencing the estimates for SWP Delta deliveries include the projected land use in the source areas and inflow into Lake Shasta and Folsom Reservoir.

Impact of Model Simulation Time-step in Estimating Projects Average Deliveries

In general, the delivery reliability of the SWP is assessed using monthly time-step CalSim II simulations. Monthly time-step simulations implicitly assume that daily hydrologic variability combined with daily physical and regulatory operating constraints are not significant to the forecast of expected average annual deliveries. In other words, it is assumed that a study with monthly inflows, reservoir releases, exports, and associated constraints would produce the same long-term average annual deliveries as a study where inflows, releases, exports, and associated constraints vary on a daily basis.

To confirm the above assumption, results were examined from a recently completed, simplified, daily time-step CalSim II simulation conducted for the California Bay-Delta Authority's Surface Storage Investigations. The assumptions for the baseline monthly and daily time-step simulations are documented in the draft report "Interim Common Model Package, Modeling Protocol and Assumptions" (CALFED 2005). The daily variability appears to have only minor impacts on SWP Table A deliveries. The results show the long-term average annual SWP Table A delivery is increased by 0.3 percent and the average annual deliveries during two 6-year droughts (1929-1934 and 1987-1992) is increased by 0.8 percent in the daily simulation.

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Chapter 4. Computer Simulation Assumptions

The selection of the assumptions and factors that go into the estimation of future water delivery reliability is very important and must be tailored to the particular water supplier. Assumptions and factors for the State Water Project focus on Sacramento and San Joaquin river basin precipitation; water rights and uses; SWP storage and conveyance facilities, including diversion facilities in the Delta; SWP service area demand; and the statutes, regulations, and contractual provisions that govern and regulate the SWP, including coordinating operations with the federal Central Valley Project (CVP). A detailed list of the study assumptions for this report is found in Appendix A.

The results of five computer simulations are included in this report. Studies 1, 2, and 3 are from the *The State Water Project Delivery Reliability Report 2002* (DWR 2003). The results of studies 1, 2 and 3 are included in this report for comparison purposes. Studies 4 and 5 are updated studies conducted specifically for this report. A significant difference between the updated studies and the earlier studies is the assumed demands for SWP Table A and Article 21. Article 21 refers to a section of the water supply contracts that allows additional water to be delivered under certain conditions (see Chapter 5 for further discussion).The assumed demands for studies 4 and 5 were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with the environmental documentation for the Monterey Agreement. The demands developed for studies 4 and 5 are within the range covered under the current SWP biological opinions.

The assumptions for the studies differ in three main categories: the assumed level of water use in the source areas (the level of development), the assumed SWP Table A and Article 21 demands, and the base model assumptions. These categories are summarized in Table 4-1.

Table 4-1 Key study assumptions

Study	Study name	Level of development (year)	SWP Table A demand (maf/year)	SWP Article 21 demand (taf/month)	Model version
SWP Delivery Reliability Report (2003)					
1	2001 Study	2001	3.0–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
2	2021A Study	2021	3.3–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
3	2021B Study	2021	4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
Updated Studies					
4	2005 Study	2005	2.3–3.9	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP
5	2025 Study	2025	3.9–4.1	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP

maf = million acre-feet

OCAP = 2004 Long-Term Central Valley Project Operations Criteria and Plan

taf = thousand acre-feet

The water use estimates for the source areas for 2001 are assumed to be representative of 2005. The water use estimates for the source areas for 2020 are assumed to be representative of 2021 and 2025 conditions.

The SWP contractors' Table A and Article 21 demands for deliveries from the Delta assumed for the five studies are shown in Table 4-1. In four of the studies, a range in Table A demands is shown because the demand is assumed to vary each year with the weather in the delivery areas. In study 3 (2021), the SWP Table A demand is maximized each year, regardless of weather. Article 21 deliveries are available on an unscheduled and interruptible basis and are not counted as part of the Table A amount. (See Chapter 5 for more discussion of Article 21.) The Article 21 demand in the updated studies (4 and 5) is higher than the earlier studies for the December through March period.

Two versions of the model are used for these studies as shown in Table 4-1. Studies 1, 2 and 3 are based on the May 2002 benchmark study version. The updated studies (4 and 5) use the most recent version, which was developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP). The assumption differences between the May 2002 benchmark version and the 2004 OCAP version that affect the SWP simulation significantly are listed below. A complete list of the differences in key assumptions is included in Appendix A.

1. Addition of a minimum pumping level at Banks Pumping Plant of 300 cubic feet per second.
2. Addition of flow requirements for flow at the mouth of the Feather River for SWP Settlement Contractors.
3. Delivery-carryover relationship adjusted to reduce delivery targets and increase carryover in critically dry years.
4. Addition of Lake Oroville end-of-September carryover target storage rule.
5. Study 5 assumes the implementation of Freeport Regional Water Project, including modified East Bay Municipal Utility District operations on the Mokelumne River.

All studies assume current SWP Delta diversion limits (often referred to as "Banks Pumping Plant capacity"), existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements.

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Chapter 5.
Study Results

The five CalSim II model studies in this report are described in Chapter 4. Studies 1, 2, and 3 are from the *The State Water Project Delivery Reliability Report 2002* (DWR 2003). Studies 4 and 5 are updated studies conducted specifically for this report. The results of studies 1, 2 and 3 are included in this report for comparison purposes. This chapter contains tables summarizing the estimated delivery amounts of the studies for the entire study period (1922-1994), dry years, and wet years and presents information on the estimated probability of SWP delivery amounts currently and twenty years in the future. The annual values for SWP deliveries estimated by CalSim II for the five studies are listed in tables B-3 through B-7 of Appendix B. These tables also show the annual Table A demands assumed for each study.

The results of the updated studies (4 and 5) are compared to the results of the earlier studies (1, 2 and 3) to identify and explain any significant differences in estimated delivery values. For most values, the differences are not large enough to be significant and are generally caused by differences in the assumed demands. There are, however, significant differences between the updated and earlier studies for the estimated deliveries during 1, 2 and 4-year droughts. These differences are discussed further in "Drought Years." Information from studies 4 and 5 was transmitted to SWP contractors (Notice Number 05-08) in May 2005. Studies 4 and 5 are referred to as studies 6 and 7 in the notice.

Article 21 Deliveries

The studies estimate delivery amounts for Table A and Article 21. As mentioned in Chapter 2, Table A is the contractual method for allocating available supply, and the total of all maximum Table A amounts for deliveries from the Delta is 4.133 million acre-feet (maf) per year. Article 21 refers to a provision in the contracts for delivering water that is available in addition to Table A amounts. (See Appendix C for more detail about Table A and Appendix D for historical delivery amounts.) Article 21 of SWP contracts allows contractors to receive additional water deliveries only under specific conditions. These conditions are:

1. It is available only when it does not interfere with Table A allocations and SWP operations;
2. It is available only when excess water is available in the Delta;
3. It is available only when conveyance capacity is not being used for SWP purposes or scheduled SWP deliveries; and
4. It cannot be stored within the SWP system. In other words, the contractors must be able to use the Article 21 water directly or store it in their own system.

Water supply under Article 21 becomes available only during wet months of the year, generally December through March. Because an SWP contractor must have an immediate use for Article 21 supply or a place to store it outside of the SWP, not all SWP contractors can take advantage of this additional supply.

The importance of Article 21 water to local water supply is tied to how each contractor uses its SWP supply. For those SWP contractors who are able to store their wet weather supplies, Article 21 supply can be stored by being put directly into a reservoir or by offsetting other water that would have been withdrawn from storage, such as local groundwater. In the absence of storage, Article 21 water is not likely to contribute significantly to local water supply reliability. Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts, and level of water supply reliability required.

Table 5-1 SWP Table A demand from the Delta

Study	Average demand		Maximum demand		Minimum demand	
	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)
SWP Delivery Reliability Report (2003):						
1. 2001 Study	3,712	90%	4,114	100%	3,007	73%
2. 2021A Study	4,026	97%	4,133	100%	3,343	81%
3. 2021B Study	4,133	100%	4,133	100%	4,133	100%
Updated Studies:						
4. 2005 Study	3,290	80%	3,862	93%	2,321	56%
5. 2025 Study	4,110	99%	4,133	100%	3,898	94%

Maximum Delta Table A is 4.133 million acre-feet per year

This report presents information on Article 21 water separately, so local agencies can determine whether it is appropriate to incorporate this supply into their analyses.

SWP Water Deliveries under Different Hydrologic Scenarios

Tables 5-1 and 5-2 summarize the assumed Table A demands for the updated (4 and 5) and the earlier (1, 2, and 3) studies and the resulting estimates for SWP deliveries. Table 5-3 presents information on the assumed Article 21 demand and the estimated Article 21 deliveries. Tables 5-4 through 5-8 summarize values for dry and wet hydrologic periods. The estimated probabilities for a given amount of annual SWP delivery are presented in Figures 5-1 and 5-2.

Assumed Table A Demands

The average, maximum, and minimum Table A demands from the Delta for the five studies are shown in Table 5-1. Study 4 has lower assumed demands than study 1. The average demand for study 4 is 80 percent of maximum Table A compared to 90 percent of maximum Table A for study 1. The primary reason for the lower demand in study 4 is that it includes a new set of annual Table A demands for the Metropolitan Water District of Southern California (MWDSC) prepared specifically for 2003 conditions by MWDSC. The average demand for study 5 is 99.4 percent of maximum Table A and is very similar to study 3. The annual assumed demand for study 5 is less than maximum Table A in only seven wet years due to the assumption that some Table A deliveries would be replaced by supplies from the Kern River.

As explained in Chapter 2 and Appendix C, the maximum Table A amounts for the 26 contractors which receive their supply from the Delta total 4.133 maf. The demands for studies 1 and 4 assume slightly earlier conditions when the maximum Table A amounts totaled slightly less than 4.133 maf (4.114 maf and 4.112 maf, respectively). To simplify the use of this report, the calculation of demand or delivery in percent of maximum Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies. This simplification has no significant effect on the annual delivery percentages for studies 1 and 4. Additional information can be found in Appendix B.

Table A and Article 21 Deliveries

Table 5-2 contains the average, maximum, and minimum estimates of Table A deliveries from the Delta for the five studies. Comparing the relevant updated and earlier studies shows the averages of the estimated delivery percentages and the maximum estimated deliveries do not vary significantly. Study 4 has an average delivery of 68 percent of maximum Table A compared to 72 percent for study 1. This lower delivery under current conditions is due to the lower demand level assumed for study 4. The slightly higher average delivery of 77 percent for study 5 compared to 75 percent for study 2 is attributed to the higher demand assumed for study 5 and to differences in modeling assumptions as summarized in Chapter 4 and listed in Appendix A. The average delivery for study 5 is one percentage

Table 5-2 SWP Table A delivery from the Delta

Study	Average delivery		Maximum delivery		Minimum delivery	
	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)
SWP Delivery Reliability Report (2003):						
1. 2001 Study	2,962	72%	3,845	93%	804	19%
2. 2021A Study	3,083	75%	4,128	100%	830	20%
3. 2021B Study	3,130	76%	4,133	100%	830	20%
Updated Studies:						
4. 2005 Study	2,818	68%	3,848	93%	159	4%
5. 2025 Study	3,178	77%	4,133	100%	187	5%

Maximum Delta Table A is 4.133 million acre-feet per year.

point higher than study 3 even though study 3 has a slightly higher demand. This slightly higher value for study 5 is due to differences in modeling assumptions.

Comparing the updated studies (2005 versus 2025 study levels) shows study 5 has an average delivery of 77 percent of maximum Table A compared to 68 percent for study 4, an increase of 9 percent. This average increase in delivery is due to the higher demand assumed for study 5. Although the average amount (quantity) of delivery is shown to increase over time, the ability of the SWP to meet the assumed demands decreases over time. The responses from the Department to the comments of the Coachella Valley Water District and the Planning and Conservation League in Appendix G discuss this subject in more detail.

The difference between the earlier studies and the updated studies for the estimated minimum Table A delivery is significant. The updated studies have a minimum delivery of 4 percent to 5 percent of maximum Table A compared to 19 to 20 percent for the studies in the *SWP Delivery Reliability Report 2002* (DWR 2003). The lower minimum delivery is primarily due to modification of the delivery-carryover storage rule. Compared to the rule used for the earlier studies, the modified rule reduces delivery by about 80 percent whenever carryover storage (sum of the end-of-September storages of Oroville Reservoir and the SWP share of San Luis Reservoir) is projected to be less than about 860 thousand acre-feet (taf). The modified rule was developed in coordination with the DWR's SWP Operations Control Office to meet the primary objective of reducing the number of years storage in Oroville Reservoir reaches a very low level. The minimum delivery occurs in 1977, the driest year in the 73-year simulation. A closer look at this estimation is done later in this chapter. It applies reasonable assumptions about the amount of Table A deliveries carried-over in San Luis Reservoir from the previous year by SWP contractors and the use of storage in San Luis Reservoir to illustrate how the estimate could be adjusted to 20 percent of maximum Table A while not reducing storage in Oroville Reservoir.

Average Article 21 demands and average, maximum, and minimum Article 21 deliveries for the five studies are shown in Table 5-3. All studies have the same Article 21 demand from April through November. The updated studies (4 and 5) assume a 200 taf increase in Article 21 demand for the period December through March compared to the earlier studies (50 taf per month).

The average Article 21 delivery for study 4 is 260 taf per year, an increase of 130 taf per year from the study 1 average delivery of 130 taf per year. This increase in delivery is a result of the increase in Article 21 demand of 200 taf per year in studies 4 and 5 and also due to the decrease in Table A demand in study 4 compared to study 1. Study 5 has an average Article 21 delivery of 120 taf per year, 40 taf per year more than study 2 and 50 taf per year more than study 3. These increases are the result of the higher assumed Article 21 demand.

Table 5-3 SWP Article 21 demand and delivery from the Delta (taf per year except as noted)

Study	Average Article 21 demand		Total	Annual delivery from the Delta		
	Dec-Mar	Apr-Nov		Average	Maximum	Minimum
SWP Delivery Reliability Report (2003):						
1. 2001 Study	504	607	1,111	130	510	0
2. 2021A Study	504	607	1,111	80	400	0
3. 2021B Study	504	607	1,111	70	400	0
Updated Studies:						
4. 2005 Study	704	607	1,311	260	1,110	0
5. 2025 Study	704	607	1,311	120	550	0

Delivery numbers rounded to the nearest 10,000 acre-feet.

Table 5-4 SWP average and dry year Table A delivery from the Delta

Study	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
SWP Delivery Reliability Report (2003):						
1. 2001 Study	72%	19%	48%	37%	41%	40%
2. 2021A Study	75%	20%	44%	39%	40%	41%
3. 2021B Study	76%	20%	44%	39%	40%	41%
Updated Studies:						
4. 2005 Study	68%	4%	41%	32%	42%	37%
5. 2025 Study	77%	5%	40%	33%	42%	38%

Drought Years

Table 5-4 includes estimates of water deliveries under an assumed repetition of historical drought periods for the five studies. The years are identified as dry by the Eight River Index, a good indicator of the relative amount of water supply available to the SWP. The Eight River Index is the sum of the unimpaired runoff from the four rivers in the Sacramento Basin used to define water conditions in the basin plus the four rivers in the San Joaquin Basin, which correspondingly define water conditions in that basin. The eight rivers are the Sacramento, Feather, Yuba, American, Stanislaus, Tuolumne, Merced, and San Joaquin. Table 5-4 also includes the average deliveries for comparison purposes.

As discussed earlier in conjunction with the minimum deliveries shown in Table 5-2, the single-year drought deliveries for the updated studies are estimated at 4 percent to 5 percent of maximum Table A compared to 19 to 20 percent for the studies in the *SWP Delivery Reliability Report 2002* (DWR 2003). The 2-year drought average annual delivery decreases from 48 percent for study 1 to 41 percent for study 4. Similarly, study 5 delivery decreases to 40 percent as compared to 44 percent for studies 2 and 3. The results for a 4-year drought show a 5 percent decrease in delivery for study 4 compared to study 1 and a 6 percent decrease in delivery for study 5 compared to studies 2 and 3, for the same reason. The decreases in each of these cases are primarily due to modification of the delivery-carryover storage rule as discussed earlier.

For the updated studies, the annual delivery for the single dry year is estimated to be about the same amount whether the dry year happens now or in twenty years. This is also true for estimated annual deliveries during the multi-year drought periods. This is projected to occur even though the amount of reservoir carryover storage resulting from the increased demand is projected to be less. This result is attributable to the operation rules governing the amount of water that must be retained for carryover storage, the fact the SWP demand between 2005 and 2025

Table 5-5 Average and dry year delivery under Article 21 (taf per year)

Year	Study 1	Study 2	Study 3	Study 4	Study 5
	2001	2021A	2021B	2005	2025
1929	0	0	0	0	0
1930	90	30	30	120	140
1931	0	0	0	0	0
1932	200	40	40	240	110
1933	130	10	10	510	550
1934	0	0	0	210	240
1976	110	0	0	190	0
1977	0	0	0	0	0
1987	0	0	0	550	180
1988	0	0	0	0	0
1989	0	0	0	0	90
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	100
1922-1994 average	130	80	70	260	120

Numbers rounded to the nearest 10,000 acre-feet.

increases only slightly, and because less water is made available under Article 21.

Table 5-5 summarizes the estimates of dry year deliveries under Article 21 for the five studies. The updated studies (4 and 5) have higher deliveries than the earlier studies (1, 2 and 3) because of assumed higher Article 21 demand. Also notice the reductions in delivery for studies 2 and 3 compared to study 1 in the years 1930, 1932, 1933, and 1976. These reductions are due to the increase in Table A deliveries. The average values for Article 21 deliveries for Study 5 is lower than study 4, primarily due to the assumed higher Table A demand in study 5.

Wet Years

Tables 5-6 and 5-7 summarize the model run results for historical wet years. As with drought years, the Eight River Index is used to identify the wet years. Because plenty of water is available for deliveries in wet years, variations in Table A delivery are due to variations in the demand assumed for each of the studies.

Table 5-7 contains information about Article 21 deliveries for the wet period 1978-1987. The information illustrates a significant decrease in the availability of Article 21 supply between study 5 and study 4. This is primarily due to the increase in Table A demand. Article 21 deliveries are generally higher in the updated studies (4 and 5) than the earlier studies (1, 2 and 3). This is attributed to the 200 taf per year increase in Article 21 demand assumed for studies 4 and 5. In addition, the increase in Article 21 deliveries for study 4 compared to the study 1 is partially due to the lower Table A demand assumed for study 4.

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for the two current condition studies (1 and 4) in Figure 5-1 and for the three future condition studies (2, 3, and 5) in Figure 5-2. The plot lines in the figures are derived from the study results listed in tables B-3 through B-7. Each line is constructed by ranking the 73 annual Table A delivery values of the relevant study from lowest to highest and calculating the percentage of values equal to or greater than the delivery value of interest. For example, for study 4 in Figure 5-1, the value of 3.3 maf is in the 30 percent position of the ranking; therefore,

Table 5-6 SWP average and wet year Table A delivery from Delta

Study	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
SWP Delivery Reliability Report (2003):						
1. 2001 Study	72%	73%	79%	80%	80%	80%
2. 2021A Study	75%	82%	89%	86%	87%	84%
3. 2021B Study	76%	100%	100%	91%	91%	87%
Updated Studies:						
4. 2005 Study	68%	60%	65%	69%	75%	72%
5. 2025 Study	77%	95%	97%	93%	93%	89%

Table 5-7 Average and wet year delivery under Article 21 (taf per year)

Year	Study 1	Study 2	Study 3	Study 4	Study 5
	2001	2021A	2021B	2005	2025
1978	100	100	100	300	300
1979	140	90	100	160	140
1980	100	70	80	140	90
1981	120	0	0	550	70
1982	390	100	60	800	170
1983	200	200	160	400	360
1984	410	380	370	550	490
1985	0	0	0	0	0
1986	50	50	60	120	80
1987	0	0	0	550	180
1922-1994 average	130	80	70	260	120

Numbers rounded to the nearest 10,000 acre-feet.

it is equaled or exceeded by 30 percent (about 22) of the 73 delivery values. The delivery value of 0.16 maf, the minimum value for study 4, is equaled or exceeded by all of the delivery values.

The curve for study 4 is generally lower than study 1 due to assumed lower annual demands. Neither curve reaches 100 percent because the assumed annual demands are 100 percent (99.5 percent) of the maximum Delta Table A in only two years for study 1 and the assumed maximum demand for study 4 is 93 percent of the maximum Delta Table A. In study 1, the two years with demand at 100 percent are dry years so delivery of 100 percent is not possible. The divergence of the two curves for the minimum delivery amounts (100 percent probability of being equaled or exceeded) is due to modification of the delivery-carryover storage rule.

Study 5 shows higher deliveries than study 3 for delivery values exceeded by up to 70 percent of the values, and mostly lower deliveries for values exceeded by 80 to 100 percent of the values. Because the assumed demands are nearly the same for these two studies, the delivery differences between study 5 and study 3 are primarily due to modification of the delivery-carryover storage relationship. The delivery-carryover relationship assumed in study 5 allows less delivery than study 3 in dry years which results in higher carryover storage and higher deliveries in normal to above normal years. Study 5 deliveries reach 100 percent 26 percent of the time, the highest percentage for the five studies.

The amount of SWP Table A delivery per year, either in percent of maximum Delta Table A or in thousand acre-feet, associated with a

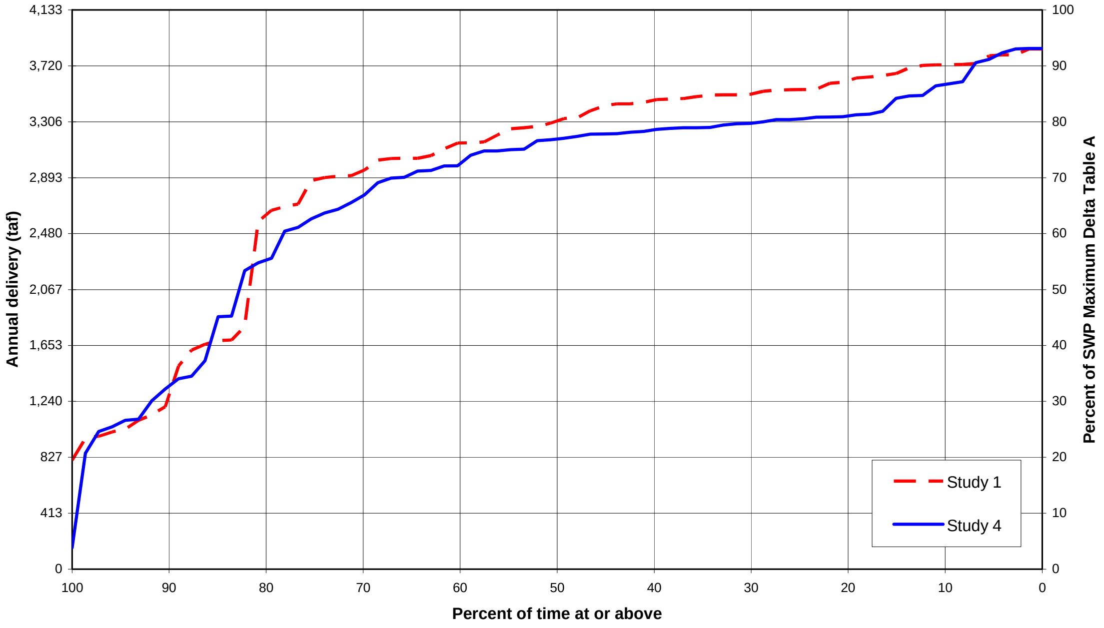


Figure 5-1 SWP Delta Table A delivery probability for year 2005

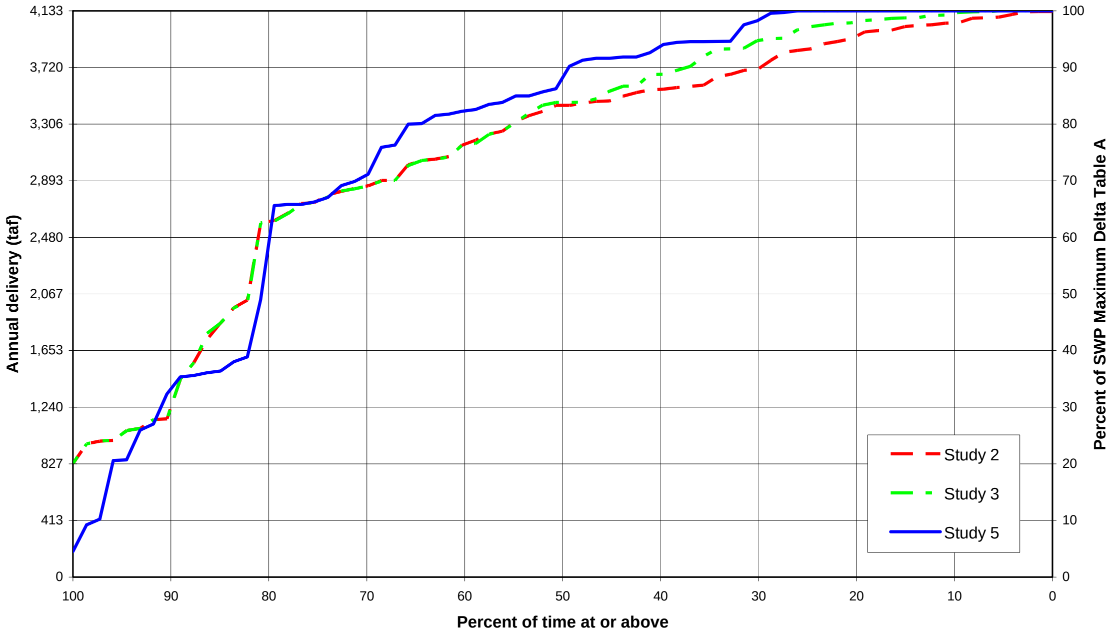


Figure 5-2 SWP Delta Table A delivery probability for year 2025

specific degree of reliability can be estimated from Figures 5-1 and 5-2 for 2005 and 2025 conditions, respectively. The study 4 curve in Figure 5-1 is recommended to be used to represent 2005 conditions, and the study 5 curve in Figure 5-2 is recommended to be used to represent 2025 conditions. By referencing the curve for study 5 in Figure 5-2, the following can be deduced:

- In 75 percent of the years, the annual water delivery of the SWP is estimated to be at or above 2.70 maf per year (65 percent of 4.13 maf).

- In 50 percent of the years, it is estimated to be at or above 3.50 maf per year (85 percent of 4.13 maf).
- In 25 percent of the years, it is at 4.13 maf per year.

Figures 5-1 and 5-2 depict the estimated reliability for the total of SWP deliveries. Under conditions when almost all contractors are requesting their maximum Table A, such as study 5, this information can be directly applied to individual long-term water supply contracts for the SWP. For example, if a water agency has a maximum SWP Table A amount of 400 taf, at least 260 taf per year (65 percent of 400 taf) is estimated to be delivered 75 percent of the time.

Potential Adjustments to 1977 CalSim II Table A Deliveries

The CalSim II model, a planning model, is best used for estimating SWP performance over long periods of time. Considerable judgment should be applied when evaluating CalSim II results for shorter periods of time. This is especially true for estimates for a single year. The updated studies (studies 4 and 5) show that the changes in the operations criteria assumed for the SWP produce a delivery estimate of about 5 percent of maximum Delta Table A for the driest year on record (1977). This estimate is lower than the amount actually delivered from the Delta in 1977 (733 taf, 18 percent of maximum Delta Table A), as well as lower than what was shown in *SWP Delivery Reliability Report 2002* (DWR 2003). The discussion below presents some adjustments contractors may consider in estimating Table A deliveries under weather conditions similar to 1977.

In order to understand what led to the lower delivery estimates for 1977, it is best to start with 1975. The year 1975 is a wet year and is immediately followed by two critically dry years (1977 being the driest year on record during the last 80 years of historical hydrology). SWP Table A deliveries estimated in study 4 for 1975, 1976, and 1977 are 3.23 maf, 3.27 maf, and 159 taf, respectively. For study 5 the respective deliveries are 4.13 maf, 3.14 maf, and 187 taf. As currently practiced and allowed under the SWP water supply contracts, many of the contractors would carry over a portion of their allocated Table A water during 1975 and 1976 to succeeding years. In the case of 1977, it is reasonable to assume that up to 500 taf of 1976 allocated Table A water could be carried over to 1977. In addition, due to the slightly conservative delivery-carryover rule curve used in these studies, the minimum SWP storage in San Luis Reservoir for 1977, which occurs during the June-August period, averages about 190 taf for both studies 4 and 5. The minimum pool for the SWP share of San Luis Reservoir is just over 40 taf. In a year as critically dry as 1977, it is also reasonable to assume an additional 150 taf would be made available for deliveries bringing the SWP storage in San Luis Reservoir to minimum pool. After August, the SWP storage in San Luis Reservoir begins to rise. It is reasonable to expect additional deliveries to be made in the September-December period.

In summary, under the hydrologic conditions similar to a critically dry year like 1977, project deliveries can be expected to range from 4 or 5 to 20 percent of Table A, depending upon such factors as the delivery-carryover risk curve applied by SWP operators and the amount of allocated Table A water carried over from the previous year by SWP contractors.

Additional Analysis of Tables B-3 through B-7 in Appendix B

The information presented earlier in this chapter is helpful in analyzing the delivery reliability of a specific water system receiving a portion of its water supply from the SWP. In addition, the series of data contained in tables B-3 through B-7 are very helpful in analyzing longer periods of time that contain not only dry periods but wetter periods, which can replenish local water supplies if there is a place to store the supply. Analysis of this information can help determine if a local agency has adequate storage for capturing these supplies or if more storage could be utilized in the local water system.

Cited Reference

[DWR] California Department of Water Resources, Bay-Delta Office. 2003. The State Water Project Delivery Reliability Report 2002. Final.

Chapter 6. Examples of How to Apply Information

The following two examples illustrate how to use the information presented in this report to develop water supply assessments for a hypothetical SWP contractor. Hypothetical examples illustrating applications of the delivery probability curves and adjustments to the data for a SWP contractor that cannot convey its maximum Table A amount are provided in *The State Water Project Delivery Reliability Report 2002*. Questions regarding the use of the information contained in these reports may be directed to the Department of Water Resources' Bay-Delta Office at (916) 653-1099.

Example 1

This example uses data directly from Table 5-4 for studies 4 and 5, and employs an allocation methodology that provides a simple means of estimating supplies to each contractor. The data in the table is interpolated for 5-year increments and contained in Table 6-1. In all but the average values in Table 6-1, the estimated percentages of Table A deliveries for the 2005 and the 2025 levels of development differ by one percentage point only. Interpolation between these values is shown in this example for illustration purposes. When values are this close, a valid alternative approach would be to use the same percentage value throughout the entire twenty-year period.

Although the percentage values are calculated using the maximum Delta Table A value, they may be directly applied to generate estimates for SWP deliveries for the entire 20-year period. This is because the Delta Table A value for 2005 is 4.114 maf/yr, 99.5 percent of the maximum Delta Table A value of 4.133 maf/yr. For comparison purposes, the percentage values for studies 1 and 4 based upon a full Table A value of 4.113 maf/yr and 4.133 maf/yr are listed in Tables B-3 and B-6. In addition, the percentages may also be used to estimate the Table A deliveries to SWP contractors in Butte and Plumas counties and Yuba City. The deliveries to these contractors would be calculated using the same method described below.

Table 6-1 shows the average percentage of maximum Delta Table A deliveries for average, single-dry year, and 2-, 4-, and 6-year multiple dry year scenarios from 2005 to 2025 in five-year increments. The maximum Table A amounts of each contractor are listed in Appendix C. Note that Table A amounts can be amended and a contractor's Table A amount over the next 20 years may be less than its maximum over some or all of this period. In this case, the contractor should use the amended Table A amounts for the corresponding years during this period. To use dry years other than those presented in Table 6-1, or to show year-to-year supplies instead of

Table 6-1 SWP average and dry year Table A delivery from the Delta in five-year intervals for studies 4 and 5

Year	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005	68%	4%	41%	32%	42%	37%
2010	70%	4%	41%	32%	42%	37%
2015	73%	4%	41%	33%	42%	37%
2020	75%	4%	41%	33%	42%	37%
2025	77%	5%	40%	33%	42%	38%

Tables for Example 1

Average Annual Values (acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	68,000	70,000	73,000	75,000	77,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1] Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 5.

Single Dry Year
1977 conditions
(acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	4,000	4,000	4,000	4,000	5,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period
1931-1934 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	32,000	32,000	33,000	33,000	33,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1] Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 5.

averages over a multiple-dry year period, see Example 2.

How to calculate supplies:

Multiply the contractor's Table A amount for a particular year by the corresponding delivery percentages for that year from Table 6-1 to get an estimated delivery amount, for the average and drought periods, for each 5 year increment from 2005 to 2025.

The example tables show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum Table A amount of 100,000 af, on average and for the various drought periods. For this example, the supplies shown for the multiple-dry year period are average supplies over the four-year drought from 1931-1934. Data from other year types, although not required in an urban water management plan, could also be presented this way.

Example 2

This example is similar to Example 1 but allows a contractor to select alternative single year or multiple-dry year sequences other than those presented in Table 6-1. This option might be selected if analyzing different hydrologic year(s) makes more sense given a contractor's other supply sources, or given the locally acceptable risk level for water delivery shortages.

This example can also be used to identify supplies projected to be available in each year of a multiple-dry year period. While the Water Code does not specifically require this, the *Urban Water Management Plan Guidebook* suggests showing year-to-year supplies (see the *UWMP Guidebook*, Section 7, Step 3).

Where to find the data

Choose a single year or multiple-year sequence from Tables B-6 and B-7 to represent single-dry year and multiple-dry year scenarios. Table B-6 contains the percent of maximum Table A deliveries under all 73 hydrologic years in the updated model study for 2005. Table B-7 contains the percent of maximum Table A deliveries under all 73 hydrologic years in the updated model study for 2025.

How to calculate supplies

Multiply the contractor's Table A amount for a particular year by the percent of maximum Table A deliveries for the selected years, to get an estimated delivery amount for the years selected, for 2005 and 2025. Values for years between 2005 and 2025 can be linearly interpolated.

The following tables show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum Table A amount of 100,000 af, in a single dry year and year-to-year over a multiple dry year period. For this example, the single dry year selected is for 1988 conditions, and the multiple dry year period selected is the three-year period from 1990-1992. In showing year-to-year supplies for the multiple dry year period, these year-to-year supplies should be shown for each five-year increment during the 20-year projection period.

Tables for Example 2

Single Dry Year
1988 conditions
(acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	21,000	18,000	15,000	13,000	10,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Tables for Example 2 (cont.)

Multiple Dry Year Period 1990-1992
1990 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	27,000	25,000	24,000	22,000	21,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1991 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	25,000	24,000	23,000	22,000	21,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1992 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	34,000	34,000	35,000	35,000	35,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Appendix A. 2005 Delivery Reliability Report CalSim II Modeling Assumptions

Two versions of the model are used for this report. Studies 1, 2 and 3 are based on the May 2002 benchmark study version. The updated studies (4 and 5) use the most recent version, which was developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP). The key assumption differences between the May 2002 benchmark version and the 2004 OCAP version are listed below.

1. Temperature flow below Keswick Dam was changed from a fixed time series flow to a dynamic storage dependent flow.

2. Relaxation of criteria for flow below Nimbus Dam when Folsom Lake storage drops below 300 thousand acre-feet.

3. Navigation control point flow criteria were modified from being dependent on water year type to being dependent on CVP agricultural allocation levels. Criteria were also relaxed for very low allocation years.

4. Clear Creek Tunnel target flows were modified to match the latest Trinity EIR analysis.

5. Addition of a minimum pumping level at Banks Pumping Plant of 300 cubic feet per second.

6. Addition of a minimum pumping level at Tracy Pumping Plant of 600 cubic feet per second.

7. Addition of flow requirements for flow at the mouth of the Feather River for Settlement Contractors.

8. Delivery-carryover relationship was adjusted to reduce delivery targets and increase carryover in critically dry years.

9. Addition of Lake Oroville end-of-September carryover target storage rule.

10. Five-step study setup modified to isolate (b)(2) accounting from “with Project” conditions.

11. Modification of American River demands as described in Tables A-2 and A-3.

12. Modification of Contra Costa Water District demands to include the effect of Los Vaqueros Reservoir operations.

13. The minimum flow of the Trinity River below Lewiston Dam in study 4 ranges from 369 to 453 thousand acre-feet per year depending on water year type. All other studies used in this report assume the Trinity River minimum flow has a greater range from 369 to 815 thousand acre-feet per year. This greater range of Trinity River minimum flows represents the Trinity Environmental Impact Statement Preferred Alternative.

14. Study 5 assumes the implementation of Freeport Regional Water Project, including modified East Bay Municipal Utility District operations on the Mokelumne River.

15. Implementation of May 2003 CVPIA 3406 (b)(2) decision and other changes:
    a. Streamlining actions to simplify analysis of the results.

   b. Anadromous Fish Restoration Program table updates to better represent management of (b)(2) water under the May 2003 (b)(2) decision.
   c. Action triggering modifications to attempt to meet 200 thousand-acre feet target during October through January period.

16. Environmental Water Account (EWA) changes include:
    a. Streamlining actions and coordination with (b)(2) actions.
    b. EWA purchase amount increase to a maximum of 250 thousand acre-feet per year.
    c. Addition of storage debt carryover accounting, including debt spill at San Luis Reservoir.
    d. Addition of EWA asset takeover by SWP and CVP at San Luis Reservoir when reservoir space utilized by EWA is needed for project operations.

All studies assume current Banks Pumping Plant capacity, existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements.

The following table is a complete list of the study assumptions.

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
Period of Simulation	73 years (1922-1994)	Same	Same	Same	Same
HYDROLOGY					
Level of Development (Land Use)	2001 Level, DWR Bulletin 160-98[1]	Same as Study 1	2020 Level, DWR Bulletin 160-98	Same as Study 2	Same as Study 2
Demands					
North of Delta (except American River)					
CVP	Land Use based, limited by Full Contract	Same	Same	Same	Same
SWP (FRSA)	Land Use based, limited by Full Contract	Same	Same	Same	Same
Non-Project	Land Use based	Same	Same	Same	Same
CVP Refuges	Firm Level 2	Same	Same	Same	Same
American River Basin					
Water rights	2001[2]	2001[3]	2020[4]	Same as Study 2	2020, as projected by Water Forum Analysis[5]
CVP	2001[2]	2001[3]	2020[6]	Same as Study 2	202 0, as projected by Water Forum Analysis[7]
San Joaquin River Basin					
Friant Unit	Regression of historical	Same	Same	Same	Same
Lower Basin	Fixed annual demands	Same	Same	Same	Same
Stanislaus River Basin	New Melones Interim Operations Plan	Same	Same	Same	Same
South of Delta					
CVP	Full Contract	Same	Same	Same	Same
CCWD	143 TAF/YR[8]	124 TAF/YR[8]	151 TAF/YR[8]	Same as Study 2	158 TAF/YR[8]

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
SWP (w/ North Bay Aqueduct)	3.0-4.1 MAF/YR	2.3-3.9 MAF/YR	3.3-4.1 MAF/YR	4.1 MAF/YR	3.9-4.1 MAF/YR
SWP Article 21 Demand	MWDSC up to 50 TAF/month, Dec-Mar, others up to 84 TAF/month	MWDSC up to 100 TAF/month, Dec-Mar, others up to 84 TAF/month	Same as Study 1	Same as Study 1	Same as Study 4
FACILITIES					
Freeport Regional Water Project	None	Same as Study 1	Same as Study 1	Same as Study 1	Included[9]
Banks Pumping Capacity	6680 cfs	Same	Same	Same	Same
Tracy Pumping Capacity	4200 cfs + deliveries upstream of DMC constriction	Same	Same	Same	Same
REGULATORY STANDARDS					
Trinity River					
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/YR)	369-453 TAF/YR	Same as Study 1	Same as Study 1	Same as Study 1
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same	Same
Clear Creek					
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to FWS and NPS, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Upper Sacramento River					
Shasta Lake End-of-September Minimum Storage	SWRCB WR 1993 Winter-run Biological Opinion (1900 TAF)	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
Minimum Flow below Keswick Dam	Flows for SWRCB WR 90-5 and 1993 Winter-run Biological Opinion temperature control, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Feather River					
Minimum Flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 CFS)	Same	Same	Same	Same
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1700 CFS)	Same	Same	Same	Same
American River					
Minimum Flow below Nimbus Dam	SWRCB D-893 (see accompanying Operations Criteria), and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same	Same
Lower Sacramento River					
Minimum Flow near Rio Vista	SWRCB D-1641	Same	Same	Same	Same
Mokelumne River					
Minimum Flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 CFS)	Same	Same	Same	Same
Minimum Flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 CFS)	Same	Same	Same	Same
Stanislaus River					
Minimum Flow below Goodwin Dam	1987 USBR, DFG agreement, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
Minimum Dissolved Oxygen	SWRCB D-1422	Same	Same	Same	Same
Merced River					
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 CFS, Nov-Mar), and Cowell Agreement	Same	Same	Same	Same
Minimum Flow at Shaffer Bridge	FERC 2179 (25-100 CFS)	Same	Same	Same	Same
Tuolumne River					
Minimum Flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/YR)	Same	Same	Same	Same
San Joaquin River					
Maximum Salinity near Vernalis	SWRCB D-1641	Same	Same	Same	Same
Minimum Flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Program per San Joaquin River Agreement	Same	Same	Same	Same
Sacramento River-San Joaquin River Delta					
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same	Same
Delta Cross Channel Gate Operation	SWRCB D-1641	Same	Same	Same	Same
Delta Exports	SWRCB D-1641, FWS use of CVPIA 3406(b)(2) water and CALFED Fisheries Agencies use of EWA assets	Same	Same	Same	Same
OPERATIONS CRITERIA					
Subsystem					
Upper Sacramento River					
Flow Objective for Navigation (Wilkins Slough)	3,500-5,000 CFS based on Lake Shasta storage condition	3,250-5,000 CFS based on CVP Ag allocation levels	Same as Study 1	Same as Study 1	Same as Study 4

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
American River					
Folsom Dam Flood Control	SAFCA, Interim re-operation of Folsom Dam, Variable 400/670 (without outlet modifications)	Same	Same	Same	Same
Flow below Nimbus Dam	Operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	Same	Same
Sacramento Water Forum Mitigation Water	None	Same as Study 1	Sacramento Water Forum (up to 47 TAF/YR in dry years)[10]	Same as Study 2	Same as Study 2
Feather River					
Flow at Mouth	No criteria	Maintain the DFG/DWR flow target above Verona or 2800 cfs for Apr-Sep dependent on Oroville inflow and FRSA allocation	Same as Study 1	Same as Study 1	Same as Study 4
Stanislaus River					
Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same	Same
San Joaquin River					
Flow near Vernalis	San Joaquin River Agreement in support of the Vernalis Adaptive Management Program	Same	Same	Same	Same
System-wide					
CVP Water Allocation					
CVP Settlement and Exchange	100% (75% in Shasta Critical years)	Same	Same	Same	Same
CVP Refuges	100% (75% in Shasta Critical years)	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
CVP Agriculture	100% - 0% based on supply (reduced by 3406(b)(2) allocation)	Same	Same	Same	Same
CVP Municipal & Industrial	100% - 50% based on supply (reduced by 3406(b)(2) allocation)	Same	Same	Same	Same
SWP Water Allocation					
North of Delta (FRSA)	Contract specific	Same	Same	Same	Same
South of Delta	Based on supply; Monterey Agreement	Same	Same	Same	Same
CVP/SWP Coordinated Operations					
Sharing of Responsibility for In-Basin-Use	1986 Coordinated Operations Agreement	Same	Same	Same	Same
Sharing of Surplus Flows	1986 Coordinated Operations Agreement	Same	Same	Same	Same
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641; use of CVPIA 3406(b)(2) only restricts CVP exports; EWA use restricts CVP and/or SWP exports as directed by CALFED Fisheries Agencies	Same	Same	Same	Same
Transfers					
Dry Year Program	None	Same	Same	Same	Same
Phase 8	None	Same	Same	Same	Same
MWDSC/CVP Settlement Contractors	None	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
CVP/SWP Integration					
Dedicated Conveyance at Banks	None	Same	Same	Same	Same
NOD Accounting Adjustments	None	Same	Same	Same	Same
CVPIA 3406(b)(2)	May 2002 benchmark study assumptions	Dept of Interior 2003 Decision	Same as Study 1	Same as Study 1	Same as Study 4
Allocation	800 TAF/YR (600 TAF/YR in Shasta Critical years)	800 TAF/YR, 700 TAF/YR in 40-30-30 Dry Years, and 600 TAF/YR in 40-30-30 Critical years	Same as Study 1	Same as Study 1	Same as Study 4
Actions	AFRP flow objectives (Oct-Jan), CVP export reduction (Dec-Jan), 1995 WQCP (up to 450 TAF/YR), VAMP (Apr 15- May 16) CVP export restriction, Post (May 16-31) VAMP CVP export restriction, Ramping of CVP export (Jun), Pre (Apr 1-15) VAMP CVP export restriction, CVP export reduction (Feb-Mar), Additional Upstream Releases (Feb-Sep)	1995 WQCP, Fish flow objectives (Oct-Jan), VAMP (Apr 15- May 16) CVP export restriction, 3000 CFS CVP export limit in May and June (D1485 Striped Bass continuation), Post (May 16-31) VAMP CVP export restriction, Ramping of CVP export (Jun), Upstream Releases (Feb-Sep)	Same as Study 1	Same as Study 1	Same as Study 4
Accounting adjustments per May 2003 Interior Decision	None	No limit on responsibility for non-discretionary D1641 requirements no Reset with the Storage metric and no Offset with the Release and Export metrics	Same as Study 1	Same as Study 1	Same as Study 4

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 **2001 Study,** **2003 Report**	**Study 4** **2005 Study,** **Updated Studies**	**Study 2** **2021A Study,** **2003 Report**	**Study 3** **2021B Study,** **2003 Report**	**Study 5** **2025 Study,** **Updated Studies**
CALFED Environmental Water Account					
Actions	Total exports restricted to 4,000 cfs, 1 wk/mon, Dec-Mar (wet year: 2 wk/mon), VAMP (Apr 15- May 16) export restriction, Pre (Apr 1-15) and Post (May 16-31) VAMP export restriction, Ramping of export (Jun)	Dec-Feb reduce total exports by 50 TAF/month relative to total exports without EWA; VAMP (Apr 15- May 16) export restriction on SWP; Post (May 16-31) VAMP export restriction on SWP and potentially on CVP if B2 Post-VAMP action is not taken; Ramping of exports (Jun)	Same as Study 1	Same as Study 1	Same as Study 4
Assets	50% of use of JPOD, 50% of any CVPIA 3406(b)(2) or ERP releases pumped by SWP, flexing of Delta Export/Inflow Ratio (not explicitly modeled), dedicated 500 CFS increase of Jul-Sep Banks PP capacity, north-of-Delta (35 TAF/Yr) and south-of-Delta purchases (50-200 TAF/Yr), 100 TAF/Yr from south-of-Delta source shifting agreements, and 200 TAF/YR south-of-Delta groundwater storage capacity	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. The purchases range from 0 TAF in Wet Years to approximately 153 TAF in Critical Years NOD, and 57 TAF in Critical Years to 250 TAF in Wet Years SOD. Variable assets include the following: used of 50% JPOD export capacity, acquisition of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, flexing of Delta Export/Inflow Ratio (post-processed from CalSim II results), dedicated 500 CFS pumping capacity at Banks in Jul-Sep	Same as Study 1	Same as Study 1	Same as Study 4

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	**Study 4 2005 Study, Updated Studies**	**Study 2 2021A Study, 2003 Report**	**Study 3 2021B Study, 2003 Report**	**Study 5 2025 Study, Updated Studies**
Debt restrictions	No planned carryover of debt past Sep, no reset of unpaid debt, debt carried past Sep paid back by Feb	Delivery debt paid back in full upon assessment; Storage debt paid back over time based on asset/action priorities; SOD and NOD debt carryover is allowed; SOD debt carryover is explicitly managed or spilled; NOD debt carryover must be spilled; SOD and NOD asset carryover is allowed.	Same as Study 1	Same as Study 1	Same as Study 4

[1] 2000 Level of Development defined by linearly interpolated values from the 1995 Level of Development and 2020 Level of Development from DWR Bulletin 160-98

[2] 1998 level demands defined in Sacramento Water Forum's EIR with a few updated entries.

[3] Presented in attached Table 2001 American River Demand Assumptions

[4] Sacramento Water Forum 2025 level demands defined in Sacramento Water Forum's EIR.

[5] Presented in attached Table 2020 American River Demand Assumptions

[6] Sacramento Water Forum 2025 level demands defined in Sacramento Water Forum's EIR. Freeport Alternative defined in EBMUD Supplemental Water Supply Project REIR/SEIS.

[7] Same as footnote 5 but modified with PCWA 35 TAF CVP contract supply diverted at the new American River PCWA Pump Station

[8] Delta diversions include operations of Los Vaqueros Reservoir and represents average annual diversion

[9] Includes modified EBMUD operations of the Mokelumne River

[10] This is implemented only in the PCWA Middle Fork Project releases used in defining the CALSIM II inflows to Folsom Lake

Table A-2 2001 American River Demand Assumptions

Location / Purveyor	Allocation Type (maximum acre-feet)					
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total
Auburn Dam Site (D300)						
Placer County Water Agency	0	0	0	8,500	0	8,500
Total	**0**	**0**	**0**	**8,500**	**0**	**8,500**
Folsom Reservoir (D8)						
Sacramento Suburban	0	0	0	0	0	0
City of Folsom (includes P.L. 101-514)	0	0	0	20,000	0	20,000
Folsom Prison	0	0	0	2,000	0	2,000
San Juan Water District (Placer County)	0	0	0	10,000	0	10,000
San Juan Water District (Sacramento County) (includes P.L. 101-514)	0	11,200	0	33,000	0	44,200
El Dorado Irrigation District	0	7,550	0	0	0	7,550
El Dorado Irrigation District (P.L. 101-514)	0	0	0	0	0	0
City of Roseville	0	32,000	0	0	0	32,000
Placer County Water Agency	0	0	0	0	0	0
Total	**0**	**50,750**	**0**	**65,000**	**0**	**115,750**
Folsom South Canal (D9)						
So. Cal WC/ Arden Cordova WC	0	0	0	3,500	0	3,500
California Parks and Recreation	0	100	0	0	0	100
SMUD (export)	0	0	0	15,000	0	15,000
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	0
Canal Losses	0	0	0	1,000	0	1,000
Total	**0**	**100**	**0**	**19,500**	**0**	**19,600**
Nimbus to Mouth (D302)						
City of Sacramento	0	0	0	63,335	0	63,335
Arcade Water District	0	0	0	2,000	0	2,000
Carmichael Water District	0	0	0	8,000	0	8,000
Total	**0**	**0**	**0**	**73,335**	**0**	**73,335**
Sacramento River (D162)						
Placer County Water Agency	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Sacramento River (D167/D168)						
City of Sacramento	0	0	0	38,665	0	38,665
Sacramento County Water Agency (SMUD transfer)	0	0	0	0	0	0
Sacramento County Water Agency (P.L. 101-514)	0	0	0	0	0	0
EBMUD (export)	0	0	0	0	0	0
Total	**0**	**0**	**0**	**38,665**	**0**	**38,665**
Total from the American River	**0**	**50,850**	**0**	**166,335**	**0**	**217,185**

Table A-3 2020 American River Demand Assumptions

Location / Purveyor	Allocation Type (maximum acre-feet)						Folsom Unimpaired Inflow (FUI)			Notes
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total	FUI = Total TAF (Mar – Sep) + 60 TAF			
Auburn Dam Site (D300)										
Placer County Water Agency	0	35,000	0	35,500	0	70,500	70,500	70,500	70,500	1/2/3/12
Total	**0**	**35,000**	**0**	**35,500**	**0**	**70,500**	**70,500**	**70,500**	**70,500**	
Folsom Reservoir (D8)										
Sacramento Suburban	0	0	0	29,000	0	29,000	29,000	0	0	4/5/11
City of Folsom (includes P.L. 101-514)	0	7,000	0	27,000	0	34,000	34,000	34,000	20,000	1/2/3
Folsom Prison	0	0	0	5,000	0	5,000	5,000	5,000	5,000	
San Juan Water District (Placer County)	0	0	0	25,000	0	25,000	25,000	25,000	10,000	1/2/3/11
San Juan Water District (Sac County) (includes P.L. 101-514)	0	24,200	0	33,000	0	57,200	57,200	57,200	44,200	1/2/3
El Dorado Irrigation District	0	7,550	0	17,000	0	24,550	24,550	24,550	22,550	1/2/3
El Dorado Irrigation District (P.L. 101-514)	0	7,500	0	0	0	7,500	7,500	7,500	0	1/2/3
City of Roseville	0	32,000	0	30,000	0	62,000	54,900	54,900	39,800	1/2/3/11/12
Placer County Water Agency	0	0	0	0	0	0	0	0	0	11
Total	**0**	**78,250**	**0**	**166,000**	**0**	**244,250**	**237,150**	**208,150**	**141,550**	
Folsom South Canal (D9)										
So. Cal WC/ Arden Cordova WC	0	0	0	5,000	0	5,000	5,000	5,000	5,000	
California Parks and Recreation	0	5,000	0	0	0	5,000	5,000	5,000	5,000	
SMUD (export)	0	15,000	0	15,000	0	30,000	30,000	30,000	15,000	1/2/3
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	0	0	0	0	1/2/3
Canal Losses	0	0	0	1,000	0	1,000	1,000	1,000	1,000	
Total	**0**	**20,000**	**0**	**21,000**	**0**	**41,000**	**41,000**	**41,000**	**26,000**	
Nimbus to Mouth (D302)										
City of Sacramento	0	0	0	96,300	0	96,300	96,300	96,300	50,000	6/7/8

Table A-3 2020 American River Demand Assumptions (cont.)

Location / Purveyor	Allocation Type (maximum acre-feet)						Folsom Unimpaired Inflow (FUI)			Notes
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total	FUI = Total TAF (Mar – Sep) + 60 TAF			
Arcade Water District	0	0	0	11,200	0	11,200	11,200	11,200	3,500	13
Carmichael Water District	0	0	0	12,000	0	12,000	12,000	12,000	12,000	
Total	**0**	**0**	**0**	**119,500**	**0**	**119,500**	**119,500**	**119,500**	**65,500**	
Sacramento River (D162)										
Placer County Water Agency	0	0	0	0	0	0	0	0	0	
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Sacramento River (D167/D168)										
City of Sacramento	0	0	0	34,300	0	34,300	34,300	34,300	80,600	8
Sacramento County Water Agency (SMUD transfer)	0	30,000	0	0	0	30,000				10
Sacramento County Water Agency (P.L. 101-514)	0	15,000	0	0	0	15,000				10
EBMUD (export)	0	133,000	0	0	0	133,000				
Total	**0**	**178,000**	**0**	**34,300**	**0**	**212,300**	**34,300**	**34,300**	**80,600**	
Total demands from the American River	**0**	**133,250**	**0**	**342,000**	**0**	**475,250**	**468,150**	**439,150**	**303,550**	

Notes

[1] Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 950,000 af.

[2] Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 950,000 af but greater than 400,000 af.

[3] Driest years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 400,000 af.

[4] Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 1,600,000 af.

[5] Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 1,600,000 af.

[6] Wet/average years as it applies to the City of Sacramento are time periods when the flows bypassing the E. A. Fairbairn Water Treatment Plant diversion exceed the "Hodge flows."

[7] Drier years are time periods when the flows bypassing the City's E.A. Fairbairn Water Treatment Plant diversion do not exceed the "Hodge flows."

[8] For modeling purposes, it is assumed that the City of Sacramento's total annual diversions from the American and Sacramento River in year 2030 would be 130,600 af.

[10] The total demand for Sacramento County Water Agency would be up to 78,000 af. The 45,000 af represents firm entitlements; the additional 33,000 af of demand is expected to be met by intermittent surplus supply. The intermittent supply is subject to Reclamation reduction (50%) in dry years.

[11] Water Rights Water provided by releases from PCWA's Middle Fork Project; inputs into upper American River model must be consistent with these assumptions.

[12] Demand requires "Replacement Water" as indicated below

[13] Arcade WD demand modeled as step function: one demand when FUI > 400, another demand when FUI < 400.

Appendix B. Results of Report Studies

A study to estimate the supply reliability of the State Water Project is done using a computer program that simulates the operation of the SWP on a monthly basis over a 73-year historical record of rainfall and runoff (1922–1994). The simulation model integrates all the relevant water resource components and calculates key water management parameters, such as:

- the amount of water released from reservoirs in the Sacramento-San Joaquin valleys,
- the amount of water required to maintain Delta water quality standards,
- the amount of water to be pumped from the Delta by the SWP and the Central Valley Project (CVP), and
- the amount of water that can be delivered by each of these projects.

The information required to run the simulation is referred to as the “model input.” The most significant categories of input are:

- the physical description of the water system facilities (maximum pumping or release capacity, maximum reservoir storages, etc.);
- institutional requirements (delivery contract requirements, Delta water quality standards, the operations agreement between the SWP and CVP, endangered species requirements, and other requirements of federal and state laws, etc);
- hydrology (river and stream flows adjusted for water use in the source areas); and
- the level of SWP water demand.

CalSim II is the current version of the computer simulation model used to estimate SWP delivery reliability. All versions of CalSim employ commercially available linear programming software as a solution device. The application of the software, graphical user interface, and input/output devices are discussed in the documentation for CalSim.

The model studies selected for this report answer two questions.

1. “What is the estimated current delivery reliability of the SWP?” and
2. “What is the estimate for SWP deliveries in the year 2025, if there were no new facilities or improvements to existing facilities, SWP water demand increased, and the institutional requirements existing today were in place?”

The key study assumptions are shown in Table B-1 and listed in more detail in Chapter 4 and Appendix A. Additional discussions of these studies are on DWR’s Modeling Branch’s Website for the SWP Delivery Reliability Report 2002 (DWR 2003) studies and on the US Bureau of Reclamation’s Website for Operations Criteria and Plan (OCAP) studies (http://modeling.water.ca.gov/hydro/studies/SWPReliability/index.html and http://www.usbr.gov/mp/cvo/ocap_page.html, respectively).

Study Results

The annual delivery amounts calculated by the supply reliability studies are contained in Tables B-3 through B-7 at the back of this appendix. The tables show the demand level in thousand acre-feet (taf), the amount of delivery from the Delta, and percent of full Delta Table A calculated for each year of simulation for the five studies. Delta Table A refers to the total of the Table A amounts for each of the SWP contractors receiving water from the Delta. Of the 29 SWP contractors, 26 receive their deliveries from the Delta. The total maximum Table A amount for all SWP contractors is 4.173 maf/year. Of this amount, 4.133 maf/yr is the maximum Delta Table A amount.

Table B-1 Key study assumptions

Study	Study name	Level of development (year)	SWP Table A demand (maf/year)	SWP Article 21 demand (taf/month)	Model version
		SWP Delivery Reliability Report (2003)			
1	2001 Study	2001	3.0–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
2	2021A Study	2021	3.3–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
3	2021B Study	2021	4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
		Updated Studies			
4	2005 Study	2005	2.3–3.9	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP
5	2025 Study	2025	3.9–4.1	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP

maf = million acre-feet
OCAP = 2004 Long-Term Central Valley Project Operations Criteria and Plan
taf = thousand acre-feet

Table B-2 SWP average and dry year Table A delivery from the Delta for studies 4 and 5

Year	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005	68%	4%	41%	32%	42%	37%
2025	77%	5%	40%	33%	42%	38%

To simplify the use of this report, the calculation of delivery in percent of full Delta Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies. The demands for studies 1 and 4 were developed assuming slightly earlier conditions when the maximum Delta Table A amounts totaled slightly less than 4.133 maf (4.114 maf and 4.112 maf, respectively). To show the effect of these minor differences in Table A totals, the annual deliveries in percent of full Delta Table A for study 1 (Table B-3) are calculated with the earlier Delta Table A total of 4.114 maf and also with the maximum Delta Table A total of 4.133 maf. Similarly, study 4 results in Table B-6 are calculated with the earlier and maximum Delta Table A totals. The tables show that most years have the same delivery percentage for both Table A totals.

These values must be interpreted within the confines of the assumptions upon which they are calculated. For example, for the year 1958 in study 5, the annual delivery is calculated to be 4,133 taf or 100 percent of maximum Delta Table A (see Table B-7). This result should be stated as follows:

If the rainfall were the same as it was in 1958 but (1) the level of water use in the source area was increased to the level it would be in 2025; (2) SWP facilities and operation requirements were the same as they are today; and (3) SWP contractor demands were at their maximum Delta Table A level, the SWP would deliver approximately 4,133 taf or 100 percent of the maximum Delta Table A.

Actually, the conditional statement associated with the result for any particular year is even more complicated than this because the result is also dependent upon the rainfall that has occurred in previous years. For example, if the previous year (1957) were wet, runoff for 1958 for the same amount of rainfall would be greater than if 1957 were dry. In addition, reservoir storage for the beginning of 1958 would vary depending upon the weather conditions in

1957. This linkage makes each year's simulation dependent on the previous year's and, hence, links the entire historical series.

Table B-2 contains a summary of the delivery estimates for the SWP for important dry periods in history computed by the studies. Studies 4 and 5 were selected to represent the estimated 2005 and 2025 deliveries, respectively. This information can be helpful in analyzing the delivery reliability of a specific water system that receives a portion of its water supply from the SWP. The series of data contained in Tables B-3 through B-7 are also helpful in analyzing longer periods of time that contain not only dry periods but wetter periods, which can replenish water supplies.

Finally, to help analyze the chance of receiving a given level of delivery in any particular year, a probability distribution curve is useful. It simply shows the percent of the years the annual delivery estimate is at or above a given value. The probability distribution curves for the five studies are included as figures B-1 and B-2. For example, for study 5 (Figure B-2), the curve indicates that in 75 percent of the years, the annual delivery reliability is estimated to be at or above 65 percent of the maximum Delta Table A amount or 2.70 maf. Similarly, annual delivery reliability during 50 percent of the years is estimated to be at or above 85 percent of the maximum Delta Table A or 3.50 maf. The curve also shows that in 25 percent of the years, annual delivery reliability is estimated to be at 100 percent of the maximum Delta Table A.

Table B-3 SWP water delivery from the Delta for Study 1 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.114 maf	Percent of future maximum Table A - 4.133 maf	Model Article 21 supply
1922	3,407	3,389	82%	82%	175
1923	3,717	3,727	91%	90%	143
1924	3,961	1,014	25%	25%	0
1925	3,940	1,502	36%	36%	0
1926	3,777	2,951	72%	71%	0
1927	3,543	3,504	85%	85%	220
1928	3,897	3,337	81%	81%	155
1929	3,952	1,037	25%	25%	0
1930	3,922	2,697	66%	65%	92
1931	3,971	1,141	28%	28%	0
1932	3,673	1,620	39%	39%	199
1933	3,939	1,663	40%	40%	134
1934	3,981	1,689	41%	41%	0
1935	3,697	3,439	84%	83%	81
1936	3,769	3,638	88%	88%	0
1937	3,451	3,297	80%	80%	87
1938	3,418	3,439	84%	83%	470
1939	3,673	3,475	84%	84%	227
1940	3,713	3,544	86%	86%	102
1941	3,013	3,036	74%	73%	100
1942	3,583	3,599	87%	87%	513
1943	3,632	3,545	86%	86%	447
1944	3,563	3,449	84%	83%	0
1945	3,613	3,479	85%	84%	136
1946	3,710	3,724	91%	90%	3
1947	3,954	2,653	64%	64%	0
1948	3,959	2,681	65%	65%	2
1949	3,864	2,568	62%	62%	2
1950	3,812	2,909	71%	70%	0
1951	3,779	3,794	92%	92%	311
1952	3,078	3,108	76%	75%	103
1953	3,790	3,801	92%	92%	272
1954	3,833	3,803	92%	92%	98
1955	3,761	1,694	41%	41%	0
1956	3,639	3,649	89%	88%	261
1957	3,759	3,331	81%	81%	96
1958	3,481	3,492	85%	84%	441
1959	4,055	3,506	85%	85%	265
1960	4,114	1,795	44%	43%	0
1961	4,114	2,873	70%	70%	0
1962	3,689	3,158	77%	76%	21
1963	3,634	3,630	88%	88%	223
1964	3,907	3,262	79%	79%	5
1965	3,586	3,256	79%	79%	98
1966	3,722	3,731	91%	90%	147
1967	3,439	3,424	83%	83%	497
1968	3,792	3,548	86%	86%	402
1969	3,157	3,151	77%	76%	100
1970	3,714	3,727	91%	90%	406
1971	3,837	3,845	93%	93%	0
1972	4,012	3,057	74%	74%	2
1973	3,611	3,592	87%	87%	261
1974	3,650	3,664	89%	89%	297
1975	3,720	3,737	91%	90%	415
1976	4,014	3,150	77%	76%	110
1977	3,948	804	20%	19%	0
1978	3,126	3,036	74%	73%	100
1979	3,527	3,509	85%	85%	140
1980	3,197	3,208	78%	78%	100
1981	3,834	3,532	86%	85%	124
1982	3,451	3,471	84%	84%	386
1983	3,007	3,036	74%	73%	200
1984	3,692	3,706	90%	90%	408
1985	3,753	3,540	86%	86%	0
1986	3,345	3,023	73%	73%	51
1987	3,905	2,894	70%	70%	0
1988	4,026	968	24%	23%	0
1989	4,097	2,903	71%	70%	0
1990	3,961	1,101	27%	27%	0
1991	3,957	983	24%	24%	0
1992	3,880	1,199	29%	29%	0
1993	3,559	3,505	85%	85%	133
1994	3,739	3,272	80%	79%	9
Average	3,712	2,962	72%	72%	134
Maximum	4,114	3,845	93%	93%	513
Minimum	3,007	804	20%	19%	0

Table B-4 SWP Water Delivery from the Delta for Study 2 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.133 maf	Model Article 21 supply
1922	4,133	4,043	98%	0
1923	4,133	3,670	89%	0
1924	3,980	972	24%	0
1925	4,133	1,445	35%	0
1926	4,133	2,856	69%	113
1927	4,133	4,032	98%	124
1928	4,133	3,255	79%	3
1929	3,971	1,070	26%	0
1930	4,133	2,734	66%	27
1931	4,133	1,086	26%	0
1932	4,116	1,855	45%	39
1933	4,133	1,966	48%	6
1934	4,133	1,564	38%	0
1935	3,907	3,562	86%	59
1936	4,133	3,655	88%	5
1937	4,133	3,189	77%	65
1938	4,133	4,128	100%	192
1939	3,948	3,443	83%	1
1940	4,133	3,856	93%	22
1941	3,481	3,472	84%	0
1942	3,881	3,894	94%	378
1943	4,120	3,591	87%	375
1944	3,711	3,443	83%	2
1945	3,948	3,574	86%	123
1946	3,969	3,772	91%	0
1947	3,973	2,602	63%	0
1948	4,133	2,587	63%	2
1949	3,996	2,656	64%	0
1950	4,133	2,895	70%	0
1951	4,094	3,994	97%	230
1952	3,510	3,538	86%	100
1953	4,063	3,989	97%	236
1954	4,133	3,830	93%	6
1955	3,995	1,735	42%	0
1956	4,133	4,127	100%	129
1957	4,029	3,069	74%	3
1958	3,942	3,910	95%	335
1959	4,133	3,477	84%	167
1960	4,133	2,021	49%	0
1961	4,133	2,815	68%	0
1962	3,933	3,153	76%	2
1963	4,133	4,046	98%	134
1964	4,030	3,050	74%	0
1965	3,966	3,234	78%	3
1966	4,046	3,844	93%	61
1967	4,033	3,979	96%	167
1968	4,128	3,583	87%	398
1969	3,583	3,556	86%	93
1970	4,004	3,929	95%	398
1971	4,133	4,082	99%	0
1972	4,133	2,727	66%	0
1973	4,119	3,699	89%	211
1974	4,090	4,107	99%	147
1975	4,113	4,088	99%	209
1976	4,032	2,789	67%	0
1977	4,133	830	20%	0
1978	3,898	3,706	90%	100
1979	4,133	3,512	85%	89
1980	3,751	3,462	84%	74
1981	4,133	3,400	82%	0
1982	4,009	4,027	97%	101
1983	3,343	3,370	82%	200
1984	4,061	4,079	99%	379
1985	3,905	3,326	80%	0
1986	3,898	3,011	73%	52
1987	3,923	2,837	69%	0
1988	4,045	992	24%	0
1989	4,133	2,895	70%	0
1990	4,133	1,151	28%	0
1991	4,133	999	24%	0
1992	4,133	1,155	28%	0
1993	4,133	4,018	97%	156
1994	4,133	3,042	74%	0
Average	4,026	3,083	75%	78
Maximum	4,133	4,128	100%	398
Minimum	3,343	830	20%	0

Table B-5 SWP Water Delivery from the Delta for Study 3 (taf)

Year	Model fixed Table A demand	Model Table A delivery	Percent of maximum Table A - 4.133 maf	Model Article 21 supply
1922	4,133	4,043	98%	0
1923	4,133	3,670	89%	0
1924	4,133	972	24%	0
1925	4,133	1,446	35%	0
1926	4,133	2,856	69%	113
1927	4,133	4,031	98%	124
1928	4,133	3,255	79%	3
1929	4,133	1,070	26%	0
1930	4,133	2,734	66%	27
1931	4,133	1,086	26%	0
1932	4,133	1,855	45%	39
1933	4,133	1,967	48%	6
1934	4,133	1,564	38%	0
1935	4,133	3,729	90%	59
1936	4,133	3,669	89%	0
1937	4,133	3,165	77%	71
1938	4,133	4,129	100%	197
1939	4,133	3,444	83%	1
1940	4,133	3,856	93%	22
1941	4,133	4,084	99%	0
1942	4,133	4,122	100%	75
1943	4,133	3,584	87%	318
1944	4,133	3,465	84%	3
1945	4,133	3,547	86%	123
1946	4,133	3,801	92%	0
1947	4,133	2,597	63%	0
1948	4,133	2,586	63%	2
1949	4,133	2,654	64%	0
1950	4,133	2,893	70%	0
1951	4,133	3,996	97%	222
1952	4,133	4,133	100%	14
1953	4,133	3,931	95%	244
1954	4,133	3,860	93%	33
1955	4,133	1,779	43%	0
1956	4,133	4,126	100%	111
1957	4,133	3,067	74%	3
1958	4,133	4,063	98%	306
1959	4,133	3,467	84%	97
1960	4,133	2,007	49%	0
1961	4,133	2,818	68%	0
1962	4,133	3,153	76%	2
1963	4,133	4,046	98%	134
1964	4,133	3,050	74%	0
1965	4,133	3,233	78%	3
1966	4,133	3,853	93%	56
1967	4,133	4,069	98%	115
1968	4,133	3,584	87%	398
1969	4,133	4,078	99%	13
1970	4,133	3,933	95%	358
1971	4,133	4,082	99%	0
1972	4,133	2,725	66%	0
1973	4,133	3,699	89%	211
1974	4,133	4,133	100%	143
1975	4,133	4,102	99%	211
1976	4,133	2,775	67%	0
1977	4,133	830	20%	0
1978	4,133	3,915	95%	100
1979	4,133	3,493	85%	98
1980	4,133	3,465	84%	75
1981	4,133	3,387	82%	0
1982	4,133	4,133	100%	63
1983	4,133	4,133	100%	160
1984	4,133	4,101	99%	369
1985	4,133	3,322	80%	0
1986	4,133	3,006	73%	62
1987	4,133	2,835	69%	0
1988	4,133	993	24%	0
1989	4,133	2,895	70%	0
1990	4,133	1,151	28%	0
1991	4,133	999	24%	0
1992	4,133	1,155	28%	0
1993	4,133	4,018	97%	156
1994	4,133	3,042	74%	0
Average	4,133	3,130	76%	68
Maximum	4,133	4,133	100%	398
Minimum	4,133	830	20%	0

Table B-6 SWP water delivery from the Delta for Study 4 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.112 maf	Percent of future maximum Table A - 4.133 maf	Model Article 21 supply
1922	3,750	3,743	91%	91%	104
1923	3,251	3,251	79%	79%	106
1924	3,489	1,244	30%	30%	0
1925	3,353	1,870	45%	45%	0
1926	3,393	2,981	72%	72%	54
1927	3,860	3,845	93%	93%	213
1928	3,458	3,384	82%	82%	134
1929	2,907	1,108	27%	27%	0
1930	3,326	2,855	69%	69%	117
1931	2,933	1,018	25%	25%	0
1932	3,139	1,406	34%	34%	242
1933	3,427	1,330	32%	32%	512
1934	3,470	1,541	37%	37%	206
1935	3,798	3,769	92%	91%	229
1936	3,596	3,573	87%	86%	0
1937	3,492	3,362	82%	81%	80
1938	3,344	3,344	81%	81%	714
1939	3,262	3,262	79%	79%	349
1940	3,239	3,219	78%	78%	154
1941	2,526	2,527	61%	61%	246
1942	3,167	3,167	77%	77%	918
1943	3,104	3,104	75%	75%	623
1944	3,090	3,091	75%	75%	0
1945	3,112	3,101	75%	75%	359
1946	3,215	3,215	78%	78%	249
1947	3,422	3,292	80%	80%	0
1948	3,395	2,942	72%	71%	0
1949	3,313	2,264	55%	55%	0
1950	3,465	3,199	78%	77%	0
1951	3,497	3,497	85%	85%	388
1952	2,585	2,588	63%	63%	275
1953	3,323	3,323	81%	80%	513
1954	3,294	3,294	80%	80%	523
1955	3,228	2,207	54%	53%	0
1956	3,581	3,586	87%	87%	324
1957	3,235	3,235	79%	78%	257
1958	2,980	2,980	72%	72%	1,106
1959	3,547	3,480	85%	84%	366
1960	3,555	1,865	45%	45%	0
1961	3,580	2,659	65%	64%	97
1962	3,690	3,262	79%	79%	0
1963	3,823	3,818	93%	92%	202
1964	3,492	3,323	81%	80%	0
1965	3,059	3,059	74%	74%	177
1966	3,282	3,282	80%	79%	518
1967	2,950	2,946	72%	71%	923
1968	3,324	3,329	81%	81%	552
1969	2,636	2,632	64%	64%	275
1970	3,257	3,257	79%	79%	552
1971	3,341	3,341	81%	81%	0
1972	3,457	3,342	81%	81%	414
1973	3,097	3,092	75%	75%	384
1974	3,184	3,184	77%	77%	854
1975	3,229	3,229	79%	78%	903
1976	3,471	3,265	79%	79%	189
1977	3,421	159	4%	4%	0
1978	3,623	3,603	88%	87%	300
1979	3,512	3,501	85%	85%	160
1980	2,715	2,709	66%	66%	138
1981	3,358	3,358	82%	81%	546
1982	2,890	2,890	70%	70%	801
1983	2,497	2,498	61%	60%	400
1984	3,227	2,766	67%	67%	552
1985	3,214	3,214	78%	78%	0
1986	2,321	2,297	56%	56%	120
1987	2,896	2,896	70%	70%	546
1988	2,967	856	21%	21%	0
1989	3,551	3,174	77%	77%	0
1990	3,628	1,099	27%	27%	0
1991	3,425	1,052	26%	25%	0
1992	3,366	1,426	35%	34%	0
1993	3,862	3,848	94%	93%	159
1994	3,689	3,306	80%	80%	0
Average	3,290	2,818	69%	68%	262
Maximum	3,862	3,848	94%	93%	1,106
Minimum	2,321	159	4%	4%	0

Table B-7 SWP water delivery from the Delta for Study 5 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A -4.133 maf	Model Article 21 supply
1922	4,133	4,133	100%	21
1923	4,133	4,133	100%	0
1924	4,133	382	9%	0
1925	4,133	1,491	36%	190
1926	4,133	2,721	66%	279
1927	4,133	4,133	100%	301
1928	4,133	3,379	82%	0
1929	4,133	1,118	27%	0
1930	4,133	2,738	66%	141
1931	4,133	1,072	26%	0
1932	4,133	1,572	38%	112
1933	4,133	1,337	32%	547
1934	4,133	1,471	36%	242
1935	4,133	4,061	98%	218
1936	4,133	3,729	90%	0
1937	4,133	3,369	82%	70
1938	4,133	4,133	100%	200
1939	4,133	3,450	83%	0
1940	4,133	4,116	100%	114
1941	3,898	3,908	95%	0
1942	4,133	4,133	100%	123
1943	4,133	3,787	92%	487
1944	4,133	3,542	86%	0
1945	4,133	3,889	94%	118
1946	4,133	3,828	93%	0
1947	4,133	2,771	67%	0
1948	4,133	2,940	71%	0
1949	4,133	2,025	49%	0
1950	4,133	3,400	82%	0
1951	4,133	4,133	100%	252
1952	3,898	3,912	95%	0
1953	4,133	4,133	100%	296
1954	4,133	4,133	100%	0
1955	4,133	1,505	36%	0
1956	4,133	4,133	100%	352
1957	4,133	3,565	86%	0
1958	4,133	4,133	100%	229
1959	4,133	3,787	92%	107
1960	4,133	1,607	39%	0
1961	4,133	2,712	66%	299
1962	4,133	3,311	80%	1
1963	4,133	4,133	100%	161
1964	4,133	2,889	70%	0
1965	4,133	3,465	84%	47
1966	4,133	4,133	100%	178
1967	4,133	4,133	100%	157
1968	4,133	3,797	92%	465
1969	3,898	3,910	95%	63
1970	4,133	4,122	100%	493
1971	4,133	4,133	100%	0
1972	4,133	2,721	66%	0
1973	4,133	4,032	98%	259
1974	4,133	4,133	100%	69
1975	4,133	4,133	100%	134
1976	4,133	3,137	76%	0
1977	4,133	187	5%	0
1978	3,898	3,902	94%	300
1979	4,133	3,773	91%	144
1980	3,898	3,513	85%	86
1981	4,133	3,797	92%	71
1982	4,133	4,133	100%	171
1983	3,898	3,909	95%	357
1984	4,133	4,133	100%	490
1985	4,133	3,413	83%	0
1986	3,898	2,857	69%	83
1987	4,133	3,307	80%	183
1988	4,133	423	10%	0
1989	4,133	3,513	85%	91
1990	4,133	855	21%	0
1991	4,133	850	21%	0
1992	4,133	1,461	35%	102
1993	4,133	4,133	100%	255
1994	4,133	3,153	76%	0
Average	4,110	3,178	77%	124
Maximum	4,133	4,133	100%	547
Minimum	3,898	187	5%	0

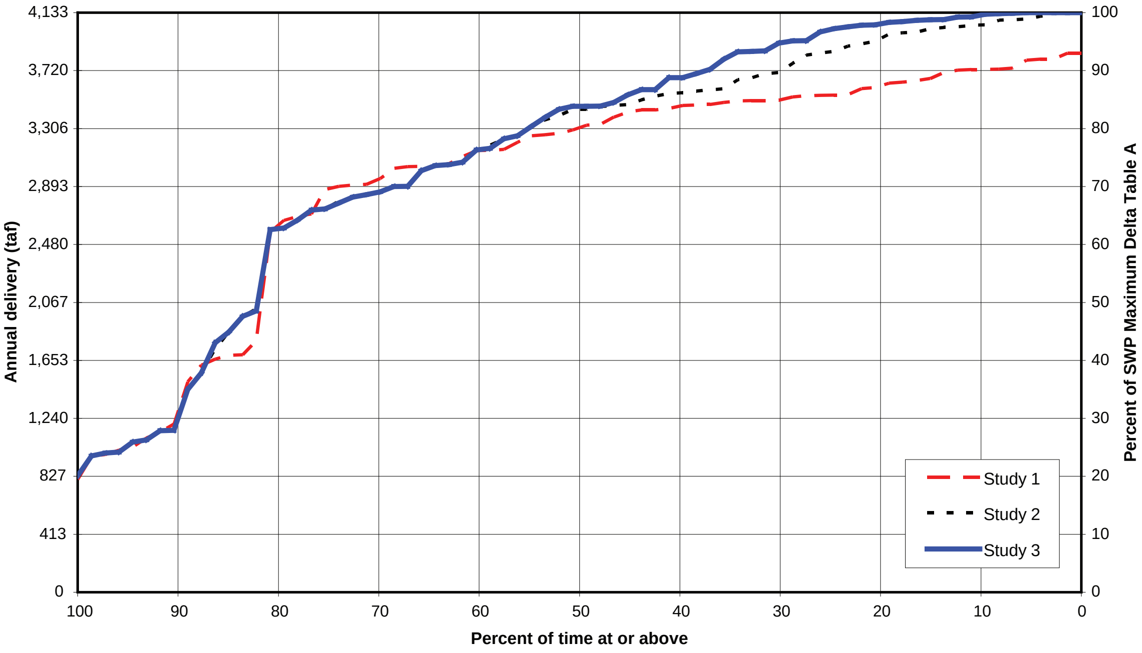


Figure B-1 SWP Delta Table A delivery probability for studies 1, 2 and 3

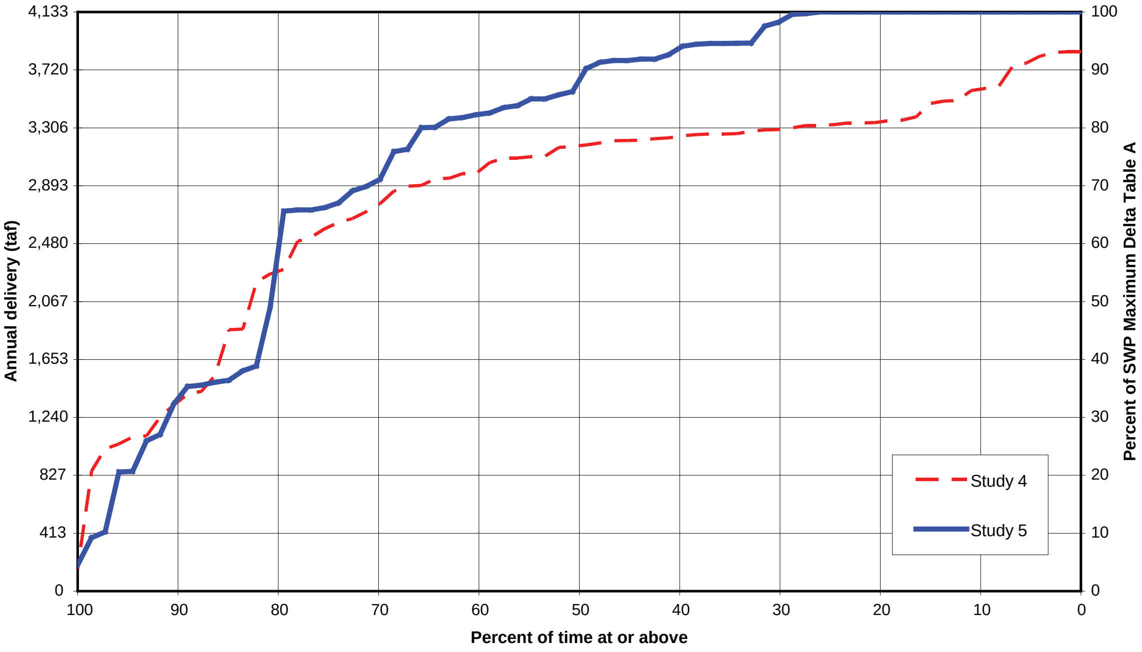


Figure B-2 SWP Delta Table A delivery probability for studies 4 and 5

Appendix C. State Water Project Table A Amounts

What is State Water Project Table A?

The contracts between the Department of Water Resources and the 29 State Water Project water contractors define the terms and conditions governing the water delivery and cost repayment for the SWP. Table A is an exhibit to these contracts. Comprehension of Table A is important in understanding the information in this report. To understand the table, it is necessary to understand how the contracts work.

All water-supply related costs of the SWP are paid by the contractors, and Table A serves as a basis for allocating some of the costs among the contractors. In addition, Table A plays a key role in the annual allocation of available supply among contractors. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4.2 million acre-feet (maf) per year. This was referred to as the minimum project yield, and it was recognized that in some years the project would be unable to deliver that amount and in other years project supply could exceed that amount. The 4.2 maf number was used as the basis for apportioning available supply to each contractor and as a factor in calculating each contractor's share of the project's costs. This apportionment is accomplished by Table A in each contract. Table A lists by year and acre-feet the portion of the 4.2 maf deliverable to each contractor. Other contract provisions permit changes to an individual contractor's Table A under special circumstances. The total of the maximums in all the contracts now equals 4.173 maf.

A copy of the consolidated Table A from all the contracts follows this explanation. The amounts listed in Table A cannot be viewed as an indication of the SWP water delivery reliability, nor should these amounts be used to support an expectation that a certain amount of water will be delivered to a contractor in any particular time span. Table A is simply a tool for apportioning available supply and cost obligations under the contract. In this report, reference to "Table A amounts" means the amounts listed in Table A. Contractors also receive other classifications of water from the project, as distinguished from Table A (for example, Article 21 water, and turnback pool water). These other contract provisions are discussed in Appendix D.

Table C-1 Maximum Annual SWP Table A Amounts

SWP Contractors	Maximum Table A
Delivered from the Delta	
North Bay	
Napa County FC&WCD	29,025
Solano County WA	47,756
Subtotal	**76,781**
South Bay	
Alameda County FC&WCD, Zone 7	80,619
Alameda County WD	42,000
Santa Clara Valley WD	100,000
Subtotal	**222,619**
San Joaquin Valley	
Oak Flat WD	5,700
County of Kings	9,305
Dudley Ridge WD	57,343
Empire West Side ID	3,000
Kern County WA	998,730
Tulare Lake Basin WSD	95,922
Subtotal	**1,170,000**
Central Coastal	
San Luis Obispo County FC&WCD	25,000
Santa Barbara County FC&WCD	45,486
Subtotal	**70,486**
Southern California	
Antelope Valley-East Kern WA	141,400
Castaic Lake WA	95,200
Coachella Valley WD	121,100
Crestline-Lake Arrowhead WA	5,800
Desert WA	50,000
Littlerock Creek ID	2,300
Mojave WA	75,800
Metropolitan WDSC	1,911,500
Palmdale WD	21,300
San Bernardino Valley MWD	102,600
San Gabriel Valley MWD	28,800
San Gorgonio Pass WA	17,300
Ventura County FCD	20,000
Subtotal	**2,593,100**
Delta Subtotal	**4,132,986**
Feather River	
County of Butte	27,500
Plumas County FC&WCD	2,700
City of Yuba City	9,600
Subtotal	**39,800**
Grand Total	**4,172,786**

Appendix D. Recent State Water Project Deliveries

SWP Contract Water Types

The State Water Project contracts define several classifications of water available for delivery to contractors under specific circumstances. All classifications are considered "project" water. Many contractors make frequent use of these additional water types to increase or decrease the amount available to them under Table A.

Table A Water

Each contract's Table A is the amount in acre-feet that is used to determine the portion of available supply to be delivered to that contractor. Table A water is water delivered according to this apportionment methodology and is given first priority for delivery.

Article 21 Water

Article 21 of the contracts permits delivery of water excess to delivery of Table A and some other water types to those contractors requesting it. It is available under specific conditions discussed in Chapter 5. Article 21 water is apportioned to those contractors requesting it in the same proportion as their Table A.

Turnback Pool Water

Contractors may choose to offer their allocated Table A water excess to their needs to other contractors through two pools in February and March. Contributing contractors receive a reduction in charges, and taking contractors pay extra.

Carryover Water

Pursuant to the long-term water supply contracts, the Department of Water Resources (DWR) has offered contractors the opportunity to carry over a portion of their allocated water approved for delivery in the current year for delivery during the next year. The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The water supply contracts state the criteria of carrying over Table A water from one year to the next. Normally, carryover water is water that has been exported during the year, has not been delivered to the contractor during that year, and has remained stored in the SWP share of San Luis Reservoir to be delivered during the following year. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs.

Updated Historical Deliveries

The tables in this appendix list annual historical deliveries by various water classifications for each contractor for 1995 through 2004. Similar delivery tables for years 1995 through 2002 are included in the *State Water Project Delivery Reliability Report 2002*. Amounts listed for these years are slightly different due to accounting adjustments made by DWR's State Water Project Analysis Office.

Table D-1 Historical State Water Project Deliveries: 1995

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	203				203
Plumas County FC&WCD	308				308
City of Yuba City	910				910
Napa County FC&WCD	5,182				5,182
Solano County WA	21,345				21,345
Alameda County FC&WCD, Zone 7	30,091				30,091
Alameda County WD	17,793				17,793
Santa Clara Valley WD	28,756				28,756
Oak Flat WD	5,169				5,169
County of Kings	4,000				4,000
Dudley Ridge WD	57,700			2,986	60,686
Empire West Side ID	957	106		568	1,631
Kern County WA	1,089,063	59,671		2,795	1,151,529
Tulare Lake Basin WSD	71,679	4,553		25,637	101,869
Antelope Valley-East Kern WA	47,286				47,286
Castaic Lake WA (+Rch 31A, 5 & 7)	25,660			1,573	27,233
Coachella Valley WD	23,100				23,100
Crestline-Lake Arrowhead WA	409				409
Desert WA	38,100				38,100
Littlerock Creek ID	480				480
Mojave WA	3,722				3,722
Metropolitan WDSC	396,600			19,442	416,042
Palmdale WD	6,961				6,961
San Bernardino Valley MWD	696				696
San Gabriel Valley MWD	12,922				12,922
Totals	**1,889,092**	**64,330**	**0**	**53,001**	**2,006,423**
Total South of Delta	**1,887,671**	**64,330**	**0**	**53,001**	**2,005,002**

Table D-2 Historical State Water Project Deliveries: 1996

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	257				257
Plumas County FC&WCD	360				360
City of Yuba City	820				820
Napa County FC&WCD	4,893				4,893
Solano County WA	29,144			855	29,999
Alameda County FC&WCD, Zone 7	18,903				18,903
Alameda County WD	19,662				19,662
Santa Clara Valley WD	88,829			1,021	89,850
Oak Flat WD	4,904				4,904
County of Kings	4,000				4,000
Dudley Ridge WD	52,491	4,457			56,948
Empire West Side ID	1,371			497	1,868
Kern County WA	1,117,060	15,653		52,350	1,185,063
Tulare Lake Basin WSD	118,500	8,537	71,268	38,570	236,875
San Luis Obispo County FC&WCD	100				100
Antelope Valley-East Kern WA	56,356				56,356
Castaic Lake WA (+Rch 31A, 5 & 7)	32,500				32,500
Coachella Valley WD	23,100		39,119		62,219
Crestline-Lake Arrowhead WA	485				485
Desert WA	38,100		64,522		102,622
Littlerock Creek ID	494				494
Mojave WA	7,427				7,427
Metropolitan WDSC	553,259			40,121	593,380
Palmdale WD	11,434				11,434
San Bernardino Valley MWD	6,064				6,064
San Gabriel Valley MWD	15,989				15,989
Totals	**2,206,502**	**28,647**	**174,909**	**133,414**	**2,543,472**
Total South of Delta	**2,205,065**	**28,647**	**174,909**	**133,414**	**2,542,035**

Table D-3 Historical State Water Project Deliveries: 1997

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	185				185
Plumas County FC&WCD	231				231
City of Yuba City	1,005				1,005
Napa County FC&WCD	4,341				4,341
Solano County WA	35,530				35,530
Alameda County FC&WCD, Zone 7	27,522				27,522
Alameda County WD	24,063				24,063
Santa Clara Valley WD	95,601				95,601
Oak Flat WD	5,238				5,238
Dudley Ridge WD	51,623	7,141	12,544		71,308
Kern County WA	1,092,543	10,264			1,102,807
Tulare Lake Basin WSD	21,156	1,213			22,369
San Luis Obispo County FC&WCD	1,199				1,199
Santa Barbara County FC&WCD	7,439				7,439
Antelope Valley-East Kern WA	61,752	641			62,393
Castaic Lake WA (+Rch 31A, 5 & 7)	27,712				27,712
Coachella Valley WD	23,100		35,000		58,100
Crestline-Lake Arrowhead WA	651				651
Desert WA	38,100		15,000		53,100
Littlerock Creek ID	444				444
Mojave WA	10,374				10,374
Metropolitan WDSC	738,990				738,990
Palmdale WD	11,861				11,861
San Bernardino Valley MWD	9,654				9,654
San Gabriel Valley MWD	16,002	2,173			18,175
Ventura County FCD	1,850				1,850
Totals	**2,308,166**	**21,432**	**62,544**	**0**	**2,392,142**
Total South of Delta	**2,306,745**	**21,432**	**62,544**	**0**	**2,390,721**

Table D-4 Historical State Water Project Deliveries: 1998

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	527				527
City of Yuba City	1,054				1,054
Napa County FC&WCD	5,359				5,359
Solano County WA	21,377	9,982		407	31,766
Alameda County FC&WCD, Zone 7	17,941				17,941
Alameda County WD	19,075				19,075
Santa Clara Valley WD	62,526			884	63,410
Oak Flat WD	4,401				4,401
County of Kings	3	12			15
Dudley Ridge WD	52,919	984		1,747	55,650
Empire West Side ID				542	542
Kern County WA	856,906			1,684	858,590
Tulare Lake Basin WSD	11,367	9,310			20,677
San Luis Obispo County FC&WCD	3,592				3,592
Santa Barbara County FC&WCD	18,618				18,618
Antelope Valley-East Kern WA	52,926				52,926
Castaic Lake WA (+Rch 31A, 5 & 7)	20,093				20,093
Coachella Valley WD	23,100		55,000		78,100
Crestline-Lake Arrowhead WA	187				187
Desert WA	38,100		20,000		58,100
Littlerock Creek ID	404				404
Mojave WA	3,925				3,925
Metropolitan WDSC	359,213			33,672	392,885
Palmdale WD	8,752				8,752
San Bernardino Valley MWD	1,878				1,878
San Gabriel Valley MWD	9,310				9,310
Ventura County FCD	1,850				1,850
Totals	**1,595,403**	**20,288**	**75,000**	**38,936**	**1,729,627**
Total South of Delta	**1,593,822**	**20,288**	**75,000**	**38,936**	**1,728,046**

Table D-5 Historical State Water Project Deliveries: 1999

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	286				286
City of Yuba City	1,096				1,096
Napa County FC&WCD	4,550	754			5,304
Solano County WA	37,753				37,753
Alameda County FC&WCD, Zone 7	46,000	2,910			48,910
Alameda County WD	34,871	2,781			37,652
Santa Clara Valley WD	67,465	15,480			82,945
Oak Flat WD	4,871				4,871
County of Kings	4,000				4,000
Dudley Ridge WD	51,870	4,990	6,566		63,426
Empire West Side ID	3,000	176			3,176
Kern County WA	1,077,755	58,241	42,154		1,178,150
Tulare Lake Basin WSD	118,500	49,898	121,337		289,735
San Luis Obispo County FC&WCD	3,743				3,743
Santa Barbara County FC&WCD	20,137				20,137
Antelope Valley-East Kern WA	69,073				69,073
Castaic Lake WA (+Rch 31A, 5 & 7)	32,899				32,899
Coachella Valley WD	23,100		27,380		50,480
Crestline-Lake Arrowhead WA	1,132				1,132
Desert WA	38,100		20,000		58,100
Littlerock Creek ID	342				342
Mojave WA	5,144				5,144
Metropolitan WDSC	829,777	22,840			852,617
Palmdale WD	13,278				13,278
San Bernardino Valley MWD	12,874				12,874
San Gabriel Valley MWD	18,000				18,000
Ventura County FCD	1,850				1,850
Totals	**2,521,466**	**158,070**	**217,437**	**0**	**2,896,973**
Total South of Delta	**2,520,084**	**158,070**	**217,437**	**0**	**2,895,591**

Table D-6 Historical State Water Project Deliveries: 2000

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	586				586
City of Yuba City	901				901
Napa County FC&WCD	3,136	297		1,525	4,958
Solano County WA	32,882	1,040		1,417	35,339
Alameda County FC&WCD, Zone 7	53,877	3,740			57,617
Alameda County WD	33,598	2,380			35,978
Santa Clara Valley WD	70,433	18,381		13,174	101,988
Oak Flat WD	4,494			14	4,508
County of Kings	3,600				3,600
Dudley Ridge WD	38,673	7,454	12,193	2,884	61,204
Empire West Side ID	1,271	528			1,799
Kern County WA	825,856	78,908	233,202	13,193	1,151,159
Tulare Lake Basin WSD	98,595	56,818	27,073	15,827	198,313
San Luis Obispo County FC&WCD	3,962				3,962
Santa Barbara County FC&WCD	22,741				22,741
Antelope Valley-East Kern WA	83,577				83,577
Castaic Lake WA (+Rch 31A, 5 & 7)	40,680				40,680
Coachella Valley WD	20,790	17,820	3,713		42,323
Crestline-Lake Arrowhead WA	1,194				1,194
Desert WA	34,290	17,820	6,124		58,234
Mojave WA	9,135				9,135
Metropolitan WDSC	1,273,729	103,124		169,529	1,546,382
Palmdale WD	8,221			839	9,060
San Bernardino Valley MWD	18,399				18,399
San Gabriel Valley MWD	14,000	475			14,475
Ventura County FCD	4,050				4,050
Totals	**,702,670**	**308,785**	**282,305**	**218,402**	**3,512,162**
Total South of Delta	**2,701,183**	**308,785**	**282,305**	**218,402**	**3,510,675**

Table D-7 Historical State Water Project Deliveries: 2001

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	513				513
City of Yuba City	1,065				1,065
Napa County FC&WCD	4,293	996	82	1,723	7,094
Solano County WA	17,756	2,304		1,021	21,081
Alameda County FC&WCD, Zone 7	22,307		308	5,990	28,605
Alameda County WD	13,695	10	107	4,192	18,004
Santa Clara Valley WD	35,689			12,233	47,922
Oak Flat WD	2,089		22	101	2,212
County of Kings	1,560				1,560
Dudley Ridge WD	18,467	933	347	6,815	26,562
Empire West Side ID		253		1,107	1,360
Kern County WA	363,204	23,233	6,502	92,052	484,991
Tulare Lake Basin WSD	40,830	8,755	769	7,889	58,243
San Luis Obispo County FC&WCD	4,184		99		4,283
Santa Barbara County FC&WCD	14,285	396	296		14,977
Antelope Valley-East Kern WA	45,071		899		45,970
Castaic Lake WA (+Rch 31A, 5 & 7)	30,471	850	618		31,939
Coachella Valley WD	9,009		91		9,100
Crestline-Lake Arrowhead WA	1,057				1,057
Desert WA	14,859		151		15,010
Mojave WA	4,433				4,433
Metropolitan WDSC	686,545	10,415	7,949	200,000	904,909
Palmdale WD	8,170			2,257	10,427
San Bernardino Valley MWD	26,488				26,488
San Gabriel Valley MWD	6,534				6,534
Ventura County FCD	1,850				1,850
Totals	**1,374,424**	**48,145**	**18,240**	**335,380**	**1,776,189**
Total South of Delta	**1,372,846**	**48,145**	**18,240**	**335,380**	**1,774,611**

Table D-8 Historical State Water Project Deliveries: 2002

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	419				419
City of Yuba City	1,181				1,181
Napa County FC&WCD	2,022	827	283	3,743	6,875
Solano County WA	28,223	2,242			30,465
Alameda County FC&WCD, Zone 7	40,707	1,484	556	8,113	50,860
Alameda County WD	24,250	83	862	2,331	27,526
Santa Clara Valley WD	55,896	202	2,053	3,311	61,462
Oak Flat WD	3,841	50	76	134	4,101
County of Kings	2,800		54		2,854
Dudley Ridge WD	38,688	1,861	1,177	1,994	43,720
Empire West Side ID	1,278	26		101	1,405
Kern County WA	670,884	21,951	20,543	15,680	729,058
Tulare Lake Basin WSD	73,785	3,749	2,289	5,385	85,208
San Luis Obispo County FC&WCD	4,355				4,355
Santa Barbara County FC&WCD	24,166	436	324	3,455	28,381
Antelope Valley-East Kern WA	53,907		1,008	3,256	58,171
Castaic Lake WA (+Rch 31A, 5 & 7)	61,880	280		6,657	68,817
Coachella Valley WD	16,170	111	474		16,755
Crestline-Lake Arrowhead WA	2,189				2,189
Desert WA	26,670	189	781		27,640
Mojave WA	4,346				4,346
Metropolitan WDSC	1,273,205	9,624	14,335	97,940	1,395,104
Palmdale WD	8,359		437		8,796
San Bernardino Valley MWD	68,268			3,801	72,069
San Gabriel Valley MWD	18,353			4,698	23,051
Ventura County FCD	4,998				4,998
Totals	**2,510,840**	**43,115**	**45,252**	**160,599**	**2,759,806**
Total South of Delta	**2,509,240**	**43,115**	**45,252**	**160,599**	**2,758,206**

Table D-9 Historical State Water Project Deliveries: 2003

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	551				551
City of Yuba City	1,324				1,324
Napa County FC&WCD	6,026	376	180	1,055	7,637
Solano County WA	25,135	2,280		1,918	29,333
Alameda County FC&WCD, Zone 7	30,695		656	13,099	44,450
Alameda County WD	31,086		354	5,150	36,590
Santa Clara Valley WD	90,620	936	841	14,104	106,501
Oak Flat WD	4,059	19	48	140	4,266
County of Kings	3,600	58	34		3,692
Dudley Ridge WD	49,723	1,928	482	1,452	53,585
Empire West Side ID	1,074	175		187	1,436
Kern County WA	841,697	27,891	8,419	22,380	900,387
Tulare Lake Basin WSD	94,376	6,243	938	4,284	105,841
San Luis Obispo County FC&WCD	4,417	36			4,453
Santa Barbara County FC&WCD	24,312	339	43	2,274	26,968
Antelope Valley-East Kern WA	52,730		250	7,049	60,029
Castaic Lake WA (+Rch 31A, 5 & 7)	49,895	991	90	4,760	55,736
Coachella Valley WD	14,045	204	194		14,443
Crestline-Lake Arrowhead WA	1,563				1,563
Desert WA	23,168	330	321		23,819
Mojave WA	10,907			3,528	14,435
Metropolitan WDSC	1,550,356	17,622	16,920	134,845	1,719,743
Palmdale WD	9,701			1,846	11,547
San Bernardino Valley MWD	25,371	200		1,844	27,415
San Gabriel Valley MWD	13,034	200			13,234
San Gorgonio Pass WA	116				116
Ventura County FCD	5,000				5,000
Totals	**2,964,581**	**59,828**	**29,770**	**219,915**	**3,274,094**
Total South of Delta	**2,962,706**	**59,828**	**29,770**	**219,915**	**3,272,219**

Table D-10 Historical State Water Project Deliveries: 2004

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	1,440				1,440
City of Yuba City	1,434				1,434
Napa County FC&WCD	5,030	1,450	52	1,602	8,134
Solano County WA	15,991	7,787		47	23,825
Alameda County FC&WCD, Zone 7	38,895			11,466	50,361
Alameda County WD	20,959		214	6,714	27,887
Santa Clara Valley WD	52,867	2,983	508		56,358
Oak Flat WD	4,324		29	276	4,629
County of Kings	5,850	3,157	46		9,053
Dudley Ridge WD	36,676	7,393	291	1,886	46,246
Empire West Side ID	1,310	626		1,626	3,562
Kern County WA	641,368	86,513	5,075	38,729	771,685
Tulare Lake Basin WSD	58,125	15,299	489	5,638	79,551
San Luis Obispo County FC&WCD	4,096	69			4,165
Santa Barbara County FC&WCD	29,358		122		29,480
Antelope Valley-East Kern WA	50,532			9,199	59,731
Castaic Lake WA (+Rch 31A, 5 & 7)	46,358	1,618		35,785	83,761
Coachella Valley WD	8,631		89	6,745	15,465
Crestline-Lake Arrowhead WA	2,006				2,006
Desert WA	9,966		102	11,122	21,190
Mojave WA	13,176				13,176
Metropolitan WDSC	1,195,807	91,601	10,223	215,000	1,512,631
Palmdale WD	10,549			1,613	12,162
San Bernardino Valley MWD	35,523			20,631	56,154
San Gabriel Valley MWD	15,600				15,600
San Gorgonio Pass WA	837				837
Ventura County FCD	5,250				5,250
Totals	**2,311,958**	**218,496**	**17,240**	**368,079**	**2,915,773**
Total South of Delta	**2,309,084**	**218,496**	**17,240**	**368,079**	**2,912,899**

Appendix E. Technical Memorandum Report Summaries: Historical SWP/CVP Operations Simulation and CalSim II Model Sensitivity Analysis

Study

This appendix presents summaries of the findings of the CalSim II Simulation of Historical SWP/CVP Operations and a CalSim II Model Sensitivity Analysis Study. The entire reports are available at the websites listed at the end of this appendix.

1. CalSim II Simulation of Historical SWP/CVP Operations

Technical Memorandum Report

Objective of Study

The purpose of the Historical Operations Study is to evaluate the ability of CalSim II to represent CVP and SWP operations, in general, and the delivery capability of the projects, in particular, through the monthly simulation of recent historical conditions.

Study Description

The period of simulation for the Historical Operations Study is water years 1975 to 1998. This 24-year period includes the 1976-77 and 1987-92 droughts, as well as the driest (1977) and the wettest (1983) years on record. The version of CalSim II used for this study is the benchmark study dated 30 September 2002, but with some inputs changed to reflect the historically changing conditions rather than a fixed level of development. Model inflows correspond to the historical flow from gage records, or are estimated from a hydrologic mass balance, or stream-flow correlation. Land use-based demands are calculated for annual varying land use, as determined from DWR's land surveys and county commissioners' reports. The operational logic has been revised to reflect the changing regulatory environment. The historical regulations have been simplified into three periods:

- October 1974–September 1992: represented by State Water Resources Control Board (SWRCB) Water Right Decision 1485 (D-1485),
- October 1992–September 1994: represented by D-1485 and the 1993 National Marine Fisheries Service (NMFS) winter-run Chinook salmon biological opinion (minimum carryover storage in Lake Shasta, and temperature related minimum instream flows downstream of Keswick Reservoir),
- October 1994–September 1998: represented by SWRCB Water Right Decision 1641 (D-1641) and the 1993 winter-run biological opinion.

The Historical Operations Study is limited in geographical scope to a dynamic operation of the Sacramento Valley, the Delta, and the CVP-SWP facilities south of the Delta. Delta inflows from the San Joaquin Valley and East Side streams are constrained to their historical values. Imports from the Trinity River system are similarly constrained.

Results and Discussion

The key performance measures in evaluating CalSim II are considered to be SWP and CVP deliveries, project storage operations, and stream flows. During the study period of water years 1975-1998, SWP demands were historically much lower than the current or projected level of demands. Simulation of historically wet years, when the system was not supply constrained, may therefore be a poor indicator of the model's ability to accurately simulate future levels of development. Particular attention is therefore placed on model results during the six-year drought of 1987-1992. Results for four key performance parameters are summarized in the table below.

The table below shows that simulated SWP Table A and CVP south-of-Delta deliveries during the drought are less than historical values. Differences are, however, within 5 percent. Comparison of Sacramento Valley inflow to the Delta (flow at Freeport) is a good measure of how well the Sacramento Valley hydrology is simulated by CalSim II. Simulated Delta inflows are 0.3 percent greater than historical. Comparison of the Net Delta Outflow Index, a measure of how well the Sacramento-San Joaquin Delta is represented by CalSim II, appears favorable. Simulated values are 3.5 percent greater than historical during the 1987-1992 period. The table also shows that simulated long-term (1975-1998) average deliveries compare quite well and are within 7 percent of historical values.

The total volume of surface water to be held in storage or routed through the model network is the same as historical. Model inflows to the Delta can deviate from historical due to three reasons: storage regulation, groundwater pumping to supplement surface water diversions, and stream-aquifer interaction.

Differences in Delta inflows are primarily caused by differences in project storage regulation (i.e. Lake Shasta, Lake Oroville and Folsom Lake). Storage operations in CalSim II are driven by two sets of rule curves. The first set of rule curves determines how much of the available project water will be held as carryover storage and how much will be delivered to meet contractors' current-year demands. The second set of rule curves determines when and how-much water will be transferred from north of Delta storage to San Luis Reservoir. These two sets of rule curves are fixed throughout the period of simulation. The rule curves have been determined in prior simulations of CalSim II. They are subjective in nature, but balance the conflicting objectives to maximize long-term average annual deliveries, to maintain water deliveries during the critically dry period 1928-34, and to keep water levels in project reservoirs above minimum levels while meeting minimum flow requirements. Secondly, differences in Delta inflows are due to differences in upstream surface water diversions and return flows. The historical consumptive water demand must be met by the model. Differences in Delta inflow, after accounting for differences in upstream storage regulation, therefore reveal how well CalSim II matches the historical mix of surface water and groundwater to meet demands. Lastly inflows to the Delta are influenced by the stream-aquifer interaction.

For a given south-of-Delta demand and a given Delta inflow, differences in model and historical project exports are indicative of how well the model represents the regulatory operating constraints to which the projects must comply, and how the model simulates storage operations in the San Luis Reservoir.

Conclusions from the study can be framed in the form of answers to some frequently asked questions about CalSim II.

Does CalSim II overestimate the projects' ability to export water from the Delta?

For the supply constrained years 1987-1992, model exports from the Delta average 4,450 taf/yr compared to a historical six-year average of 4,460 taf/yr. This suggests that CalSim II's

	Dry-period average 1987-1992				Long-term average			
	Simulated	Historical	Difference		Simulated	Historical	Difference	
Performance parameter		taf/yr		%		taf/yr		%
SWP south-of-Delta Table A deliveries	1,930	2,030	-100	-4.9	1,810	1,790	20	1.1
CVP south-of-Delta deliveries	2,230	2,320	-90	-3.9	2,650	2,490	160	6.4
Sacramento Valley inflow to the Delta	9,700	9,670	30	0.3	19,830	19,920	-90	-0.5
Net Delta Outflow Index	5,270	5,090	180	3.5	19,070	19,690	-620	-3.1

simulation of the Delta operations is representative of actual historical conditions.

Does CalSim II overestimate the availability of surface water in the Delta by meeting Sacramento Valley in-basin use through excessive groundwater pumping?

The mix of surface water and groundwater used by the model to meet Sacramento Valley consumptive demands depends primarily on project water allocation decisions and levels of minimum groundwater pumping that are specified in the model. Over the 24-year period average annual net groundwater extraction in CalSim II as compared to estimates based on the Central Valley Groundwater Surface water Model (CVGSM) is lower by 378 taf. The average annual net stream inflow from groundwater in CalSim II is 190 taf greater than estimated by the CVGSM for the same period. The combined effect of dynamically modeling groundwater operations in CalSim II (pumping, recharge and stream-aquifer interaction) leads to 188 taf/yr less water being available to the Delta. For the 1987-1992 period the combined effect results in 46 taf/yr additional water being available to the Delta.

How well does CalSim II represent stream flows?

Differences in long-term average annual flows at key stream locations are typically 1.2 percent or less. It is noted that differences are larger for the Sacramento River at the Ord Ferry gage. At this location a proportion of the water diverted upstream returns downstream so that simulated river flows are sensitive to assumed model water use efficiencies.

How well does CalSim II simulate the Sacramento Valley system?

The net Sacramento Valley accretion is calculated as the Sacramento Valley Delta inflow less releases from Whiskeytown Reservoir, Keswick Reservoir, Lake Oroville and Folsom Lake. The historical 24-year average annual net accretion is 5,950 taf/yr compared with a model value of 5,920 taf/yr.

Do different reservoir operating rules in CalSim II translate into differences in project deliveries?

Simulated month-to-month and year-to-year model results can vary significantly from historical operations. This is primarily due to differences in storage operations. However when averaged over a longer period, model operations (stream flows and deliveries) are very close to historical.

2. CalSim II Model Sensitivity Analysis Study Technical Memorandum Report

Background

The sensitivity analysis is an important component of any water resources planning model evaluation. It enhances understanding of the model, builds greater public confidence, and expands public acceptance of the model. The sensitivity analysis explores and quantifies the effects of various inputs on the model outputs. With a simple sensitivity analysis procedure, variations of model input parameters are generally investigated one at a time. With a more complex procedure, the investigation is conducted by changing a set of input parameters simultaneously. For this study, the simple sensitivity study procedure is used.

The Sensitivity Analysis Study responds to the commitment in *The State Water Project Delivery Reliability Report 2002* to conduct such a study and to issues raised during the public review of that report. The sensitivity analysis study is also one of the recommendations by the CalSim II peer review sponsored by the CALFED Science Program in December 2003. The review panel recommended such a study would help identify key input parameters that have significant effects on the model output, and to provide a systematic way to measure the sensitivity of the model output to variations of key input parameters.

Study Objectives

There are three objectives of the CalSim II Sensitivity Analysis Study:

- to examine the behavior of the SWP-CVP system performance in response to variations in selected input parameters within CalSim-II

- to help SWP contractors and others understand the impact of key assumptions within CalSim II on the SWP delivery capability
- to aid CalSim II modelers for prioritizing future model development activities on the basis of sensitivities of input parameters

Study Description

The development of the CalSim II model is an ongoing effort. DWR and Reclamation periodically release updated versions of the model. This study uses the modified benchmark study of September 30, 2002, under the D-1641 regulatory environment as the base study.

The CalSim II model uses many input parameters to define the physical characteristics of the system, as well as the regulatory environment and operational parameters. Input parameters include time series, single dimensionless coefficients, or monthly distribution curves. Some input parameters are estimated from the historical data and others are user-input or calibrated values. After discussions with model developers and project operators, 21 model input parameters in four major categories and their reasonable ranges of variations were selected for this study. Similarly, there are many output variables in different categories, including reservoir storage, flows at key locations, Delta outflows, project exports and deliveries that characterize the overall outcome of any particular simulation run. After discussions with model users, project operators, and model developers, 22 key output variables that cover various aspects of the SWP-CVP system performance were selected.

In this study, two performance measures – Sensitivity Index (SI) and Elasticity Index (EI) – are used to quantify the model output sensitivity with respect to a certain model input parameter. The SI is a first-order derivative of a model output variable with respect to an input parameter. It can be used to measure the magnitude of change in an output variable per unit change in the magnitude of an input parameter from its base value. The EI is a dimensionless expression of sensitivity that measures the relative change in an output variable to a relative change in an input parameter. As an example, assuming SI = 0.5 and EI = 0.25 for the output variable of total Delta outflow with respect to the input parameter of Oroville inflow, means that for one thousand acre-feet (taf) increase in Oroville inflow, total Delta outflow increases by 0.5 taf; and for 1 percent increase in Oroville inflow, total Delta outflow increases by 0.25 percent, respectively.

Study Results and Discussions

The complete results of the study showing sensitivity and elasticity indices for each one of the selected output variables are listed in terms of their long-term (1922–1994) averages with respect to variations of input parameters. Table E-1 highlights the behavior of some of the key output variables that define the important aspects of SWP–CVP system performance. In Table E-1, the top row is the list of model input parameters and the left-most column is the list of model output variables. In general, each cell in the table contains two numbers except cells in Columns 8 and 9. The number inside parentheses is the SI value and the number outside parentheses is the EI value. Signs in front of SI and EI values can be either positive or negative. In general, the positive sign indicates that the output variable changes in the same direction as the input parameter. For example, as shown in the Row 1 of Column 1 in the table, when SWP Table A demand increases, SWP total delivery, which is the sum of SWP Delta delivery and FRSA delivery, increases as well (SI = +0.39). SWP Delta Delivery is defined as SWP Table A deliveries to South-of-Delta plus deliveries to North Bay (Solano and Napa Counties) contractors. FRSA delivery is defined as the sum of deliveries to the Settlement Contractors in Feather River Service Area (FRSA) and Table A deliveries to Butte and Yuba Counties. The negative sign indicates that the output variable changes in the opposite direction as the input parameter. For example, as shown in the Row 5 of Column 1 in the table, when SWP Table A demand increases, Article 21 delivery decreases (SI = -0.13). In order to highlight relative sensitivity of the various input parameters, a color coded cell background has been used. A red color cell background represents a relatively higher sensitivity or (SI >= 0.2); yellow background represents a moderate sensitivity or (0.1 <= SI <= 0.2); and white background shows a lower sensitivity or (SI <= 0.1).

Table E-1 Summary excerpt of Elasticity Index (EI) and Sensitivity Index (SI) for selected variables from Table 2

Model Output Response		Model Input Parameters											
		SWP Table A Demand	Article 21 Demand	Banks Pumping Limit	Historical Land Use	Projected Land Use	Crop ET	Basin Efficiency	SWP Delivery-Carryover Curve	SWP San Luis Rule Curve	Shasta Inflow	Oroville Inflow	Folsom Inflow
		1	2	3	4	5	6	7	8	9	10	11	12
1	**SWP Total Delivery**	0.31 (0.39)	0.01 (0.16)	0.15 (1.45)	0.09 (-0.13)	-0.05 (-0.03)	0.00 (0.00)*	-0.15 (0.10)	-0.01	0.02	0.07 (0.05)	0.18 (0.19)	0.05 (0.14)
2	**CVP total Delivery**	-0.01 (-0.01)	0.00 (0.00)*	-0.01 (-0.12)	0.10 (-0.18)	0.14 (0.11)	0.16 (0.09)	-0.32 (0.26)	0.00*	0.00*	0.25 (0.22)	0.05 (0.07)	0.03 (0.09)
3	**SWP SOD Delivery**	0.55 (0.52)	0.00 (-0.01)	0.07 (0.48)	0.12 (-0.13)	-0.09 (-0.04)	-0.21 (-0.08)	-0.17 (0.08)	-0.02	0.00*	0.08 (0.04)	0.26 (0.20)	0.05 (0.12)
4	**SWP NOD Delivery**	-0.01 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.17 (0.02)	0.78 (0.08)	-0.17 (0.02)	0.00	0.00*	0.00 (0.00)	0.01 (0.00)	0.00 (0.00)
5	**Article 21 Delivery**	-2.62 (-0.13)	0.15 (0.17)	2.63 (0.96)	-0.05 (0.00)*	-0.45 (-0.01)	-0.03 (0.00)*	0.30 (-0.01)	0.08	0.46	0.34 (0.01)	-0.51 (-0.02)	0.16 (0.02)
6	**CVP SOD Delivery**	-0.01 (-0.01)	0.00 (0.00)*	-0.02 (-0.10)	0.15 (-0.15)	-0.25 (-0.11)	-0.27 (-0.09)	-0.10 (0.04)	0.00*	0.00*	0.38 (0.18)	0.08 (0.06)	0.04 (0.08)
7	**CVP NOD Delivery**	0.00 (0.00)	0.00 (0.00)*	0.00 (-0.02)	0.03 (-0.03)	0.59 (0.21)	0.66 (0.18)	-0.59 (0.22)	0.00*	0.00*	0.10 (0.04)	0.02 (0.01)	0.01 (0.01)
8	**Total Delta Outflow**	-0.08 (-0.35)	0.00 (-0.16)	-0.04 (-1.48)	0.07 (-0.36)	-0.09 (-0.22)	-0.18 (-0.30)	-0.07 (0.15)	0.00	0.00	0.27 (0.69)	0.20 (0.74)	0.07 (0.75)
9	**Banks Export**	0.35 (0.37)	0.01 (0.16)	0.20 (1.63)	0.11 (-0.14)	-0.11 (-0.06)	-0.20 (-0.08)	-0.14 (0.08)	-0.01	0.02	0.10 (0.06)	0.21 (0.18)	0.05 (0.14)
10	**Tracy Export**	-0.01 (-0.01)	0.00 (0.00)*	-0.02 (-0.10)	0.16 (-0.15)	-0.25 (-0.10)	-0.28 (-0.09)	-0.10 (0.04)	0.00*	0.00*	0.39 (0.18)	0.09 (0.06)	0.04 (0.08)
11	**Banks SWP Export**	0.37 (0.38)	0.01 (0.16)	0.18 (1.46)	0.11 (-0.13)	-0.10 (-0.05)	-0.20 (-0.08)	-0.14 (0.07)	-0.01	0.02	0.08 (0.05)	0.22 (0.18)	0.06 (0.14)
12	**Banks CVP Export**	-0.53 (-0.02)	0.00 (0.00)	0.79 (0.17)	0.42 (-0.01)	-0.37 (-0.01)	-0.43 (0.00)	-0.31 (0.00)	0.00	0.02	0.86 (0.01)	0.04 (0.00)	0.02 (0.00)*

Note: (1) Values inside parentheses are SI and outside are EI. Values with asterisks indicate that EI and SI are not monotonic functions.

(2) Cell with an asterisk (*) indicates that the SI and EI of that output variable are non-monotonic functions of the corresponding input parameter. Please refer to the main report for details.

High Sensitivity	0.2 < |SI|
Moderate Sensitivity	0.1 <= |SI| <= 0.2
Low Sensitivity	|SI| < 0.1

An examination of Row 3 of Table E-1 highlights the behavior of SWP Delta delivery with respect to changes in some of the key input parameters. It shows that the SWP Table A demand, the Banks pumping limit, and the Oroville inflow affect SWP Delta delivery the most. Folsom inflow and historical land use display moderate effects on the SWP Delta delivery. A positive SI of 0.52 for the SWP Table A demand indicates that the SWP Delta delivery will increase by an average of 0.52 taf if the SWP Table A demand increases by 1 taf; and a positive EI of 0.55 for the SWP Table A demand indicates that the SWP Delta delivery will increase by an average of 0.55 percent if the SWP Table A demand increases by one percent. Similarly, a positive SI of 0.20 for the Oroville inflow indicates that the SWP Delta delivery will increase by an average of 0.20 taf if the Oroville inflow increases by 1 taf; and a positive EI of 0.26 for the Oroville inflow indicates that the SWP Delta delivery will increase by an average of 0.26 percent if the Oroville inflow increases by one percent.

No SI values are computed for input parameters of the SWP Delivery-Carryover Curve and the SWP San Luis Rule-curve (see Columns 8 and 9) because the equivalent changes in the commensurate units of taf are difficult to define for these two parameters. A more detailed discussion of their impact on the SWP Delta delivery is presented in the Memorandum Report.

Future Work

Further analysis of this sensitivity study will be done to develop more detailed findings regarding the impact of various parameters on SWP Delta deliveries.

This sensitivity study is mainly focused on Sacramento Valley hydrology, Sacramento-San Joaquin Delta water quality, and SWP operations. Additional sensitivity studies focused on San Joaquin Valley hydrology and CVP operations are planned for the near future by Reclamation.

Linear programming solution methodology used in the CalSim II model has the potential to produce an array of sensitivity analyses as a by-product of the linear programming analysis automatically. Discussion of these results will provide a degree of transparency to model users and an internal diagnostic tool that the current CalSim II does not provide. Studying these by-products of the linear programming solution procedure will be considered during the development of the next generation of the CalSim II model.

The CALFED report, A Strategic Review of CalSim-II and its Use for Water Planning, Management, and Operations in Central California (December 2003), recommends a model uncertainty analysis be conducted. An uncertainty analysis is not the same as a sensitivity analysis. It takes a set of randomly chosen input values (that can include parameter values), passes them through a model to obtain the probability distributions (or statistical measures of the probability distributions) of the resulting outputs, while a sensitivity analysis attempts to determine the relative change in model output values given modest changes in model input values. The uncertainty analysis would help users of the model understand better the risks of various decisions and the confidence they can have in various model predictions. DWR is currently working on a contract with University of California, Davis to develop a strategy for the evaluation of the major sources of uncertainty in CalSim II modeling studies, and to implement a recommended procedure for the quantification of uncertainties in a CalSim II study.

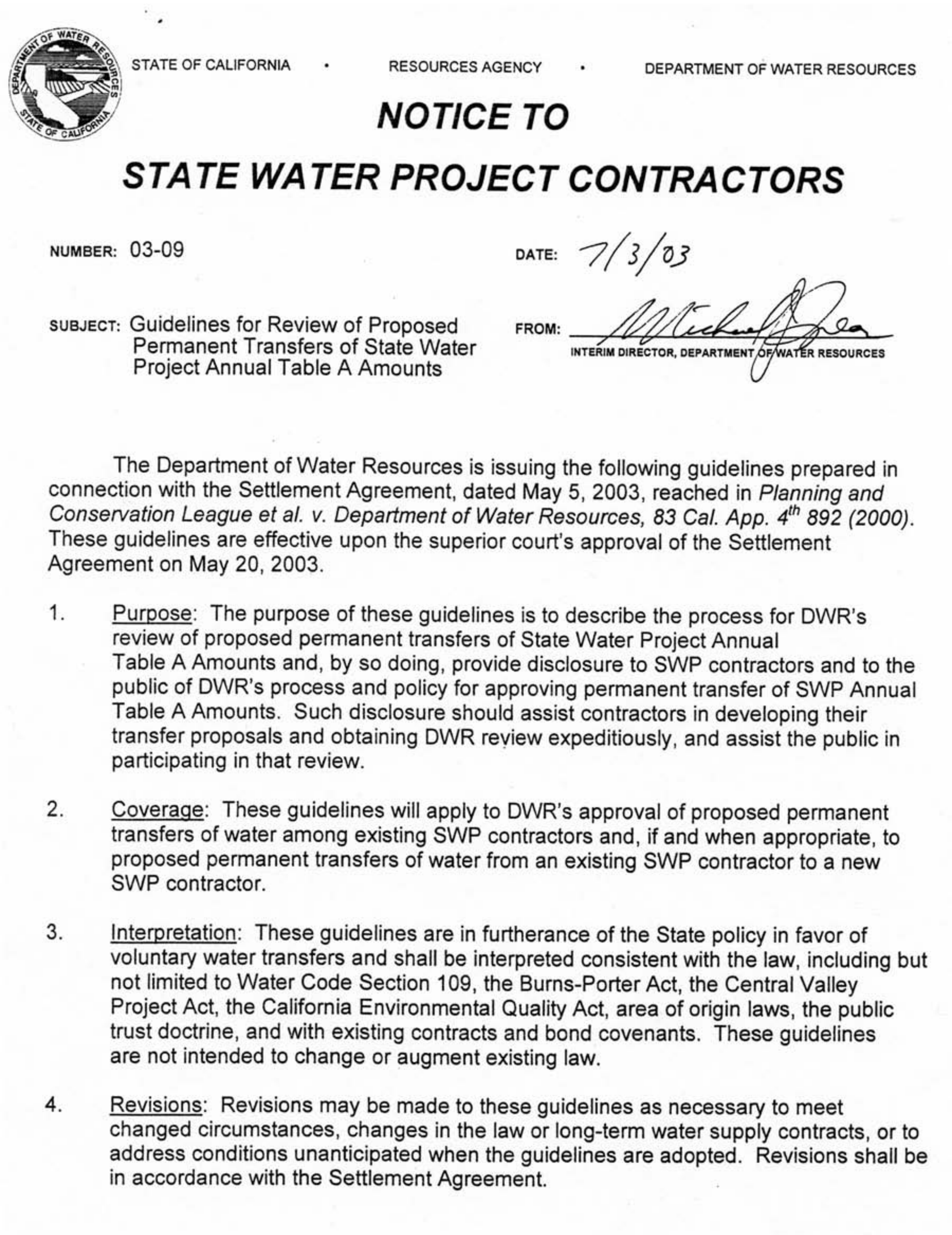
Websites for the Memorandum Reports:

1. [DWR] California Department of Water Resources, Bay-Delta Office. 2003. CalSim II Simulation of Historical SWP/CVP Operations. Technical Memorandum Report. Availability: http://science.calwater.ca.gov/pdf/CalSimII_Simulation.pdf

2. [DWR] California Department of Resources, Bay-Delta Office. 2005. CalSim II Model Sensitivity Analysis Study. Technical Memorandum Report. Availability: http://baydeltaoffice.water.ca.gov/

Appendix F. Guidelines for Review of Proposed Permanent Transfers of SWP Annual Table A Amounts

This appendix contains a copy of the Notice to State Water Project Contractors Number 03-09 entitled "Guidelines for Review of Proposed Permanent Transfers of State Water Project Annual Table A Amounts". These guidelines are being included per the Settlement Agreement, dated May 5, 2003, reached in the Planning and Conservation League et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000).



STATE OF CALIFORNIA • RESOURCES AGENCY • DEPARTMENT OF WATER RESOURCES

NOTICE TO STATE WATER PROJECT CONTRACTORS

NUMBER: 03-09

DATE: 7/3/03

SUBJECT: Guidelines for Review of Proposed Permanent Transfers of State Water Project Annual Table A Amounts

FROM: INTERIM DIRECTOR, DEPARTMENT OF WATER RESOURCES

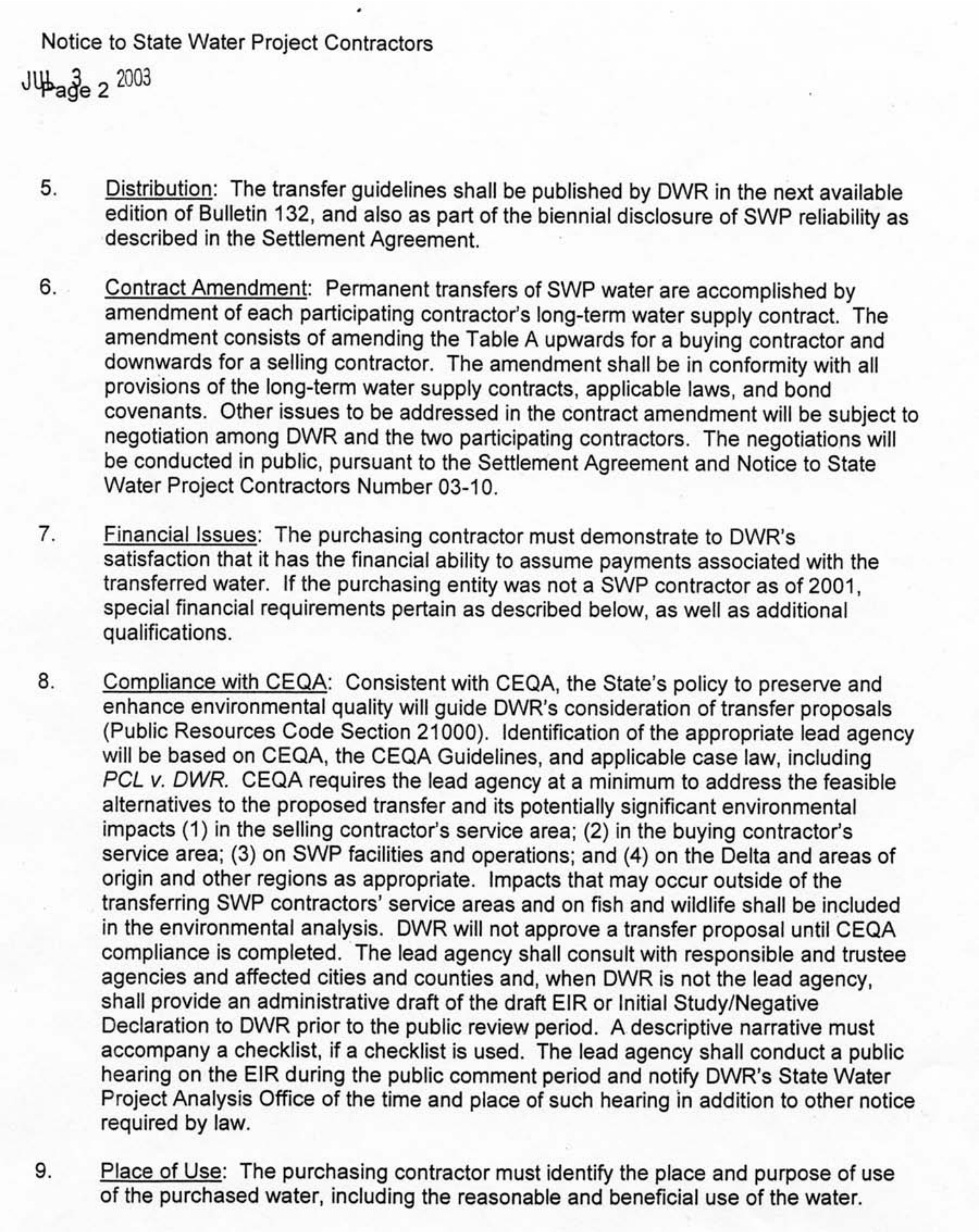
The Department of Water Resources is issuing the following guidelines prepared in connection with the Settlement Agreement, dated May 5, 2003, reached in *Planning and Conservation League et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000).* These guidelines are effective upon the superior court's approval of the Settlement Agreement on May 20, 2003.

1. Purpose: The purpose of these guidelines is to describe the process for DWR's review of proposed permanent transfers of State Water Project Annual Table A Amounts and, by so doing, provide disclosure to SWP contractors and to the public of DWR's process and policy for approving permanent transfer of SWP Annual Table A Amounts. Such disclosure should assist contractors in developing their transfer proposals and obtaining DWR review expeditiously, and assist the public in participating in that review.

2. Coverage: These guidelines will apply to DWR's approval of proposed permanent transfers of water among existing SWP contractors and, if and when appropriate, to proposed permanent transfers of water from an existing SWP contractor to a new SWP contractor.

3. Interpretation: These guidelines are in furtherance of the State policy in favor of voluntary water transfers and shall be interpreted consistent with the law, including but not limited to Water Code Section 109, the Burns-Porter Act, the Central Valley Project Act, the California Environmental Quality Act, area of origin laws, the public trust doctrine, and with existing contracts and bond covenants. These guidelines are not intended to change or augment existing law.

4. Revisions: Revisions may be made to these guidelines as necessary to meet changed circumstances, changes in the law or long-term water supply contracts, or to address conditions unanticipated when the guidelines are adopted. Revisions shall be in accordance with the Settlement Agreement.



Notice to State Water Project Contractors
Page 2
JUL 3 2003

5. Distribution: The transfer guidelines shall be published by DWR in the next available edition of Bulletin 132, and also as part of the biennial disclosure of SWP reliability as described in the Settlement Agreement.

6. Contract Amendment: Permanent transfers of SWP water are accomplished by amendment of each participating contractor's long-term water supply contract. The amendment consists of amending the Table A upwards for a buying contractor and downwards for a selling contractor. The amendment shall be in conformity with all provisions of the long-term water supply contracts, applicable laws, and bond covenants. Other issues to be addressed in the contract amendment will be subject to negotiation among DWR and the two participating contractors. The negotiations will be conducted in public, pursuant to the Settlement Agreement and Notice to State Water Project Contractors Number 03-10.

7. Financial Issues: The purchasing contractor must demonstrate to DWR's satisfaction that it has the financial ability to assume payments associated with the transferred water. If the purchasing entity was not a SWP contractor as of 2001, special financial requirements pertain as described below, as well as additional qualifications.

8. Compliance with CEQA: Consistent with CEQA, the State's policy to preserve and enhance environmental quality will guide DWR's consideration of transfer proposals (Public Resources Code Section 21000). Identification of the appropriate lead agency will be based on CEQA, the CEQA Guidelines, and applicable case law, including *PCL v. DWR.* CEQA requires the lead agency at a minimum to address the feasible alternatives to the proposed transfer and its potentially significant environmental impacts (1) in the selling contractor's service area; (2) in the buying contractor's service area; (3) on SWP facilities and operations; and (4) on the Delta and areas of origin and other regions as appropriate. Impacts that may occur outside of the transferring SWP contractors' service areas and on fish and wildlife shall be included in the environmental analysis. DWR will not approve a transfer proposal until CEQA compliance is completed. The lead agency shall consult with responsible and trustee agencies and affected cities and counties and, when DWR is not the lead agency, shall provide an administrative draft of the draft EIR or Initial Study/Negative Declaration to DWR prior to the public review period. A descriptive narrative must accompany a checklist, if a checklist is used. The lead agency shall conduct a public hearing on the EIR during the public comment period and notify DWR's State Water Project Analysis Office of the time and place of such hearing in addition to other notice required by law.

9. Place of Use: The purchasing contractor must identify the place and purpose of use of the purchased water, including the reasonable and beneficial use of the water.

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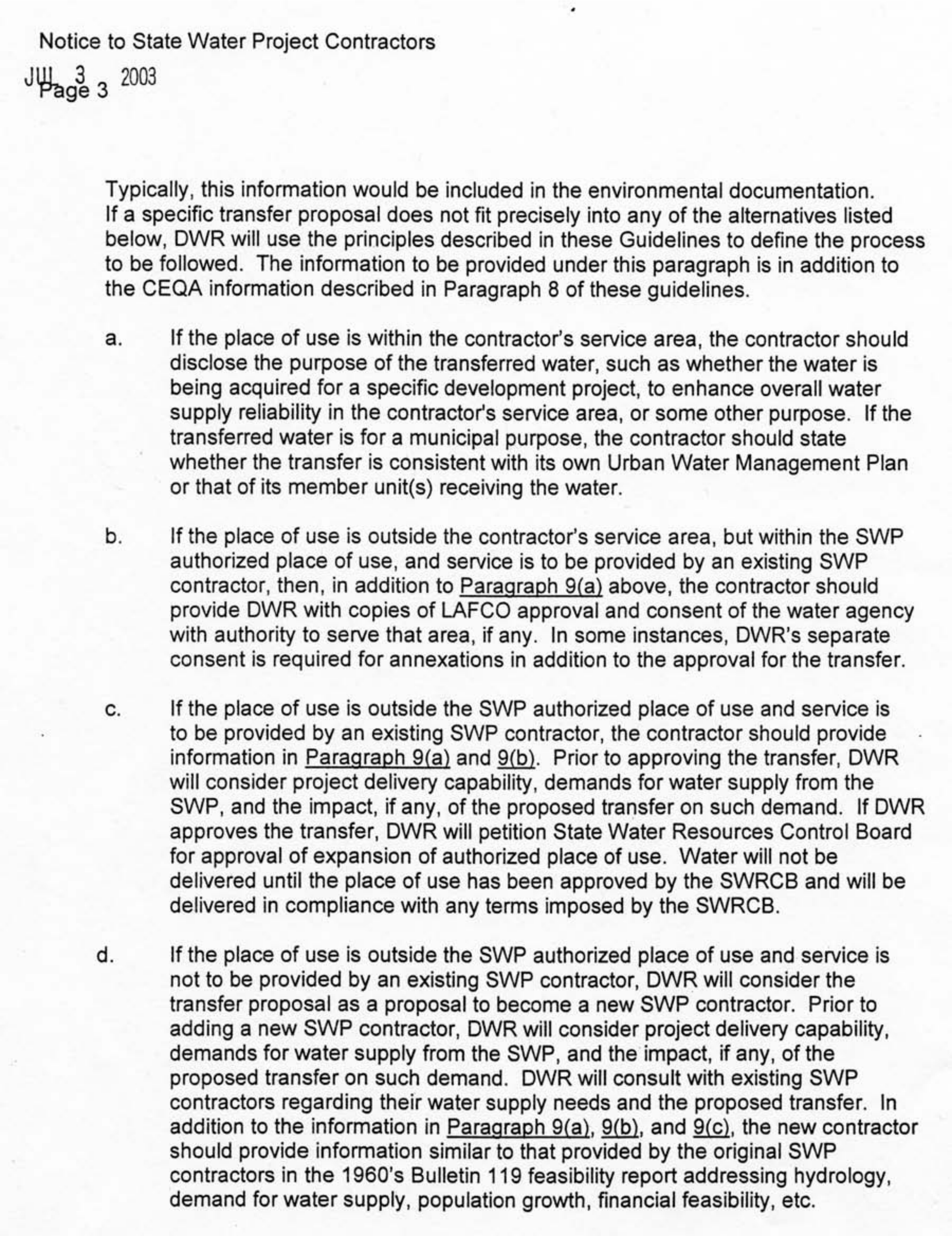


Notice to State Water Project Contractors

JUL 3 2003

Page 3

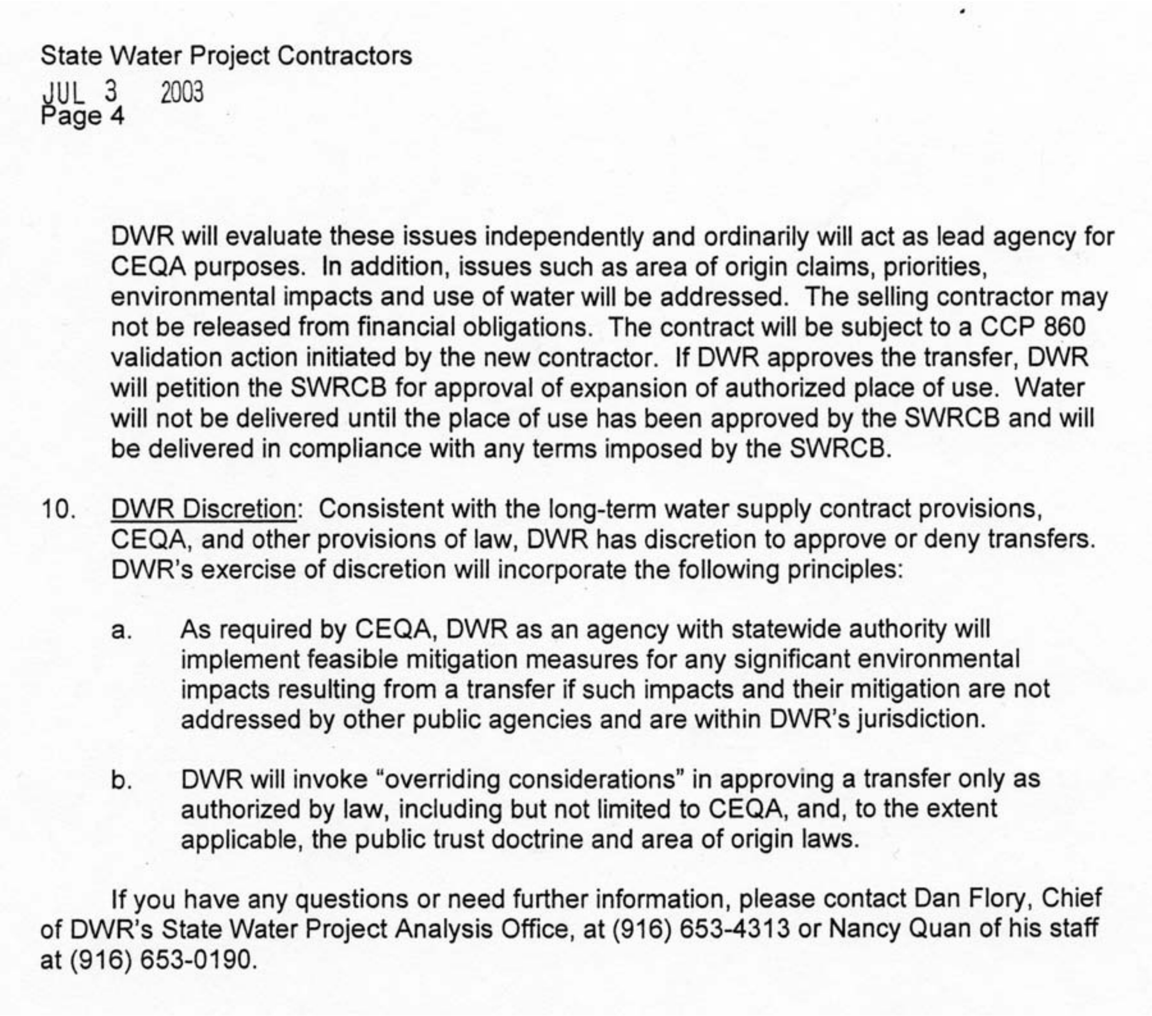
Typically, this information would be included in the environmental documentation. If a specific transfer proposal does not fit precisely into any of the alternatives listed below, DWR will use the principles described in these Guidelines to define the process to be followed. The information to be provided under this paragraph is in addition to the CEQA information described in Paragraph 8 of these guidelines.

a. If the place of use is within the contractor's service area, the contractor should disclose the purpose of the transferred water, such as whether the water is being acquired for a specific development project, to enhance overall water supply reliability in the contractor's service area, or some other purpose. If the transferred water is for a municipal purpose, the contractor should state whether the transfer is consistent with its own Urban Water Management Plan or that of its member unit(s) receiving the water.

b. If the place of use is outside the contractor's service area, but within the SWP authorized place of use, and service is to be provided by an existing SWP contractor, then, in addition to Paragraph 9(a) above, the contractor should provide DWR with copies of LAFCO approval and consent of the water agency with authority to serve that area, if any. In some instances, DWR's separate consent is required for annexations in addition to the approval for the transfer.

c. If the place of use is outside the SWP authorized place of use and service is to be provided by an existing SWP contractor, the contractor should provide information in Paragraph 9(a) and 9(b). Prior to approving the transfer, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

d. If the place of use is outside the SWP authorized place of use and service is not to be provided by an existing SWP contractor, DWR will consider the transfer proposal as a proposal to become a new SWP contractor. Prior to adding a new SWP contractor, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. DWR will consult with existing SWP contractors regarding their water supply needs and the proposed transfer. In addition to the information in Paragraph 9(a), 9(b), and 9(c), the new contractor should provide information similar to that provided by the original SWP contractors in the 1960's Bulletin 119 feasibility report addressing hydrology, demand for water supply, population growth, financial feasibility, etc.



State Water Project Contractors
JUL 3 2003
Page 4

DWR will evaluate these issues independently and ordinarily will act as lead agency for CEQA purposes. In addition, issues such as area of origin claims, priorities, environmental impacts and use of water will be addressed. The selling contractor may not be released from financial obligations. The contract will be subject to a CCP 860 validation action initiated by the new contractor. If DWR approves the transfer, DWR will petition the SWRCB for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

10. DWR Discretion: Consistent with the long-term water supply contract provisions, CEQA, and other provisions of law, DWR has discretion to approve or deny transfers. DWR's exercise of discretion will incorporate the following principles:

    a. As required by CEQA, DWR as an agency with statewide authority will implement feasible mitigation measures for any significant environmental impacts resulting from a transfer if such impacts and their mitigation are not addressed by other public agencies and are within DWR's jurisdiction.

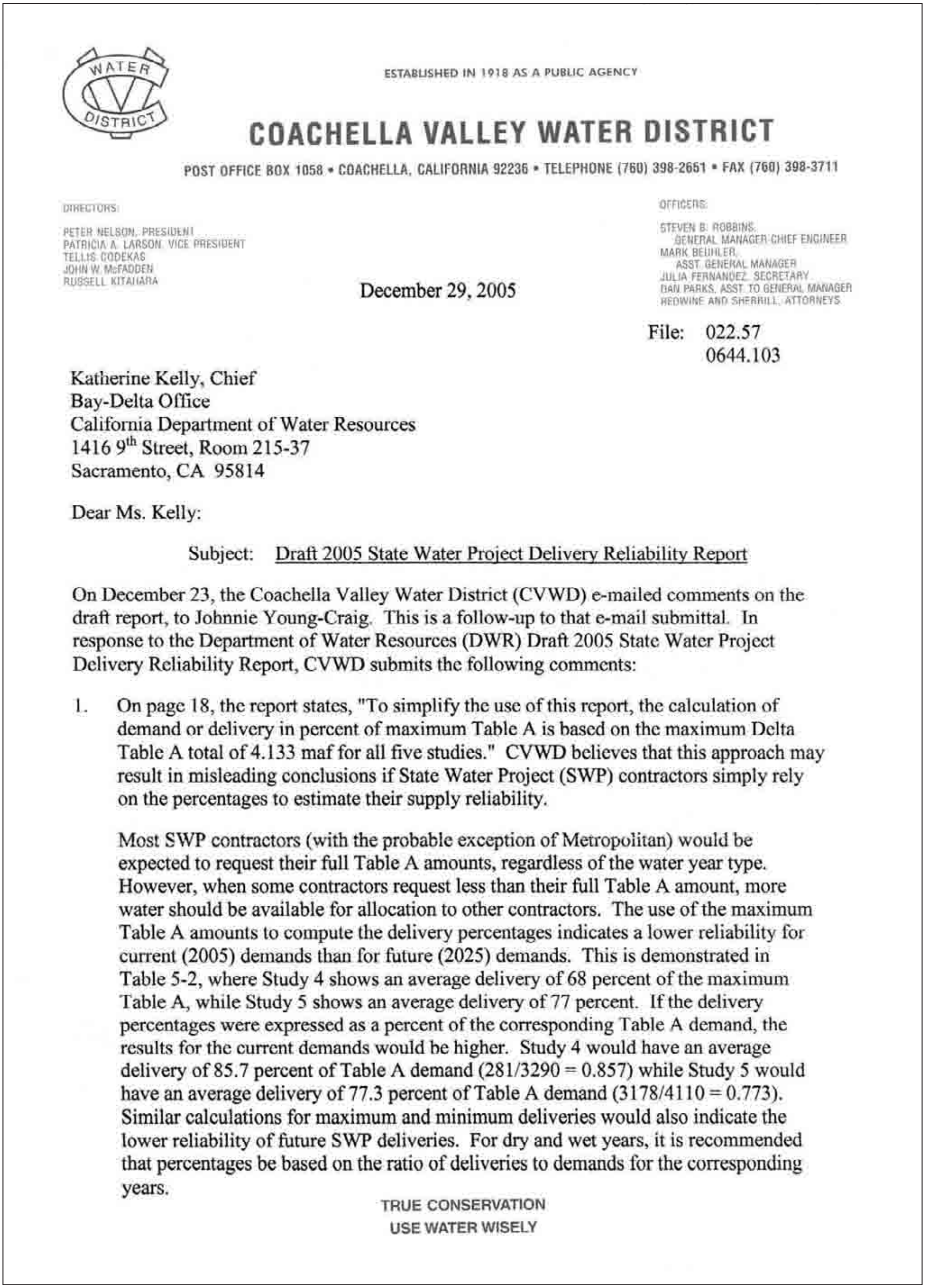
    b. DWR will invoke "overriding considerations" in approving a transfer only as authorized by law, including but not limited to CEQA, and, to the extent applicable, the public trust doctrine and area of origin laws.

If you have any questions or need further information, please contact Dan Flory, Chief of DWR's State Water Project Analysis Office, at (916) 653-4313 or Nancy Quan of his staff at (916) 653-0190.

Appendix G. Comment Letters on the Draft Report and the Department's Responses

Written comments from the public on the *Draft State Water Project Delivery Reliability Report* (November 2005) were accepted through December 2005. DWR reviewed the letters and made appropriate modifications to the report. These letters and the responses to them are contained in this appendix.

Index



ESTABLISHED IN 1918 AS A PUBLIC AGENCY

COACHELLA VALLEY WATER DISTRICT

POST OFFICE BOX 1058 • COACHELLA, CALIFORNIA 92236 • TELEPHONE (760) 398-2651 • FAX (760) 398-3711

December 29, 2005

File: 022.57
0644.103

Katherine Kelly, Chief
Bay-Delta Office
California Department of Water Resources
1416 9th Street, Room 215-37
Sacramento, CA 95814

Dear Ms. Kelly:

Subject: Draft 2005 State Water Project Delivery Reliability Report

On December 23, the Coachella Valley Water District (CVWD) e-mailed comments on the draft report, to Johnnie Young-Craig. This is a follow-up to that e-mail submittal. In response to the Department of Water Resources (DWR) Draft 2005 State Water Project Delivery Reliability Report, CVWD submits the following comments:

1. On page 18, the report states, "To simplify the use of this report, the calculation of demand or delivery in percent of maximum Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies." CVWD believes that this approach may result in misleading conclusions if State Water Project (SWP) contractors simply rely on the percentages to estimate their supply reliability.

   Most SWP contractors (with the probable exception of Metropolitan) would be expected to request their full Table A amounts, regardless of the water year type. However, when some contractors request less than their full Table A amount, more water should be available for allocation to other contractors. The use of the maximum Table A amounts to compute the delivery percentages indicates a lower reliability for current (2005) demands than for future (2025) demands. This is demonstrated in Table 5-2, where Study 4 shows an average delivery of 68 percent of the maximum Table A, while Study 5 shows an average delivery of 77 percent. If the delivery percentages were expressed as a percent of the corresponding Table A demand, the results for the current demands would be higher. Study 4 would have an average delivery of 85.7 percent of Table A demand (281/3290 = 0.857) while Study 5 would have an average delivery of 77.3 percent of Table A demand (3178/4110 = 0.773). Similar calculations for maximum and minimum deliveries would also indicate the lower reliability of future SWP deliveries. For dry and wet years, it is recommended that percentages be based on the ratio of deliveries to demands for the corresponding years.

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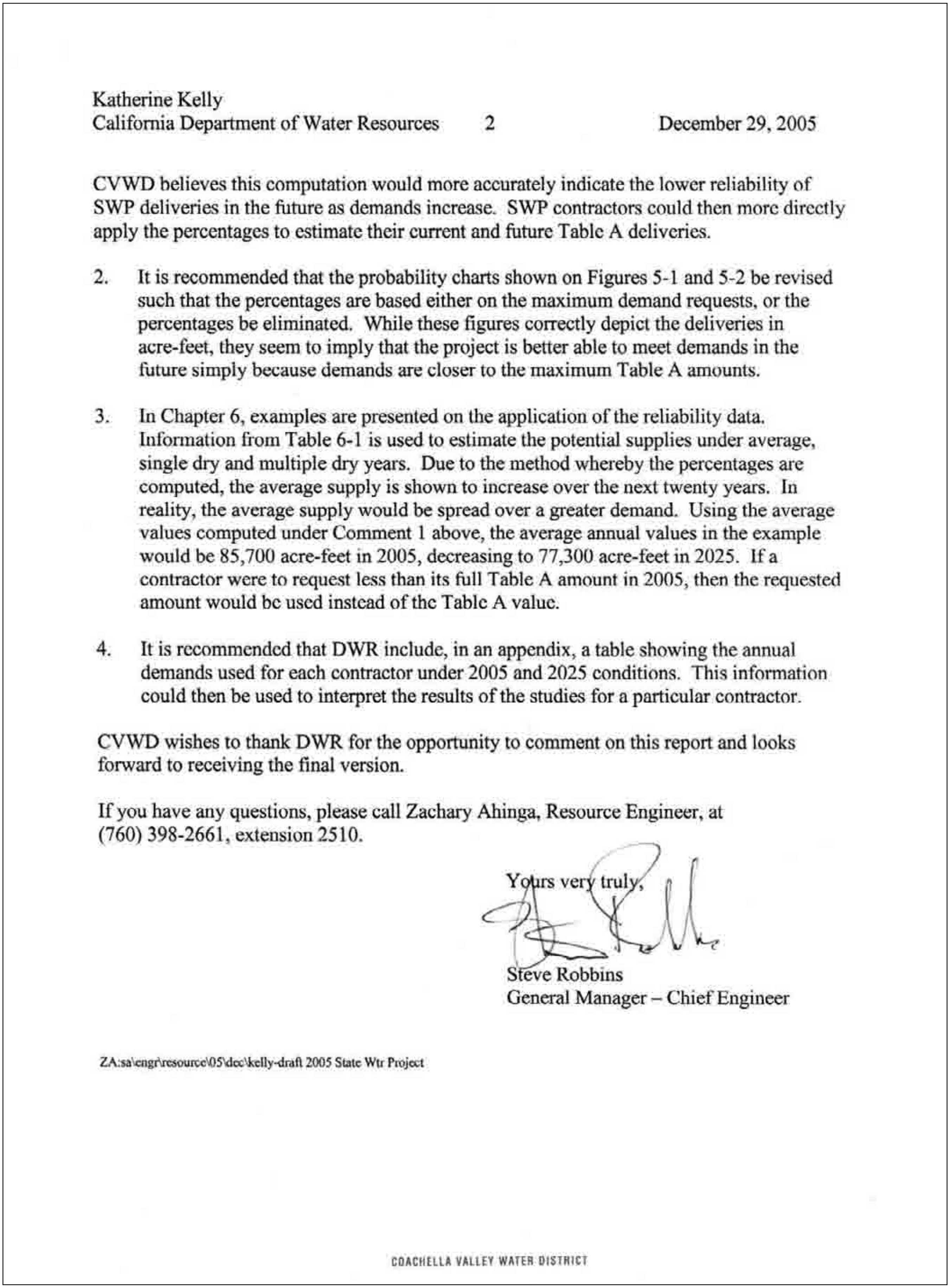


Katherine Kelly
California Department of Water Resources 2 December 29, 2005

CVWD believes this computation would more accurately indicate the lower reliability of SWP deliveries in the future as demands increase. SWP contractors could then more directly apply the percentages to estimate their current and future Table A deliveries.

2. It is recommended that the probability charts shown on Figures 5-1 and 5-2 be revised such that the percentages are based either on the maximum demand requests, or the percentages be eliminated. While these figures correctly depict the deliveries in acre-feet, they seem to imply that the project is better able to meet demands in the future simply because demands are closer to the maximum Table A amounts.

3. In Chapter 6, examples are presented on the application of the reliability data. Information from Table 6-1 is used to estimate the potential supplies under average, single dry and multiple dry years. Due to the method whereby the percentages are computed, the average supply is shown to increase over the next twenty years. In reality, the average supply would be spread over a greater demand. Using the average values computed under Comment 1 above, the average annual values in the example would be 85,700 acre-feet in 2005, decreasing to 77,300 acre-feet in 2025. If a contractor were to request less than its full Table A amount in 2005, then the requested amount would be used instead of the Table A value.

4. It is recommended that DWR include, in an appendix, a table showing the annual demands used for each contractor under 2005 and 2025 conditions. This information could then be used to interpret the results of the studies for a particular contractor.

CVWD wishes to thank DWR for the opportunity to comment on this report and looks forward to receiving the final version.

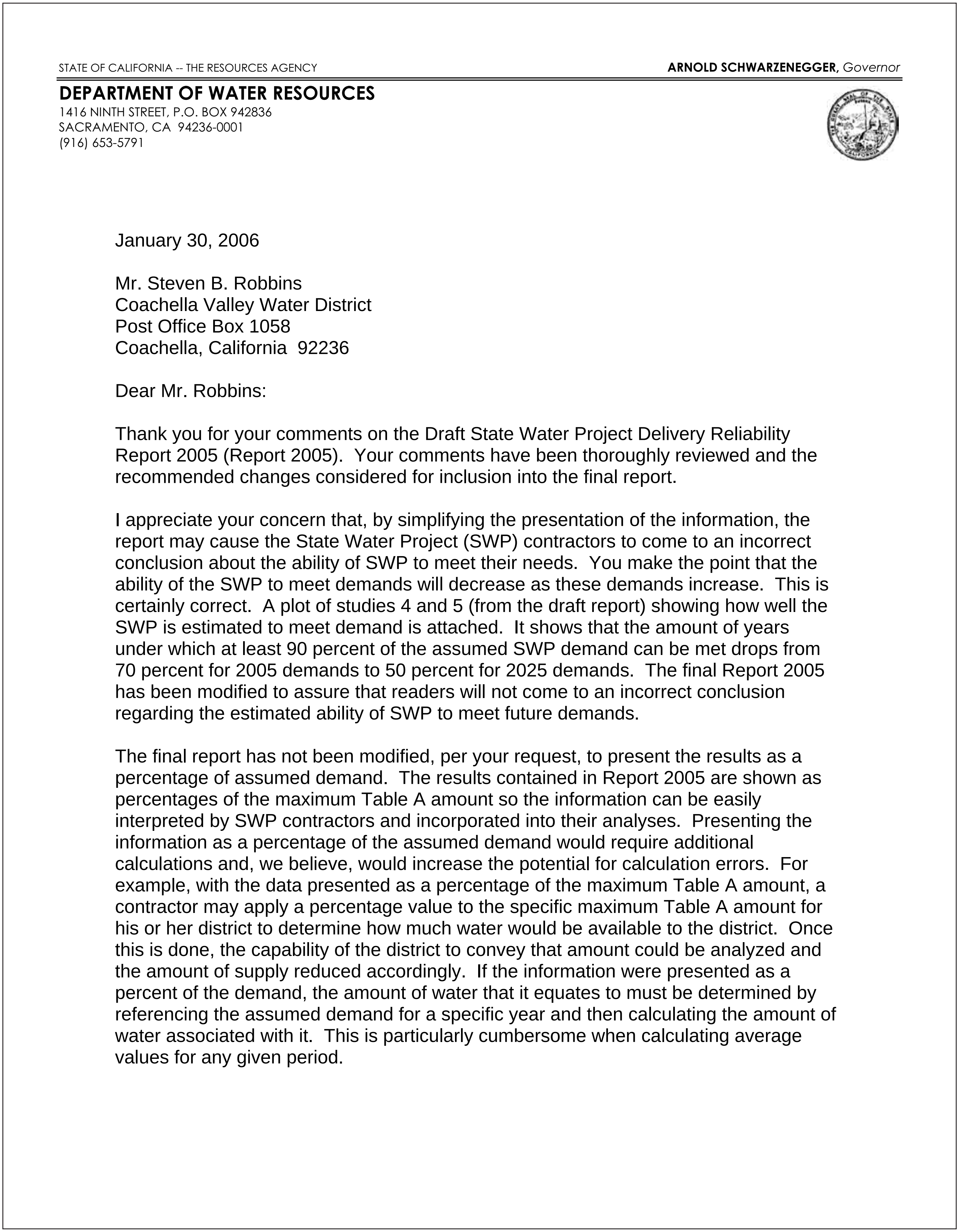
If you have any questions, please call Zachary Ahinga, Resource Engineer, at (760) 398-2661, extension 2510.

Yours very truly,

Steve Robbins
General Manager – Chief Engineer

ZA:sa\engr\resource\05\dec\kelly-draft 2005 State Wtr Project

COACHELLA VALLEY WATER DISTRICT



STATE OF CALIFORNIA -- THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

January 30, 2006

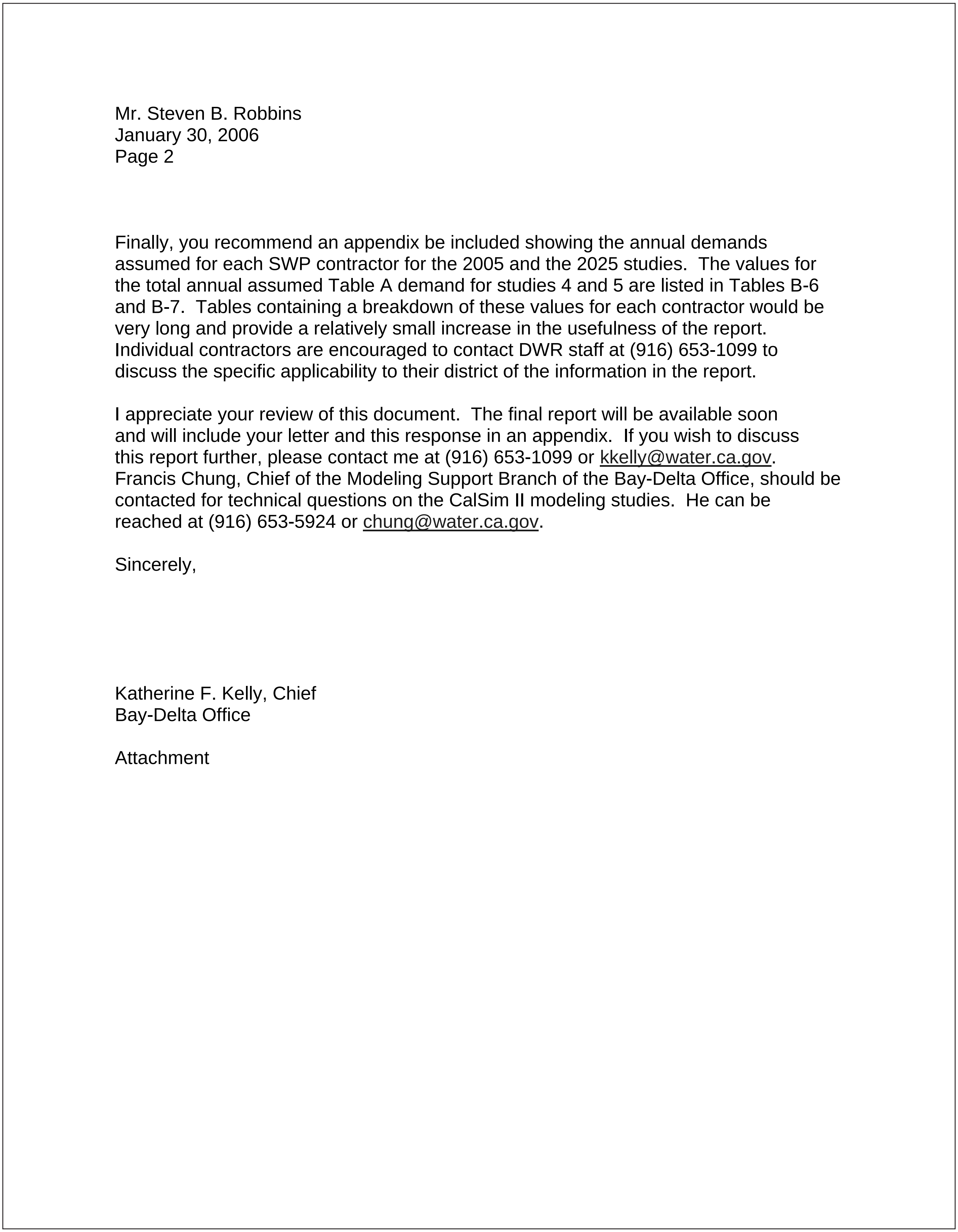
Mr. Steven B. Robbins
Coachella Valley Water District
Post Office Box 1058
Coachella, California 92236

Dear Mr. Robbins:

Thank you for your comments on the Draft State Water Project Delivery Reliability Report 2005 (Report 2005). Your comments have been thoroughly reviewed and the recommended changes considered for inclusion into the final report.

I appreciate your concern that, by simplifying the presentation of the information, the report may cause the State Water Project (SWP) contractors to come to an incorrect conclusion about the ability of SWP to meet their needs. You make the point that the ability of the SWP to meet demands will decrease as these demands increase. This is certainly correct. A plot of studies 4 and 5 (from the draft report) showing how well the SWP is estimated to meet demand is attached. It shows that the amount of years under which at least 90 percent of the assumed SWP demand can be met drops from 70 percent for 2005 demands to 50 percent for 2025 demands. The final Report 2005 has been modified to assure that readers will not come to an incorrect conclusion regarding the estimated ability of SWP to meet future demands.

The final report has not been modified, per your request, to present the results as a percentage of assumed demand. The results contained in Report 2005 are shown as percentages of the maximum Table A amount so the information can be easily interpreted by SWP contractors and incorporated into their analyses. Presenting the information as a percentage of the assumed demand would require additional calculations and, we believe, would increase the potential for calculation errors. For example, with the data presented as a percentage of the maximum Table A amount, a contractor may apply a percentage value to the specific maximum Table A amount for his or her district to determine how much water would be available to the district. Once this is done, the capability of the district to convey that amount could be analyzed and the amount of supply reduced accordingly. If the information were presented as a percent of the demand, the amount of water that it equates to must be determined by referencing the assumed demand for a specific year and then calculating the amount of water associated with it. This is particularly cumbersome when calculating average values for any given period.



Mr. Steven B. Robbins
January 30, 2006
Page 2

Finally, you recommend an appendix be included showing the annual demands assumed for each SWP contractor for the 2005 and the 2025 studies. The values for the total annual assumed Table A demand for studies 4 and 5 are listed in Tables B-6 and B-7. Tables containing a breakdown of these values for each contractor would be very long and provide a relatively small increase in the usefulness of the report. Individual contractors are encouraged to contact DWR staff at (916) 653-1099 to discuss the specific applicability to their district of the information in the report.

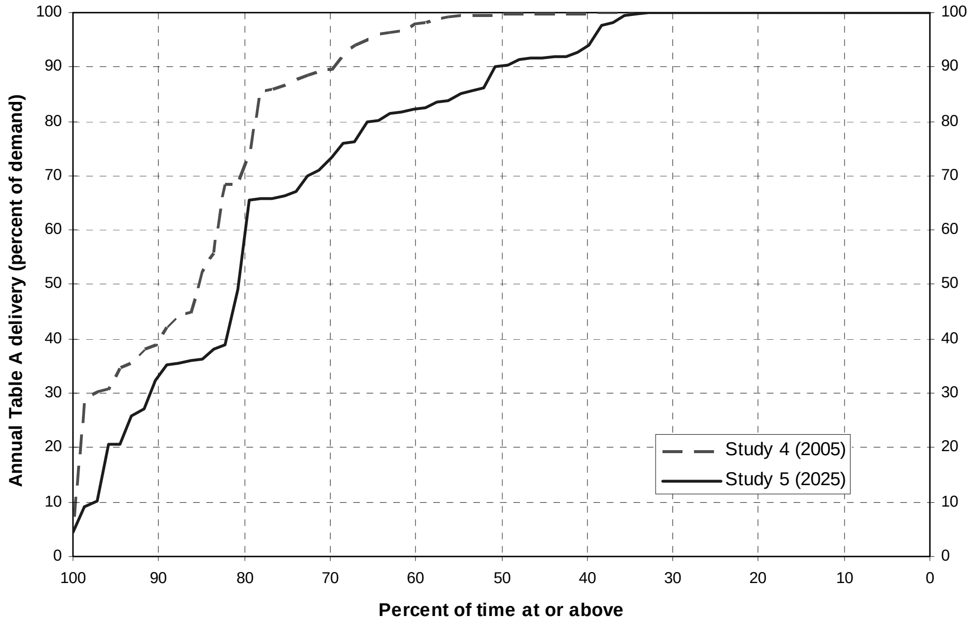
I appreciate your review of this document. The final report will be available soon and will include your letter and this response in an appendix. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim II modeling studies. He can be reached at (916) 653-5924 or chung@water.ca.gov.

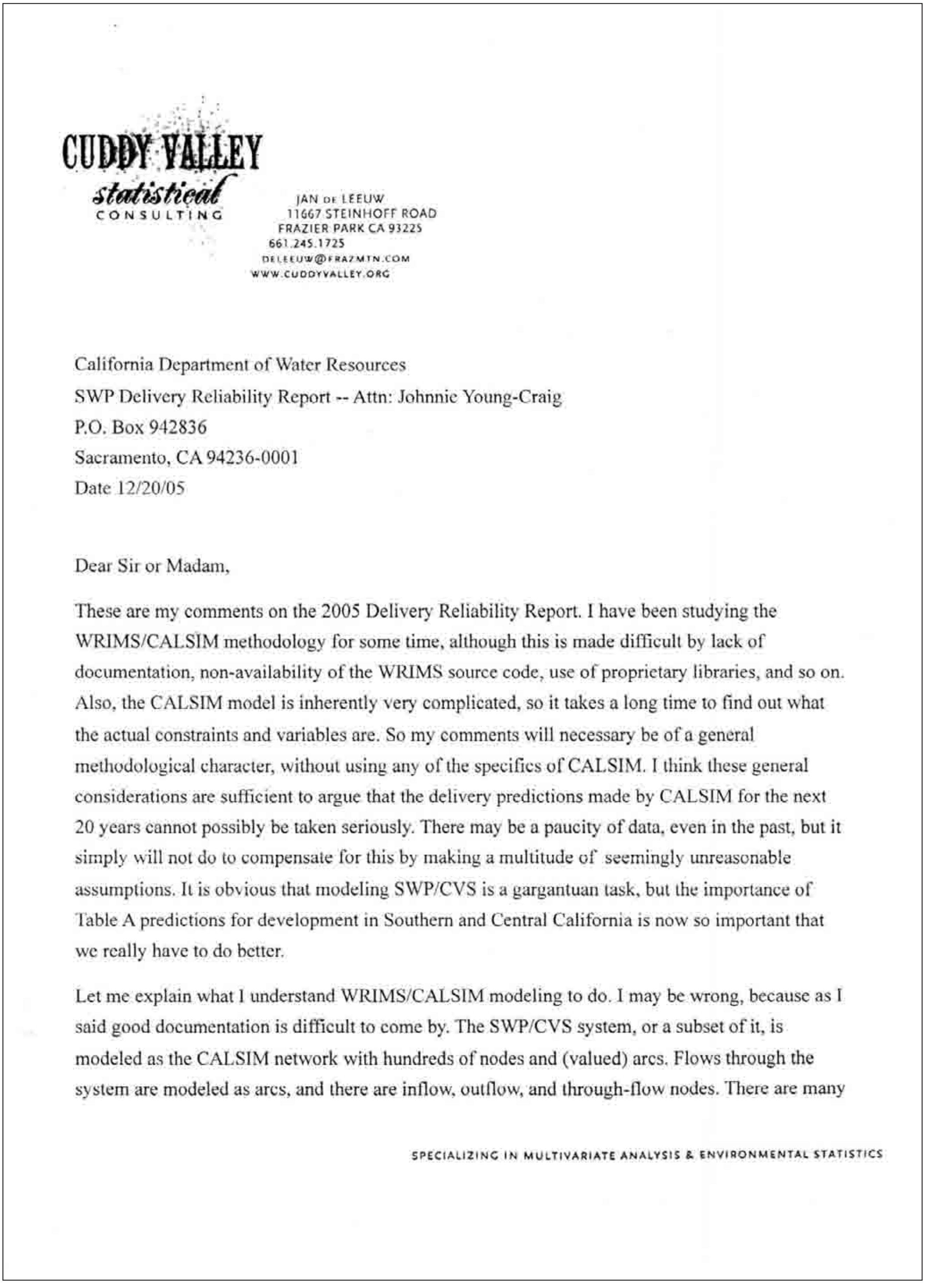
Sincerely,

Katherine F. Kelly, Chief
Bay-Delta Office

Attachment

SWP Delta Table A delivery probability for studies 4 and 5





CUDDY VALLEY
statistical
CONSULTING

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WWW.CUDDYVALLEY.ORG

California Department of Water Resources
SWP Delivery Reliability Report -- Attn: Johnnie Young-Craig
P.O. Box 942836
Sacramento, CA 94236-0001
Date 12/20/05

Dear Sir or Madam,

These are my comments on the 2005 Delivery Reliability Report. I have been studying the WRIMS/CALSIM methodology for some time, although this is made difficult by lack of documentation, non-availability of the WRIMS source code, use of proprietary libraries, and so on. Also, the CALSIM model is inherently very complicated, so it takes a long time to find out what the actual constraints and variables are. So my comments will necessary be of a general methodological character, without using any of the specifics of CALSIM. I think these general considerations are sufficient to argue that the delivery predictions made by CALSIM for the next 20 years cannot possibly be taken seriously. There may be a paucity of data, even in the past, but it simply will not do to compensate for this by making a multitude of seemingly unreasonable assumptions. It is obvious that modeling SWP/CVS is a gargantuan task, but the importance of Table A predictions for development in Southern and Central California is now so important that we really have to do better.

Let me explain what I understand WRIMS/CALSIM modeling to do. I may be wrong, because as I said good documentation is difficult to come by. The SWP/CVS system, or a subset of it, is modeled as the CALSIM network with hundreds of nodes and (valued) arcs. Flows through the system are modeled as arcs, and there are inflow, outflow, and through-flow nodes. There are many

SPECIALIZING IN MULTIVARIATE ANALYSIS & ENVIRONMENTAL STATISTICS constraints on the flows, depending on capacity, environmental regulations, demands, and balance of inflows and outflows at through-flow nodes. Some outflows are deliveries, some inflows are runoff and rainfall. The objective function is a combination of delivery outflows. We choose flows in such a way that (a) they satisfy the constraints, and (b) over all possible flows satisfying the constraints they maximize the objective function. In actual WRESL modeling the objective function and the constraints are linear, which means that the optimization is actually a linear programming network optimization method. I don't discuss complications, such as using mixed integer programming and soft constraints, which generally make matters worse anyway.

To discuss the results of this process, and the way they are presented, define a function F_N which gives as its value y the total delivery to the 29 SWP contractors and takes as input runoff and rainfall x. The structure of the CALSIM network, including all the constraints, is considered to be fixed. Thus F_N transforms runoff and rainfall x uniquely to delivery y, for a given structure of CALSIM (and for a given objective function). In the delivery reliability studies DWR calculates F_N (ca) for t=1,...,73 and for N a limited number of variations of the basic network. Here 73 is the number of years for which we have data, i.e. 1922 to 1994. One N is the network in 2005, another N the network in 2025. Those two networks are supposed to differ only in demand, not in the constraints defined by the infrastructure or regulations. Thus $F_N(x_t)$ is a time series of 73 different values, and as a next step DWR calculates for each number z the percentage of the 73 numbers F_N (x_t) larger than or equal to z. Let's write this as $p_N(z)$. DWR calls $p_N(z)$ the probability that the delivery of network N will be at least z aft/year.

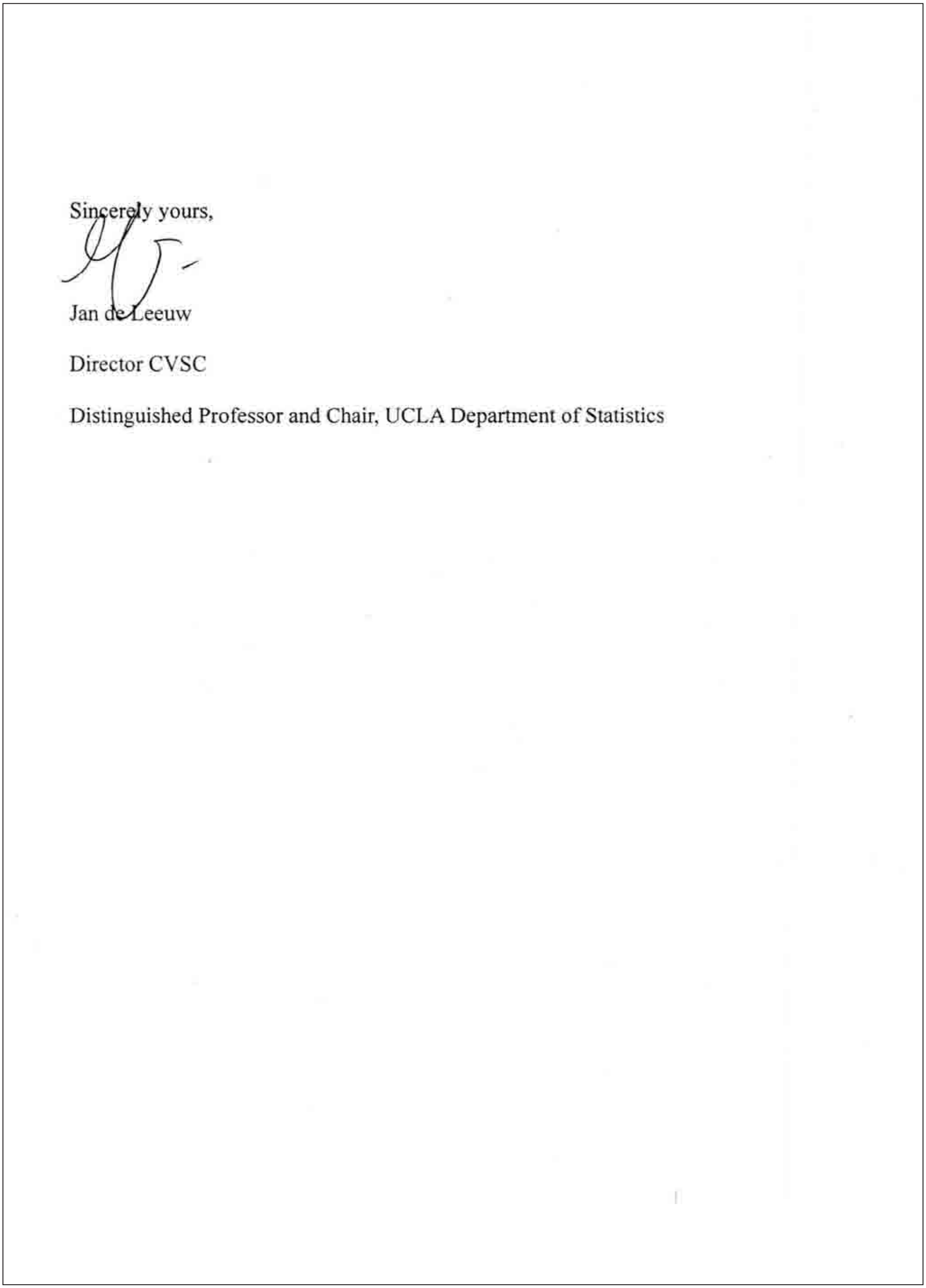
Now let us look at the assumptions inherent in this process. In the first place it assumes that F_N represents the SWP/CVS system adequately. This means that if we assume that if N is the actually network at time t and x_t is the actual rainfall at time t, then $y_t=F_N(x_t)$ should be at least close to the observed deliveries at time t. This is basically all we want, but clearly a sufficient condition for this to be the case are that N represents the infrastructure and the constraints adequately and that the many people operating SWP/CVS act as if they are optimizing a particular linear function under the particular constraints used. Both these sufficient conditions are obviously false. It is known that the model does not adequately represent the environmental regulations, it is also know that the mix-and-match strategies used by suppliers to add ground water or banked water to the system are not adequately represented either. It is unknown how serious these violations are. From the system theoretic point of view it is not necessary to assume that the network is true and the operators are optimizers, the only thing we are interested in is if y_t is sufficiently close to $F_N(x_t)$ (ands, eventually, if the predicted future observed y_t will be close to the predicted $F_N(x_t)$.

Another assumption that seems inherent in the calculations is that x_t is, in some sense, a random sample of size 73 of the possible values of rainfall/runoff in California, not just for now but also for the future. Now certainly there are large autocorrelations in the hydrologic time series x_i, so we certainly do not have independent observations. In fact, it is highly debatable if the notion of randomness applies here at all, and if we do not have a unique series of 73 observations for which there is no suitable framework of replication. Of course if randomness does not apply, then the notion of probability does not apply. But if randomness applies, then it should also be possible, and in fact highly desirable, to construct confidence regions for the $p_N(z)$ curves. Recently published time series also suggest that rainfall/runoff exhibit systematic trends, possibly related to climate change. So in particular extrapolating into the future may be risky.

For now, we will just insert some additional words of caution. A system that maximizes deliveries will obviously tend to overestimate deliveries. A system with hundreds and hundreds of variables can easily be manipulated to reproduce historic results, so future predictions are much more important than close fit. Sensitivity analysis, i.e. changing the network from N to N', is definitely important but is a huge undertaking with a network as large as CALSIM. The assumption that the constraints (except for demand) and the structure of the network will remain basically the same until 2025 seem very arbitrary. The sensitivity study looks at some variation in the pumping done at Banks, but what we want to know, of course, is the actual level of pumping in future years. There is no way to tell what the environmental regulations in 2025 will be, because those depend on politics, climate change, and possible catastrophes.

DWR argues that the CALSIM projections are the best we have. This may be true, but it may be just a reflection of historical circumstances during development of the model. It certainly does not mean that it is the best we can do. DWR also argues, in many places, that past deliveries cannot be used to reliably predict future deliveries. This is dangerous nonsense. Of course they can. Even CALSIM uses them. It is true that the structure of the network and the constraints also play an important role, but ultimately all we have is a complicated way to relate the time series of runoff/ rainfall to the time series of deliveries to the SWP contractors. With the many threats to the Delta, which the possible impact of climate change, with the rapid population growth in Southern California, with the increasing demand of Northern California, with much less water from the Colorado River going to Southern California, we may have to face the fact that "best we have" is simply not good enough any more.

In summary, I do not think the DWR Delivery Reliability estimates are, themselves, very reliable. They are build on a host of unrealistic assumptions, that are "saved" by a model with the property that it always outputs a single number. And that single number is what the clients downstream are interested in. As far as I can see, a large fraction of that number is "model" or "virtual" water. It looks good on paper, but only water agency boards and modeling divisions can live on it.



Sincerely yours,

Jan de Leeuw

Director CVSC

Distinguished Professor and Chair, UCLA Department of Statistics

STATE OF CALIFORNIA -- THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF WATER RESOURCES
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January 30, 2006

Dr. Jan de Leeuw
Cuddy Valley Statistical Consulting
11667 Steinhoff Road
Frazier Park, California 93225

Dear Dr. de Leeuw:

This letter responds to your letter dated December 20, 2005 commenting on the Draft State Water Project Delivery Reliability Report (Report 2005). Most of your comments are regarding the suitability of the CalSim II computer simulation model for estimating the delivery reliability of the State Water Project (SWP).

You state that due to the lack of documentation for the CalSim model and its tremendous complexity, you may have a limited understanding of the model. Your general understanding of the model is correct with respect to its basic structure. It should be noted that CalSim II is not an optimization model but, rather, a system simulation model. The simulation is done on a monthly time step. It is not designed to maximize deliveries but to meet the assumed annual requested contractors' demands to the extent possible while meeting all physical, operational, and institutional constraints. The CalSim II modeled operation has been critically reviewed by both the SWP and the Central Valley Project operators and they are satisfied with the degree the model results mimic the actual real-world operations. The CalSim II model has been used extensively by State Water Contractors and SWP operation staff to help them develop annual water supply guidelines.

Over the past few years, there has been significant outreach to the interested public regarding CalSim II. Explaining what the model is and how it works is a big challenge given its complexity and the varying levels of understanding desired by interested parties. As you are aware, the CalSim II model has undergone a peer review (November 2003) which was open to the public and identified the strengths and weaknesses of the model. The peer reviewers produced a report of their findings (December 2003) to which the Department of Water Resources (DWR) responded (August 2004). This response includes a description of the goals for improving different aspects of CalSim and the plan for meeting them. Improving the credibility of the model with the interested public is a top priority in the plan. We will continue to strive to increase public understanding of the model.

Dr. Jan De Leeuw
January 30, 2006
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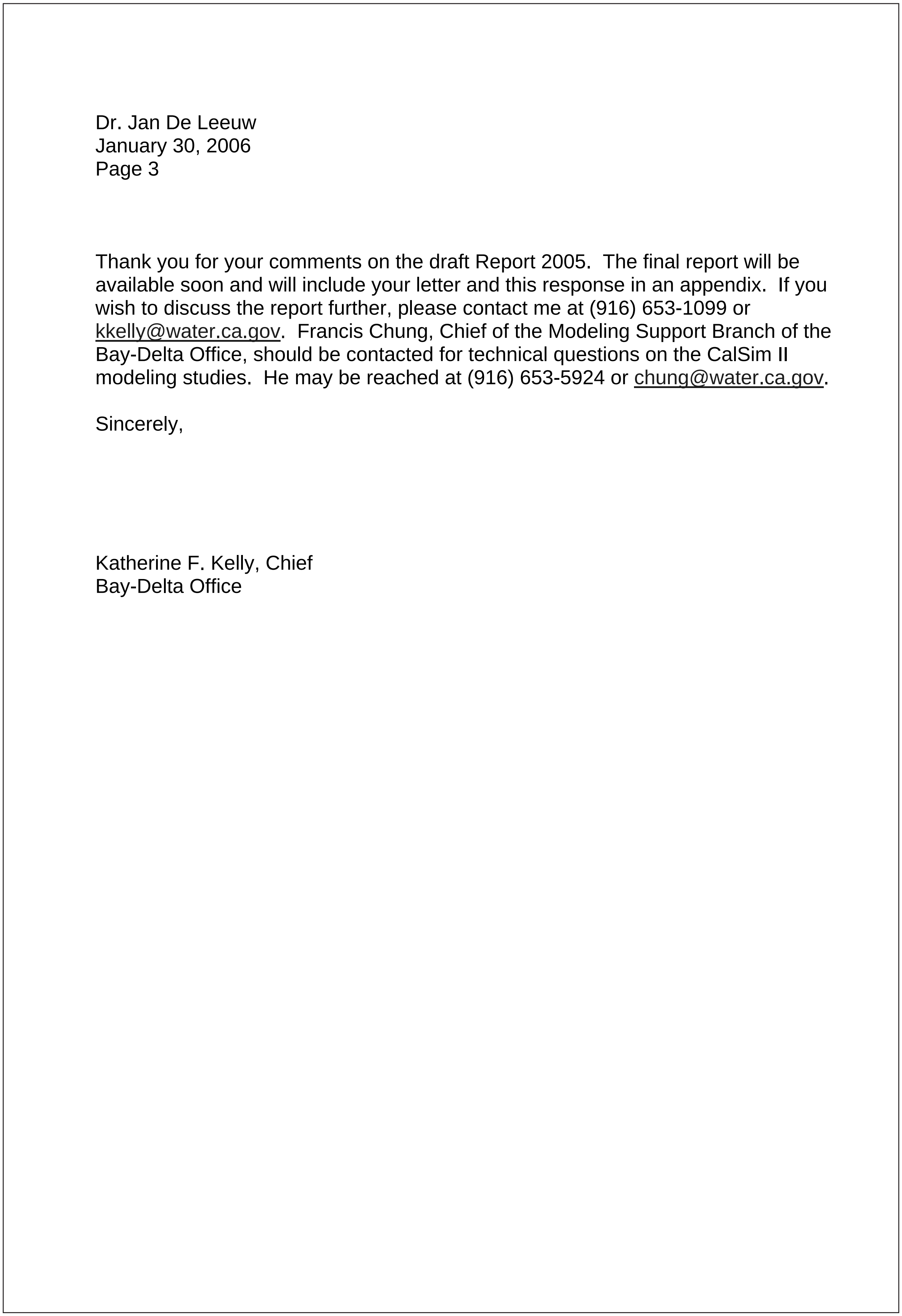
With respect to technical understanding of the model, documentation of the CalSim II Benchmark Studies (September 2002) and the associated assumptions is available on the Bay-Delta Office web site. This site also includes drafts of a CalSim Manual, Users Guide and WRSL Reference. In addition, an intense training session on CalSim was conducted in October 2003 for the interested public and was attended by 45 individuals. This training was designed to increase the technical understanding of the model, encourage informed discussion of the technical strengths and weaknesses of the model, and decrease the demand on DWR staff to conduct or assist with modeling studies by increasing the ability of other agencies and private consultants. This effort was very successful and DWR will conduct training sessions in the future as appropriate.

The CalSim II results in the Report 2005 are the best quantifications available of the delivery ability of the SWP but, as you point out, these estimates are limited because of the uncertainty of future conditions. DWR will continue to use the CalSim model as appropriate for analyses but other information is being developed that will help us analyze, understand, and prepare for our uncertain future. The potential impacts of climate change on the State's resources, including water supply, are being evaluated per the Governor's directive (Executive Order S-3-05). This effort includes broad brush estimates, using CalSim II, of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. In addition, DWR is working on three projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These are: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. Although none of these efforts will be completed before release of the next Reliability Report, some preliminary results and conclusions may be done in time for inclusion. Subsequent Reliability Reports will fully incorporate this information.

In closing, the discussion of using past deliveries to predict future deliveries has been clarified in response to your comment. You comment that it is incorrect to state that past deliveries cannot be used reliably to predict future deliveries. We certainly believe, for the SWP, past deliveries cannot be reliably used to predict future deliveries because of the significant increase over time in the demand for SWP supplies.



Dr. Jan De Leeuw
January 30, 2006
Page 3

Thank you for your comments on the draft Report 2005. The final report will be available soon and will include your letter and this response in an appendix. If you wish to discuss the report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim II modeling studies. He may be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Katherine F. Kelly, Chief
Bay-Delta Office

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December 22, 2005

Kathy Kelly
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SWP Delivery Reliability Report – Attn: Johnnie Young-Craig
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via facsimile to: (916) 653-6077
via email to: Comments-on-2005DRR@water.ca.gov

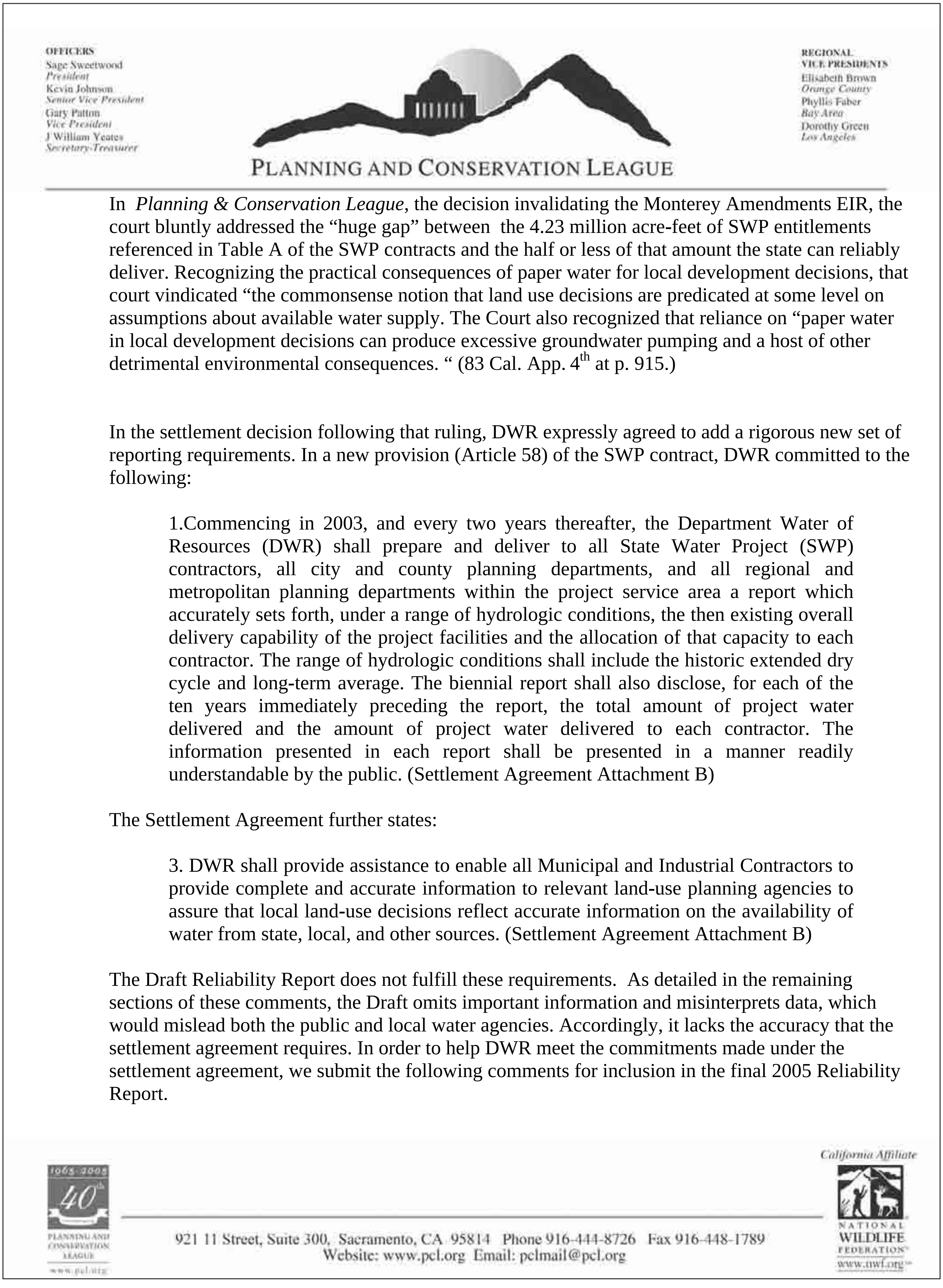
Re: Comments on Public Review Draft of the State Water Project Delivery Reliability Report 2005

Ms. Kelly:

The Planning and Conservation League (PCL), a strong advocate for accurate and realistic water supply planning, submits the following comments on DWR's Public Review Draft of the State Water Project Delivery Reliability Report (Draft Reliability Report). As one of the signatories to the court-approved settlement agreement requiring DWR to prepare these biennial reliability reports, PCL seeks to ensure that the final report lives up to the rigorous reporting requirements specified in that agreement. Serious deficiencies are present in the Draft Report that, if left uncorrected, would dangerously overestimate DWR's future ability to deliver water and compound the risk that local planning decisions will be predicated on "paper" rather than deliverable water.

The Reliability Report Should Accurately Disclose its Foundation in the Settlement Agreement and the State Water Project Contracts

The present Draft fails to inform local decision-makers and the public of the context and history behind DWR's reporting requirement. DWR's legal duty to prepare biennial reliability reports arises from the court-approved settlement agreement executed by PCL, DWR, state water contractors and other entities in the wake of the Third District Court of Appeal's ruling in the "Monterey Amendments" case, *Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892.



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In *Planning & Conservation League*, the decision invalidating the Monterey Amendments EIR, the court bluntly addressed the "huge gap" between the 4.23 million acre-feet of SWP entitlements referenced in Table A of the SWP contracts and the half or less of that amount the state can reliably deliver. Recognizing the practical consequences of paper water for local development decisions, that court vindicated "the commonsense notion that land use decisions are predicated at some level on assumptions about available water supply. The Court also recognized that reliance on "paper water in local development decisions can produce excessive groundwater pumping and a host of other detrimental environmental consequences. " (83 Cal. App. 4th at p. 915.)

In the settlement decision following that ruling, DWR expressly agreed to add a rigorous new set of reporting requirements. In a new provision (Article 58) of the SWP contract, DWR committed to the following:

> 1.Commencing in 2003, and every two years thereafter, the Department Water of Resources (DWR) shall prepare and deliver to all State Water Project (SWP) contractors, all city and county planning departments, and all regional and metropolitan planning departments within the project service area a report which accurately sets forth, under a range of hydrologic conditions, the then existing overall delivery capability of the project facilities and the allocation of that capacity to each contractor. The range of hydrologic conditions shall include the historic extended dry cycle and long-term average. The biennial report shall also disclose, for each of the ten years immediately preceding the report, the total amount of project water delivered and the amount of project water delivered to each contractor. The information presented in each report shall be presented in a manner readily understandable by the public. (Settlement Agreement Attachment B)

The Settlement Agreement further states:

> 3. DWR shall provide assistance to enable all Municipal and Industrial Contractors to provide complete and accurate information to relevant land-use planning agencies to assure that local land-use decisions reflect accurate information on the availability of water from state, local, and other sources. (Settlement Agreement Attachment B)

The Draft Reliability Report does not fulfill these requirements. As detailed in the remaining sections of these comments, the Draft omits important information and misinterprets data, which would mislead both the public and local water agencies. Accordingly, it lacks the accuracy that the settlement agreement requires. In order to help DWR meet the commitments made under the settlement agreement, we submit the following comments for inclusion in the final 2005 Reliability Report.

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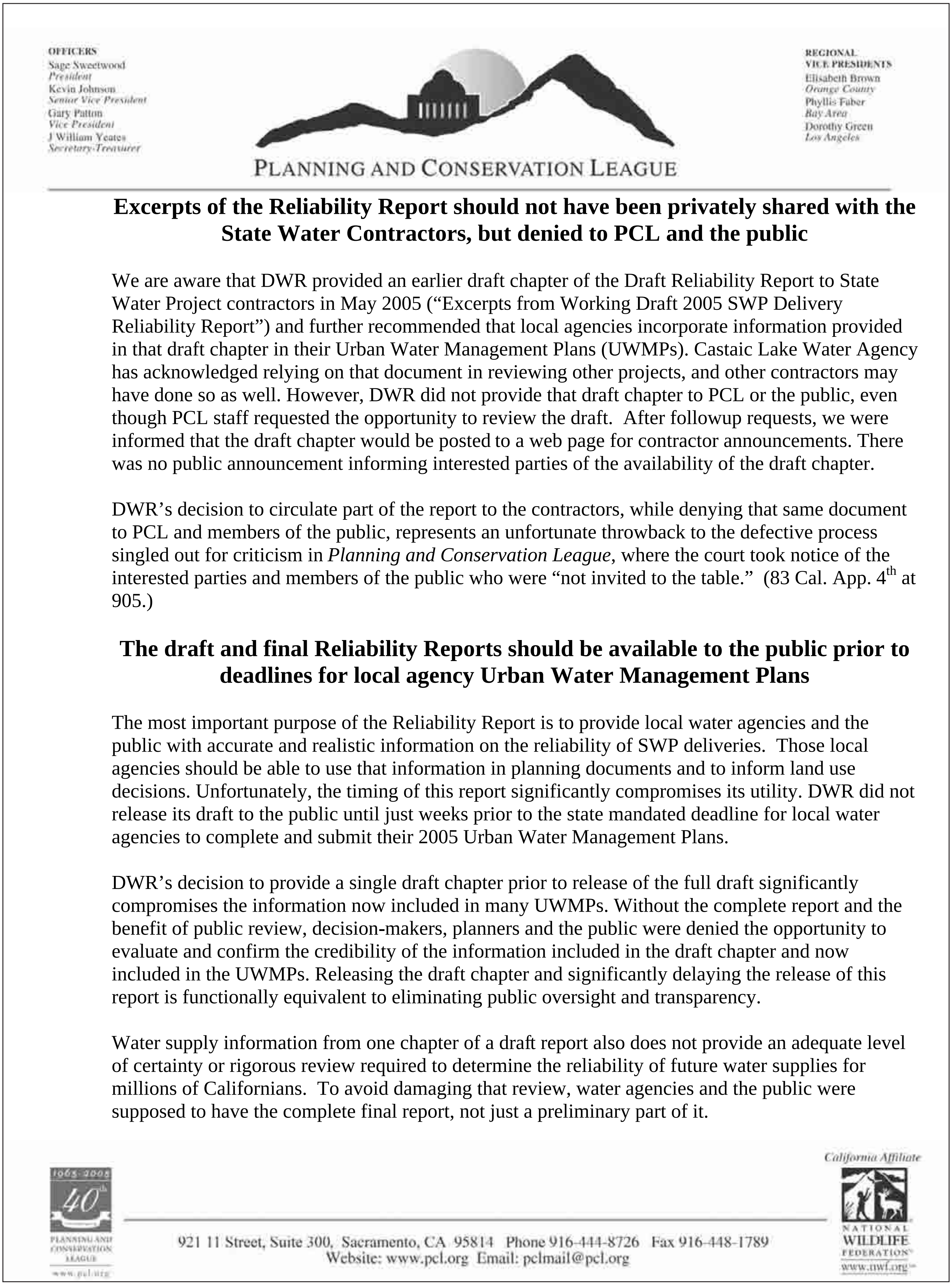

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Excerpts of the Reliability Report should not have been privately shared with the State Water Contractors, but denied to PCL and the public

We are aware that DWR provided an earlier draft chapter of the Draft Reliability Report to State Water Project contractors in May 2005 ("Excerpts from Working Draft 2005 SWP Delivery Reliability Report") and further recommended that local agencies incorporate information provided in that draft chapter in their Urban Water Management Plans (UWMPs). Castaic Lake Water Agency has acknowledged relying on that document in reviewing other projects, and other contractors may have done so as well. However, DWR did not provide that draft chapter to PCL or the public, even though PCL staff requested the opportunity to review the draft. After followup requests, we were informed that the draft chapter would be posted to a web page for contractor announcements. There was no public announcement informing interested parties of the availability of the draft chapter.

DWR's decision to circulate part of the report to the contractors, while denying that same document to PCL and members of the public, represents an unfortunate throwback to the defective process singled out for criticism in *Planning and Conservation League*, where the court took notice of the interested parties and members of the public who were "not invited to the table." (83 Cal. App. 4th at 905.)

The draft and final Reliability Reports should be available to the public prior to deadlines for local agency Urban Water Management Plans

The most important purpose of the Reliability Report is to provide local water agencies and the public with accurate and realistic information on the reliability of SWP deliveries. Those local agencies should be able to use that information in planning documents and to inform land use decisions. Unfortunately, the timing of this report significantly compromises its utility. DWR did not release its draft to the public until just weeks prior to the state mandated deadline for local water agencies to complete and submit their 2005 Urban Water Management Plans.

DWR's decision to provide a single draft chapter prior to release of the full draft significantly compromises the information now included in many UWMPs. Without the complete report and the benefit of public review, decision-makers, planners and the public were denied the opportunity to evaluate and confirm the credibility of the information included in the draft chapter and now included in the UWMPs. Releasing the draft chapter and significantly delaying the release of this report is functionally equivalent to eliminating public oversight and transparency.

Water supply information from one chapter of a draft report also does not provide an adequate level of certainty or rigorous review required to determine the reliability of future water supplies for millions of Californians. To avoid damaging that review, water agencies and the public were supposed to have the complete final report, not just a preliminary part of it.

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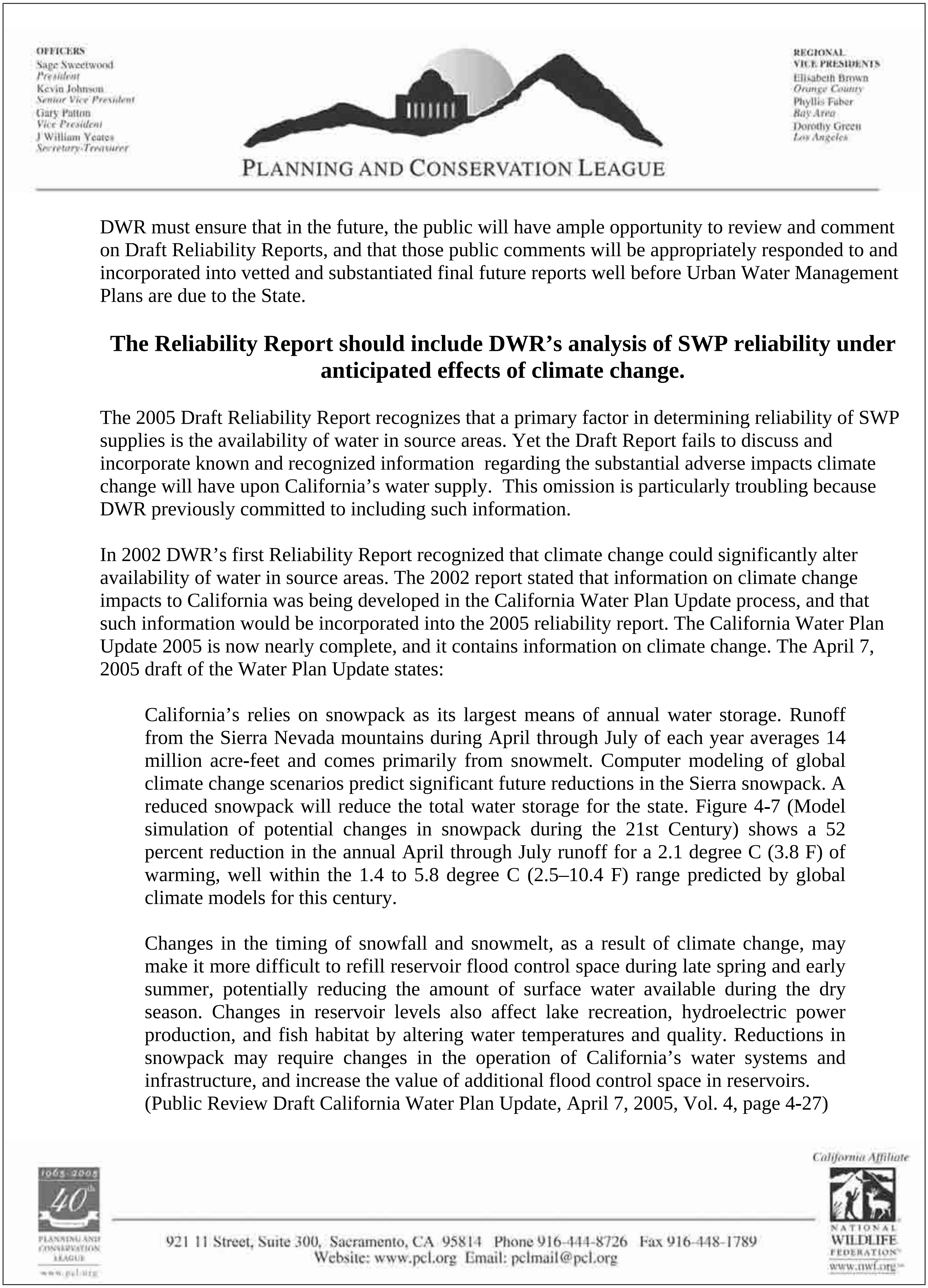

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DWR must ensure that in the future, the public will have ample opportunity to review and comment on Draft Reliability Reports, and that those public comments will be appropriately responded to and incorporated into vetted and substantiated final future reports well before Urban Water Management Plans are due to the State.

The Reliability Report should include DWR's analysis of SWP reliability under anticipated effects of climate change.

The 2005 Draft Reliability Report recognizes that a primary factor in determining reliability of SWP supplies is the availability of water in source areas. Yet the Draft Report fails to discuss and incorporate known and recognized information regarding the substantial adverse impacts climate change will have upon California's water supply. This omission is particularly troubling because DWR previously committed to including such information.

In 2002 DWR's first Reliability Report recognized that climate change could significantly alter availability of water in source areas. The 2002 report stated that information on climate change impacts to California was being developed in the California Water Plan Update process, and that such information would be incorporated into the 2005 reliability report. The California Water Plan Update 2005 is now nearly complete, and it contains information on climate change. The April 7, 2005 draft of the Water Plan Update states:

> California's relies on snowpack as its largest means of annual water storage. Runoff from the Sierra Nevada mountains during April through July of each year averages 14 million acre-feet and comes primarily from snowmelt. Computer modeling of global climate change scenarios predict significant future reductions in the Sierra snowpack. A reduced snowpack will reduce the total water storage for the state. Figure 4-7 (Model simulation of potential changes in snowpack during the 21st Century) shows a 52 percent reduction in the annual April through July runoff for a 2.1 degree C (3.8 F) of warming, well within the 1.4 to 5.8 degree C (2.5–10.4 F) range predicted by global climate models for this century.
>
> Changes in the timing of snowfall and snowmelt, as a result of climate change, may make it more difficult to refill reservoir flood control space during late spring and early summer, potentially reducing the amount of surface water available during the dry season. Changes in reservoir levels also affect lake recreation, hydroelectric power production, and fish habitat by altering water temperatures and quality. Reductions in snowpack may require changes in the operation of California's water systems and infrastructure, and increase the value of additional flood control space in reservoirs.
> (Public Review Draft California Water Plan Update, April 7, 2005, Vol. 4, page 4-27)

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Despite the commitments made in the 2002 Reliability Report, this information is not included in the recent draft of the 2005 Delivery Reliability Report.

In addition, the Draft Reliability Report misleads readers by suggesting that information on climate change impacts in California is not available. Since the release of the Draft Reliability Report 2002, a large amount of analysis on potential climate change impacts on water management in California has been published. Yet, the Draft Report 2005 states:

> The studies do not incorporate any modifications to account for changes related to climate change or assess the risk of future seismic or flooding events significantly disrupting SWP deliveries. As tools are developed to address these risks and the resulting studies become available, the information will be incorporated into the assessment of SWP delivery reliability. The results of the CalSim-II studies conducted for this update to *The State Water Project Delivery Reliability Report 2002* (DWR 2003b) represent the best available assessment of the delivery capability of the SWP. (Draft Reliability Report page 17)

However, estimates of the deliveries from the SWP under climate change conditions have been modeled and analyzed. The California Energy Commission recently completed such an analysis in their report, "Predictions of Climate Change Impacts on California Water Resources Using CalSim-II: A Technical Note" (CEC report).

In contrast to the statement included in the Draft Reliability Report, the CEC report provides assessments of SWP delivery capability under several probable climate change scenarios. This work was prepared in response to Executive Order S-3-05 issued by Governor Schwarzenegger, which called for a report on the impacts to California of global warming, including impacts to water supply, public health, agriculture, the coastline, and forestry.

It includes analysis carried out using CalSim-II, some of it performed by DWR staff.
It is disappointing that it took the initiative of the Energy Commission to generate climate change scenarios that PCL has been requesting of DWR for over two years. Moreover, DWR cannot credibly represent that such studies are impossible even after they become publicly available. To claim otherwise would fatally compromise the commitment to accuracy that is the hallmark of DWR's reporting requirement.

The figures below from the CEC Report show that under climate change hydrologies, SWP deliveries at 75% reliability could be as much as 1.9 million acre feet less than the base condition.

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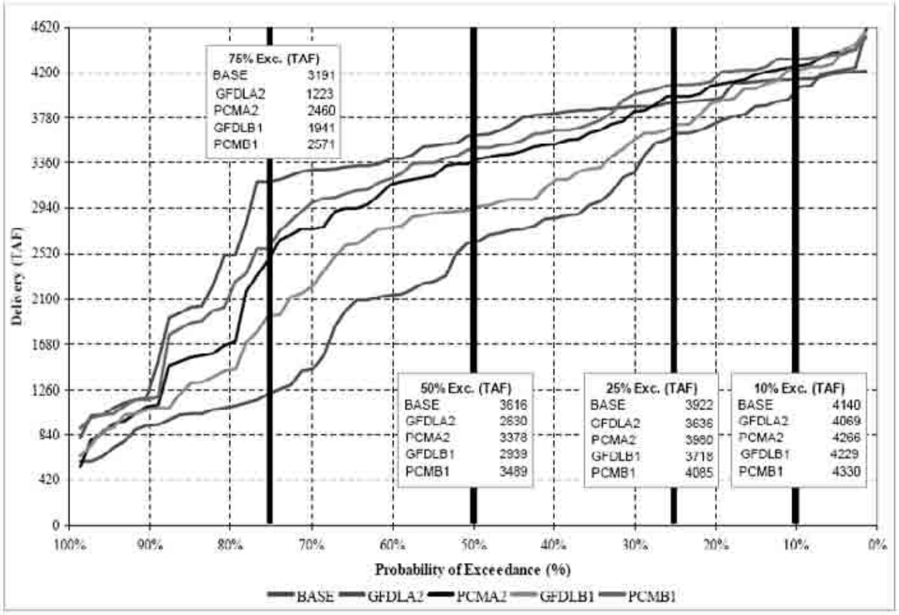

Figure 7. Exceedance probability plot of SWP Annual Deliveries under climate change scenarios PCM B1-A2 and GFDL B1-A2 for 2070-2099

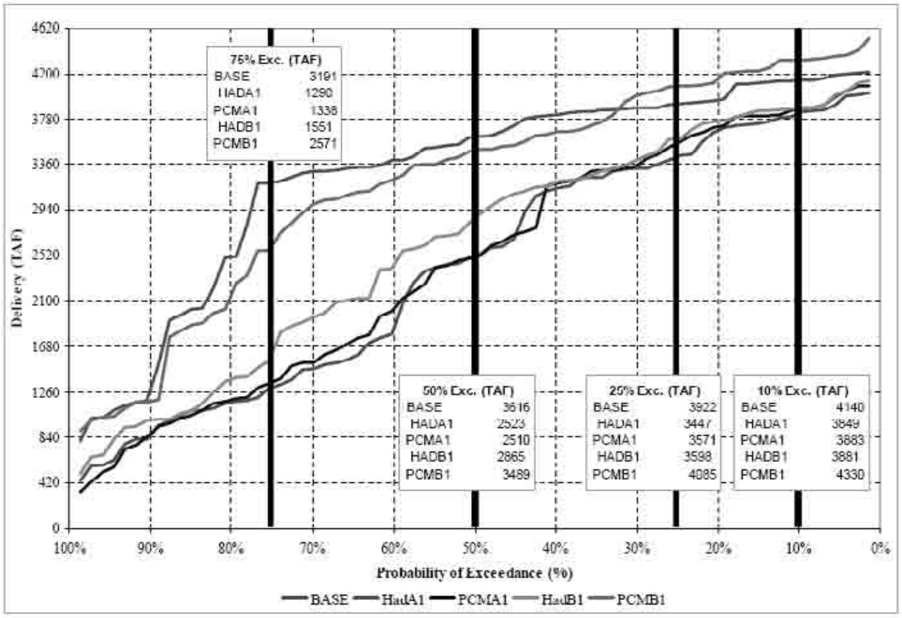

Figure 8. Exceedance probability plot of SWP Annual Deliveries under climate change scenarios PCM B1-A1 and HadCM3 B1-A1 for 2070-2099

(California Energy Commission, draft Predictions of Climate Change Impacts on California Water Resources Using CalSim-II: A Technical Note, December 2005 page 14 & 15 http://www.energy.ca.gov/2005publications/CEC-500-2005-200/CEC-500-2005-200-SD.PDF)

The CEC report concluded that modeling, "results show great negative impacts on California hydrology and water resources associated with most of climate change scenarios analyzed (only one scenario PCM run under B1 emission scenarios show just mild negative impacts)." (page 4)

This information demonstrates the range of outcomes that water managers must be prepared to address. This important assessment of the delivery capability of the SWP should be included in the Draft Reliability Report.

We also understand that DWR may have done its own analysis of the impacts of climate change on SWP deliveries. On the official State of California Climate Change Portal (http://www.climatechange.ca.gov/climate_action_team/reports/index.html) there is a reference to a study done by DWR. However unlike all of the other references, no results are included. The Reliability Report should include the results of DWR's own analysis.

Omission of this information prevents planners and decision makers from preparing for the inevitable implications for their water supplies. If the CEC already is predicting that water availability, and thus SWP deliveries, will be substantially reduced in the near future, water planners must adjust to that reality. DWR must address this problem, and will do California an enormous disservice if it continues to pretend that this problem does not exist.

Information in the Reliability Report will be used by local planners to make infrastructure investments and development decisions. The decisions made today about where to place infrastructure and where to approve development are long term commitments that will have impacts for hundreds of years into the future.

For instance, local decision-makers may chose not to place purple pipe in new development on the basis of assumed high level of delivery reliability from the SWP. Instead, decision-makers could choose to invest in new infrastructure to provide traditional supplies, including SWP supplies to new development. Once development is approved, the local area has foregone the opportunity to increase water supply reliability through use of recycled water. Should SWP supplies become significantly lower than predicted in the Reliability Report due to foreseeable impacts of climate change, significant local and statewide investments in infrastructure and housing would be stranded.

If local decisions are predicated on information from DWR that does not fully acknowledge potential constraints on DWR deliveries, they run the risk of producing excessive groundwater pumping and a host of other detrimental environmental consequences " (See *Planning and Conservation League*, 83 Cal. App. 4th at p. 915.)]

The long term nature and the resulting implications for the future of local areas as well as California as a whole, demand that the Reliability Report provide accurate, realistic information that fully discloses foreseeable uncertainty and risks.

The Report's unreliability also creates financial risks for the state. In many cases bonds will be committed to infrastructure built on expectations generated or encouraged by the Reliability Report. As with any financial investment, the risks associated with these investments must be fully disclosed to those who buy the bonds, those who approved the bonds, and those who invest in that infrastructure or in the developments supported by that infrastructure. As the state has learned in the past with levee liability, there is a potential risk that the State may be held accountable for decisions and investments made by others on the basis of false interpretation of the State's ability to protect and guarantee those investments.

The Reliability Report should include risk analysis and impacts from catastrophic failure in the Bay Delta Estuary from earthquake or flood

The Draft Reliability Report correctly identifies the availability and means of conveyance as a primary factor in determining reliability of SWP supplies. However, like climate change impacts, the Draft Report fails to include analysis or discussion of serious and eminent risks to the Bay Delta

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Estuary, an essential component of the SWP conveyance system. Significant risks to the ability of the SWP to export water from the Bay Delta Estuary are posed by the vulnerability of levees to flood, sea level rise and earthquake, as well as environmental degradation and continued declines of important fish species.

Dr. Jeffery Mount from the University of California, Davis, recently completed a risk analysis estimating that there is a 64 percent probability that the Bay Delta Estuary will experience abrupt changes resulting from flooding or seismic activity within the next fifty years. These changes would permanently alter the hydrology, water quality and ecosystem of the Estuary. Furthermore, Dr. Mount found that there is no institutional capacity to address these permanent changes. (Subsidence, Seismicity and Sea Level Rise: Hell AND High Water in the Delta; presented by Dr. Jeffery Mount to the California Bay-Delta Authority October 14, 2004.
http://calwater.ca.gov/CBDA/AgendaItems_10-13-14-04/Presentation/Item_13_6_Subsidence_Seismicity_Sea_Level_Rise.pdf)

In recent testimony to a joint committee of the California Legislature, Lester Snow, Director of DWR, outlined the serious risks to SWP water supply availability associated with Bay Delta levee failure. In his presentation, "How a Delta Earthquake Could Devastate California's Economy," Director Snow stated that extended impacts to water availability would include:

- Using most optimistic projection, levee repairs will require at least 15 months. More realistically, the repairs will take much longer.
- Southern California water agencies are drawing from reserves. Some will last up to 36 months; others will go dry sooner.
- Extreme water conservation measures enacted
- Ground water basins drawn dangerously down – may lead to contamination
- Water conservation and transfer programs enacted

(Slide 16 of Lester Snow's presentation to the joint legislative committee, November 1, 2005 http://www.publicaffairs.water.ca.gov/newsreleases/2005/11-01-05DeltaEarthquake.pdf)

Director Snow further indicated that recovery of the conveyance through the Delta could be abandoned. (Slide 19 of Lester Snow's presentation). Director Snow told the Legislature that "… we also need to recognize the Statewide impacts …if Delta water supplies are reduced or eliminated as a result of a catastrophic failure of our levee system." (Quote taken from DWR Press Release, November 1, 2005, http://www.publicaffairs.water.ca.gov/newsreleases/2005/11-01-05flood.cfm)

Accordingly, the Reliability Report should incorporate Director Snow's recommendation to recognize the risk to SWP reliability from flood, sea level rise and earthquake.

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In addition to vulnerable levees, ecosystem degradation poses a significant risk to the ability to convey SWP water reliably through the Bay Delta Estuary. Recently, data from the Department of Fish & Game's Fall Mid Water Trawl signaled that there is a serious ecosystem collapse in the Estuary, with four important pelagic fish populations at historic lows, including the California and Federally Endangered Species Act listed Delta Smelt.

In response, many agencies, including DWR are participating in an emergency science review called the 'Pelagic Organism Decline' (POD) investigation. The most recent report from the POD investigations indicates that increased exports, which increase fish entrainment and decrease available habitat, may be a primary contributor to the fisheries declines ("Interagency Ecological Program Synthesis of 2005 Work to Evaluate the Pelagic Organism Decline (POD) in the Upper San Francisco Estuary," November 2005 http://science.calwater.ca.gov/pdf/workshops/IEP_POD_2005WorkSynthesis-draft_111405.pdf).

The final Reliability Report should acknowledge the current pelagic organism decline and disclose the possibility that decreases in exports may be necessary in order to reverse those declines. Lastly, while the pelagic species decline currently is the most salient of the Bay-Delta Estuary's environmental problems, it is not the only problem that might compel delivery reductions. Bay-Delta water currently does not meet federal or state water quality standards, and many other species are listed as threatened or endangered. The final Reliability Report should acknowledge that fixing these other environmental problems also may require export reductions.

The Reliability Report should evaluate variable levels of demand, utilizing demand modeled in the Draft California Water Plan Update 2005

The Draft Reliability Report identifies the level and pattern of water demand in the delivery service area as the third primary component in determining SWP reliability. However, the Draft Reliability Report does not examine a significantly varied range of possible demand scenarios for the future. That omission is important, for such analysis would likely show that reliability is inversely proportional to California's overall level of demand.

Recent work completed by DWR for the California Water Plan provides a range of demand scenarios that should be included in the Reliability Report. The California Water Plan Update 2005 identifies three plausible demand scenarios: current trends continued; less resource intensive; and more resource intensive. Two of these three scenarios demonstrate that it is plausible that in 2030 California water demands will *decrease*, even with an expected 12 million more residents. The greatest decreases in water demands in every scenario occur in the SWP service area of Tulare Lake.

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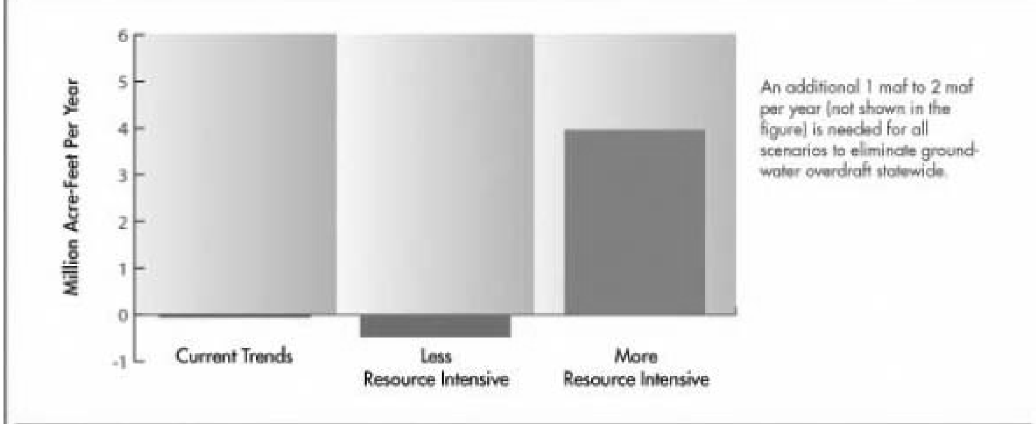
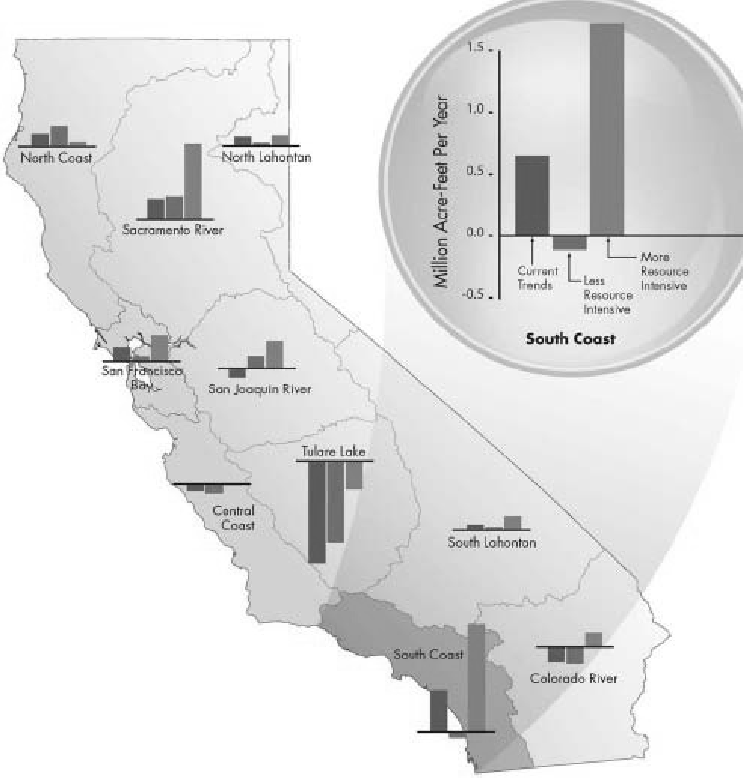
Figure 4-2 Net changes statewide in average-year water demand for baseline scenarios, 2000–2030



An additional 1 maf to 2 maf per year (not shown in the figure) is needed for all scenarios to eliminate groundwater overdraft statewide.

Water demands may change between 2000 and 2030 for average water conditions. Statewide water demand changes are shown for three baseline scenarios.

http://www.waterplan.water.ca.gov/docs/meeting_materials/ac/12.09.05/Changes_to_PRD_Slides_(12-08-2005).pdf



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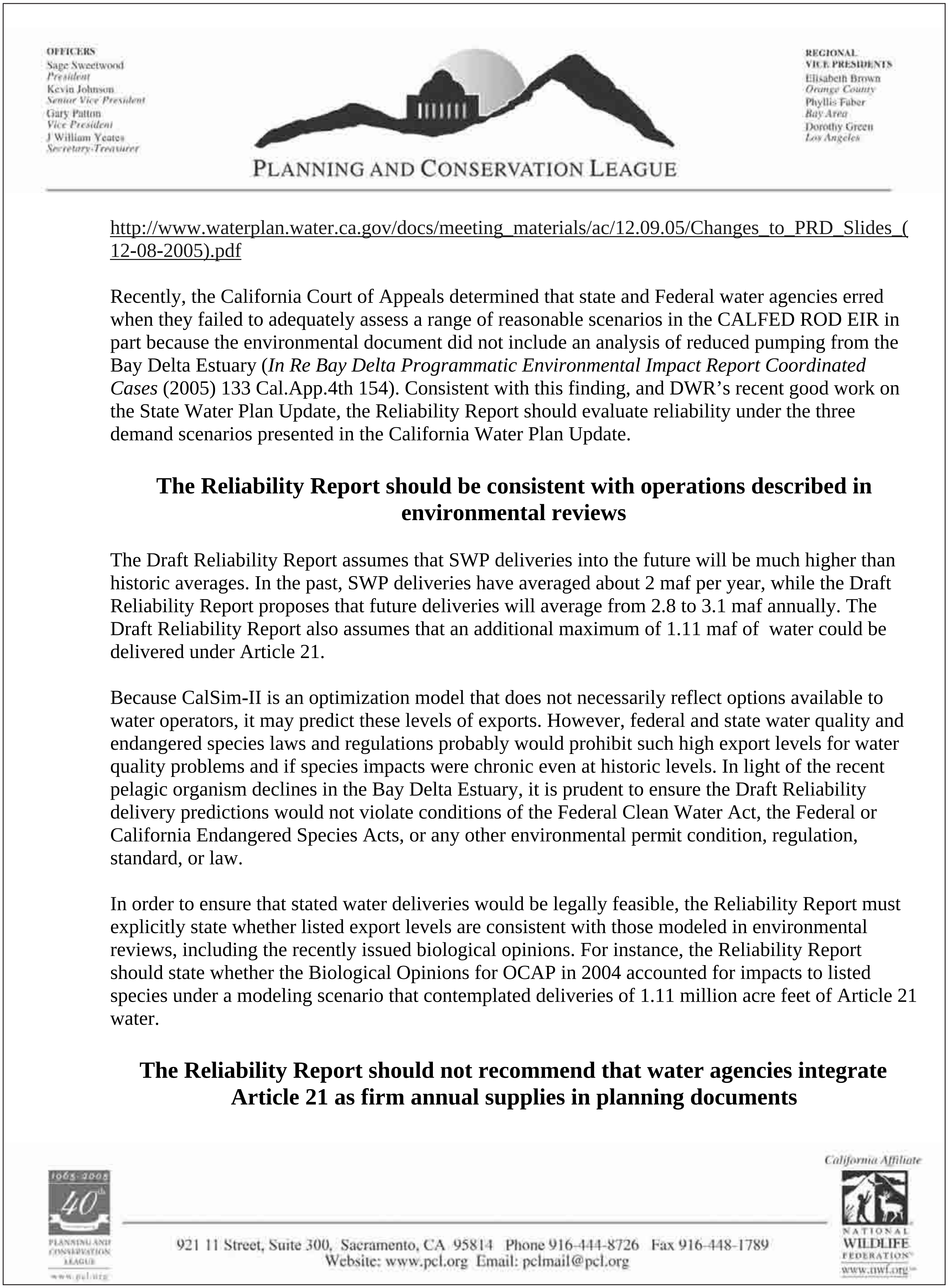

http://www.waterplan.water.ca.gov/docs/meeting_materials/ac/12.09.05/Changes_to_PRD_Slides_(12-08-2005).pdf

Recently, the California Court of Appeals determined that state and Federal water agencies erred when they failed to adequately assess a range of reasonable scenarios in the CALFED ROD EIR in part because the environmental document did not include an analysis of reduced pumping from the Bay Delta Estuary (*In Re Bay Delta Programmatic Environmental Impact Report Coordinated Cases* (2005) 133 Cal.App.4th 154). Consistent with this finding, and DWR's recent good work on the State Water Plan Update, the Reliability Report should evaluate reliability under the three demand scenarios presented in the California Water Plan Update.

The Reliability Report should be consistent with operations described in environmental reviews

The Draft Reliability Report assumes that SWP deliveries into the future will be much higher than historic averages. In the past, SWP deliveries have averaged about 2 maf per year, while the Draft Reliability Report proposes that future deliveries will average from 2.8 to 3.1 maf annually. The Draft Reliability Report also assumes that an additional maximum of 1.11 maf of water could be delivered under Article 21.

Because CalSim-II is an optimization model that does not necessarily reflect options available to water operators, it may predict these levels of exports. However, federal and state water quality and endangered species laws and regulations probably would prohibit such high export levels for water quality problems and if species impacts were chronic even at historic levels. In light of the recent pelagic organism declines in the Bay Delta Estuary, it is prudent to ensure the Draft Reliability delivery predictions would not violate conditions of the Federal Clean Water Act, the Federal or California Endangered Species Acts, or any other environmental permit condition, regulation, standard, or law.

In order to ensure that stated water deliveries would be legally feasible, the Reliability Report must explicitly state whether listed export levels are consistent with those modeled in environmental reviews, including the recently issued biological opinions. For instance, the Reliability Report should state whether the Biological Opinions for OCAP in 2004 accounted for impacts to listed species under a modeling scenario that contemplated deliveries of 1.11 million acre feet of Article 21 water.

The Reliability Report should not recommend that water agencies integrate Article 21 as firm annual supplies in planning documents

Article 21 water is by definition interruptible water; indeed, the word "interruptible" replaces the formerly used "surplus" in the Monterey Amendments. It should not be used as the basis for uninterruptible demands. Yet in chapter 6 of the Draft Reliability Report, local agencies are encouraged to include Article 21 water in a table of average annual values.

As DWR is aware, water supplies accounted for in the Urban Water Management Plans become the basis for approval of water supply assessments for new development in California. It is not only imprudent, but would provide institutional cover for unreliable planning, to recommend that local decision-makers approve housing that will be dependent on water that is 'interruptible.'

Article 21 water should be removed from the recommended table of average annual deliveries.

Use of CalSim-II as the sole tool to determine reliability is inappropriate given the following significant and yet to be resolved deficiencies

The lack of calibration and other deficiencies of CalSim-II have been made known the DWR in formal comments on the 2002 Draft by several parties, specifically Arve Sjovold and Dennis O'Conner. In addition, a 2003 expert peer review report documented numerous problems in CalSim II, and concluded that its predictions should be treated as "hypotheses." A. Close et al., A Strategic Review of CalSim II and its User for Water Planning, Management and Operations in California 13 (2003). This Draft has not adequately addressed those deficiencies. Some of these previously-highlighted deficiencies are listed below.

- CalSim-II has not been calibrated or validated
- It is unclear whether CalSim-II incorporates limitations to groundwater use in the Sacramento Valley
- The CalSim-II model should not be used to make absolute predictions, such as those incorporated into the Reliability Report
- CalSim-II does not recognize or report uncertainty

Additionally, CalSim-II may produce results not consistent with reality, replacing the problem of paper water with an even greater problem of 'cyber water.' For example, in 2001, California experienced water supply associated with approximately the 75% exceedence level, and the State Water Project was able to deliver 1,607,570 ac-ft. However, the CalSim-II simulations predicted a 75% exceedence level of supply of roughly 2,500,000 ac-ft (as read from Figure 5.1). In other words, CalSim-II overpredicted deliveries by more than 50%. These discrepancies demonstrate the need to use multiple tools to determine reliability, as well as the need to articulate limitations of this particular model. Similarly, they demonstrate that local agencies will take enormous risks if they approve projects in reliance on CalSim II's predictions that future deliveries will be substantially higher than historic deliveries.

The Draft Reliability Report attempts to respond to the recent to the recommendations and conclusions from the recent CBDA Peer Review, *A Strategic Review of CalSim II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003).

The Draft Reliability Report states:

> In *Peer Review Response*, DWR and USBR (2004) conclude the concern about overestimations of south-of-Delta deliveries is unwarranted because the 73-year study referenced by the panel is not designed to mimic historical conditions; rather it is intended to determine the reliability of the SWP when the demand equals the maximum Delta Table A amount (4.133 MAF) every year. The results of the referenced study are documented in *The SWP Delivery Reliability Report 2002*
> (DWR 2003b) as study 3 (2021B).
>
> A more appropriate method for assessing the ability of CalSim II to accurately model SWP operations is to compare the historical SWP deliveries with the simulated deliveries of the Historical Operations Study. DWR committed to conducting this study in *The SWP Delivery Reliability Report 2002* (DWR 2003b). The study is documented in the November 2003 Technical Memorandum Report *CalSim-II Simulation of Historical SWP/CVP Operations* (DWR 2003a). The Historical Operations Study is designed to assess CalSim II's ability to mimic historical operations of the SWP. In this study, historical input is used where reliable data are available. In situations where reliable historical record is not readily available, reasonable assumptions and estimates are made. (pages 10 & 11)

Before stating that this approach is the most appropriate response to the Peer Review concerns, DWR should reconvene the panel in order to review whether DWR's response satisfies the concerns raised in the original peer review. To verify that this response appropriately satisfies the concerns raised by that panel.

Additional specific comments on uses of CalSim-II in the Draft Reliability Report 2005 are attached in Appendix A.

Conclusion

PCL hopes that these comments assist DWR in arriving at a final version of the Reliability Report that corrects the serious deficiencies identified in the draft, and provides the

additional analysis recommended here. Without these additional efforts, the report would not fulfill DWR's responsibilities under the settlement agreement and the Article 58 of the SWP contracts, and would fail to provide local decision-makers with a credible basis to ensure that development decisions are grounded in an accurate assessment of deliverable SWP supply.

Sincerely,

Mindy McIntyre
Water Program Manager
Planning and Conservation League

Cc:
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APPENDIX A: **Specific comments on uses of CalSim-II in this Draft Reliability Report are highlighted below.**

Page 7: "Whatever assumptions are made, every responsible water delivery reliability analysis should expressly state the assumptions, methods and data used to produce its results. It should also be understood that those numbers depend on, and are no better then, the assumptions upon which they must necessarily rest."

This statement is entirely true. Yet this particular "water delivery reliability analysis" does not measure up to its own standard, because it does not adequately disclose the weaknesses of the key assumptions it makes and the key model upon which it relies. The reliability report should acknowledge that the simulated levels of SWP deliveries reported on the Draft Reliability Report are defined entirely by the explicit and implicit assumptions used in CalSim-II—they are CalSim-II's reliability results and not the results for the physical system itself—and should address the potential weaknesses in the "assumptions, methods and data" used to make those predictions.

Additionally, a statement such as this is so important that it should be made prominently, perhaps in a highlighted text box, rather than at the end of a paragraph in the body of the report.

Page 7: "For example, the demand 30 years ago for the SWP was not as high as it is currently or expected to be in the future. Because the need for SWP water then was relatively low, less water was exported through the SWP during normal and wet times then could have been if the demand had been higher. Simply put, less water was delivered because less water was needed."

The implicit assumption in this statement that there was no logic for contractors to take the water they were entitled to under Table A because 1) they had no need for it at that time, and 2) they had no place to store it for later use. If the assumption is that now and into the future the contractors will want to take delivery of their full Table A amounts—in other words, that circumstances have changed—then one or both of two conditions must be true 1) they need it and/or 2) they can store it. The reliability report should substantiate its reasons for assuming such a change in conditions.

On page 15, the Draft Reliability Report states that studies 4 and 5 were developed in discussions with SWP contractors and stakeholders involved with the development of the analysis associated with the environmental documentation for the Monterey Agreement. What analysis of current or future demand patterns and our available storage capacities is used to justify the assumption of a demand for the full Table A allotments? What are the assumptions about population growth, water use rates, availability of non-SWP supplies and available local storage capacity that lead to the conclusion that contractors will consistently ask for full Table A allotments?

Page 7: "Conversely, the current or projected delivery capability of the a water project would be less if (1) demand for water from a water project was at its maximum level for many years, (2) no new facilities were built, and (3) the supply of the main sources of water was recently reduced because another entity with a prior water right increased its use of that source."

This statement is unclear and counterintuitive. The Draft Reliability Report often argues that higher levels of demand will increase the delivery capability not decrease it. DWR should clarify the point it is trying to make here or eliminate this statement altogether.

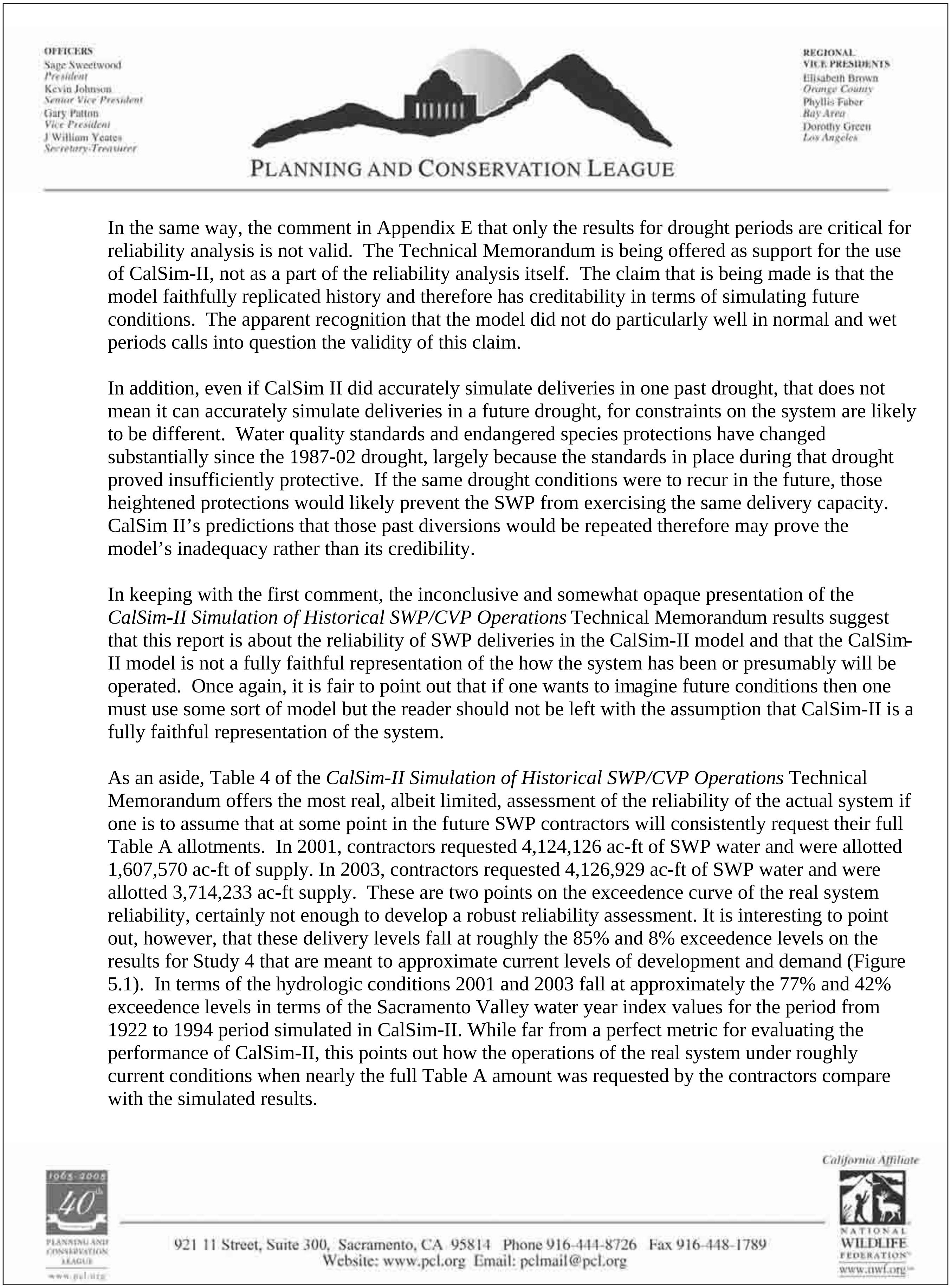
Page 8: "In the 2002 Reliability Report, the Department committed to conducting a comprehensive sensitivity analysis for assumptions contained in the CalSim-II model studies. This analysis is complete."

While this analysis is reported on in the Draft Reliability Report, DWR has made no attempt to use the results of that analysis to comment on the results of the CalSim-II modeling conducted for the reliability investigation. This seems to defeat the purpose of conducting and reporting on the sensitivity analysis. An attempt to consider the implications of the sensitivity analysis is included later in these comments.

Page 11: "The simulated deliveries in Figure 3-1 were adjusted for any differences between the historical and simulated carry-over storage in the SWP system reservoirs, Lake Oroville and SWP's portion of San Luis Reservoir."
Page 74 "(in Appendix E dealing with the Historical SWP/CVP Operations Simulation Technical Memorandum: Simulations of historically wet years, when the system was not supply constrained, may therefore be a poor indicator of the model's ability to accurately simulate future levels of development. Particular interest is therefore place on model results during the six-year drought of 1987-1992."

The Draft Reliability Report appears to offers up the Technical Memorandum Report entitled *CalSim-II Simulation of Historical SWP/CVP Operations* in order to support the legitimacy of the using CalSim-II to conduct the reliability analysis. If this is the goal then these two statements are problematic.

While the Draft Reliability Report gives no clear indication about what the adjustments referred to on page 11 entail, the fact that adjustments had to be made to generate the claimed correspondence shown in Figure 3-1 cannot stand without further explanation. The goal of the *CalSim-II Simulation of Historical SWP/CVP Operations* Technical Memorandum should have been to see if CalSim-II could be used to faithfully reproduce all aspects of system operations, not simply the SWP exports during the 1987-1992 drought. If the storage levels in SWP reservoirs were not faithfully reproduced and had to be adjusted in some unexplained way to generate the results in Figure 3-1, then the Technical Memorandum should not be used to build the creditability of the CalSim-II.



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In the same way, the comment in Appendix E that only the results for drought periods are critical for reliability analysis is not valid. The Technical Memorandum is being offered as support for the use of CalSim-II, not as a part of the reliability analysis itself. The claim that is being made is that the model faithfully replicated history and therefore has creditability in terms of simulating future conditions. The apparent recognition that the model did not do particularly well in normal and wet periods calls into question the validity of this claim.

In addition, even if CalSim II did accurately simulate deliveries in one past drought, that does not mean it can accurately simulate deliveries in a future drought, for constraints on the system are likely to be different. Water quality standards and endangered species protections have changed substantially since the 1987-02 drought, largely because the standards in place during that drought proved insufficiently protective. If the same drought conditions were to recur in the future, those heightened protections would likely prevent the SWP from exercising the same delivery capacity. CalSim II's predictions that those past diversions would be repeated therefore may prove the model's inadequacy rather than its credibility.

In keeping with the first comment, the inconclusive and somewhat opaque presentation of the *CalSim-II Simulation of Historical SWP/CVP Operations* Technical Memorandum results suggest that this report is about the reliability of SWP deliveries in the CalSim-II model and that the CalSim-II model is not a fully faithful representation of the how the system has been or presumably will be operated. Once again, it is fair to point out that if one wants to imagine future conditions then one must use some sort of model but the reader should not be left with the assumption that CalSim-II is a fully faithful representation of the system.

As an aside, Table 4 of the *CalSim-II Simulation of Historical SWP/CVP Operations* Technical Memorandum offers the most real, albeit limited, assessment of the reliability of the actual system if one is to assume that at some point in the future SWP contractors will consistently request their full Table A allotments. In 2001, contractors requested 4,124,126 ac-ft of SWP water and were allotted 1,607,570 ac-ft of supply. In 2003, contractors requested 4,126,929 ac-ft of SWP water and were allotted 3,714,233 ac-ft supply. These are two points on the exceedence curve of the real system reliability, certainly not enough to develop a robust reliability assessment. It is interesting to point out, however, that these delivery levels fall at roughly the 85% and 8% exceedence levels on the results for Study 4 that are meant to approximate current levels of development and demand (Figure 5.1). In terms of the hydrologic conditions 2001 and 2003 fall at approximately the 77% and 42% exceedence levels in terms of the Sacramento Valley water year index values for the period from 1922 to 1994 period simulated in CalSim-II. While far from a perfect metric for evaluating the performance of CalSim-II, this points out how the operations of the real system under roughly current conditions when nearly the full Table A amount was requested by the contractors compare with the simulated results.

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In terms of system reliability during dry periods, the most interesting conclusion to draw from this comparison is that actual operations in 2001, which benefited from a water supply associated with approximately the 75% exceedence level, provided a level of service of only 1,607,570 ac-ft while the CalSim-II simulations yielded a 75% exceedence level of supply of roughly 2,500,000 ac-ft (as read from Figure 5.1).

Page 16: "The Article 21 demand in the updated studies (4 and 5) is higher than the earlier studies for the December through March period."

It does not appear that DWR makes any attempt to explain why these higher levels were assumed. They are used in CalSim-II to prompt an export of water to SWP contractors when conditions warrant. While the Draft Reliability Report fairly comments on page 17 that "Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts and level of water supply reliability required", including these numbers that are driven by a somewhat unjustified level of assumed Article 21 demand is not the clearest manner in which to present reliability analysis.

Page 25: "By referencing the curve for Study 5 in Figure 5-2, the following can be deduced":

- *In 75 percent of the years, the annuall delivery of the SWP is estimated to be at of above 2.7 maf per year (65 % of 4.13 maf).*

There is nothing special about the 75, 50 and 25% thresholds used in providing a narrative description of Figure 5.2 In fact it is equally valid to open and close the list of bullets with statements like:

- The maximum amount of water that can be delivered in response to full Table A demands with 100 percent reliability, in the CalSim-II model, is 187,000 ac-ft.
- Under the least supply constricted conditions the SWP will be able to deliver, in the CalSim-II model, the full Table A allotments.

Without even worrying about whether or not the assumptions used in the CalSim-II model are valid or not, these two statements are as valid as the three offered by DWR and they create a much different impression of SWP reliability.

Even if 100% reliability is not a valid standard, water utility plans for a system that will fail 25% of the time, as is the corollary of the 75% exceedence, are no more valid. Municipal utilities are often looking for, 90-95% reliability. According to these standards, Figure 5-2 suggests that the reliability of the system is between 1.4 maf and 0.8 maf. These numbers, which are no more or less valid than those reported by DWR, are perhaps more useful for water managers in assessing the reliability of a water supply.

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Page 26: "In the case of 1977, it is reasonable to assume that up to 500 taf of 1976 allocated Table A water could be carried over to 1977."

This sort of conditional post-processing of model output, which could have ripple effect across the rest of the simulation with potential changes in model results, is not valid and this whole section should be removed. To its credit DWR does not try and use any of this after the fact hand waving in the Table and Figures published in the Draft Reliability Report. Nonetheless, by including this narrative DWR is attempting to argue both that the model can be trusted and that the model cannot be trusted. This is not legitimate model interpretation.

Page 49: "The estimate could be viewed as too low because the Department of Water Resources (DWR) is planning to have facilities in place by 2025 that will increase the reliability of the SWP. The estimate could be viewed as too high because there is the potential for exports to be required to be reduced to protect endangered fish species."

It is inappropriate to speculate on what deliveries could be with new facilities when the information is to be used under the provisions of Senate Bill 221 to verify that water supplies are available for new developments.

Page 78: "Table E-1 Summary of the Expected Elasticity Index (EI) and Sensitivity Index (SI) for Selected Variables."

These very interesting results are included in the Draft Reliability Report and are then ignored completely interpreting the results of the reliability analysis. Let us for example attempt to recast the statement offered above:

- The maximum amount of water that can be delivered in response to full Table A demands with 100 percent reliability, according to the CalSim-II model, is 187,000 ac-ft.

If the sensitivity analysis is valid, it is legitimate to make the following statements.

- If the assumed levels of Banks Pumping vary by ±10% relative to the base level assumed in the CalSim-II simulation, then the maximum amount of water that be delivered in response to full Table A demands with 100 percent reliability, in the CalSim-II model, will very between 184,195 and 189,805 ac-ft.
- If the assumed levels of Oroville inflows vary by ±10% relative to the base level assumed in the CalSim-II simulation, then the maximum amount of water that can be delivered in response to full Table A demands with 100 percent reliability, according to the CalSim-II model, will very between 182,138 and 191,862 ac-ft.

DWR should either make these sorts of statements or they should not attempt to use the results of the sensitivity analysis to assert the legitimacy of the use of CalSim-II for SWP reliability analysis.

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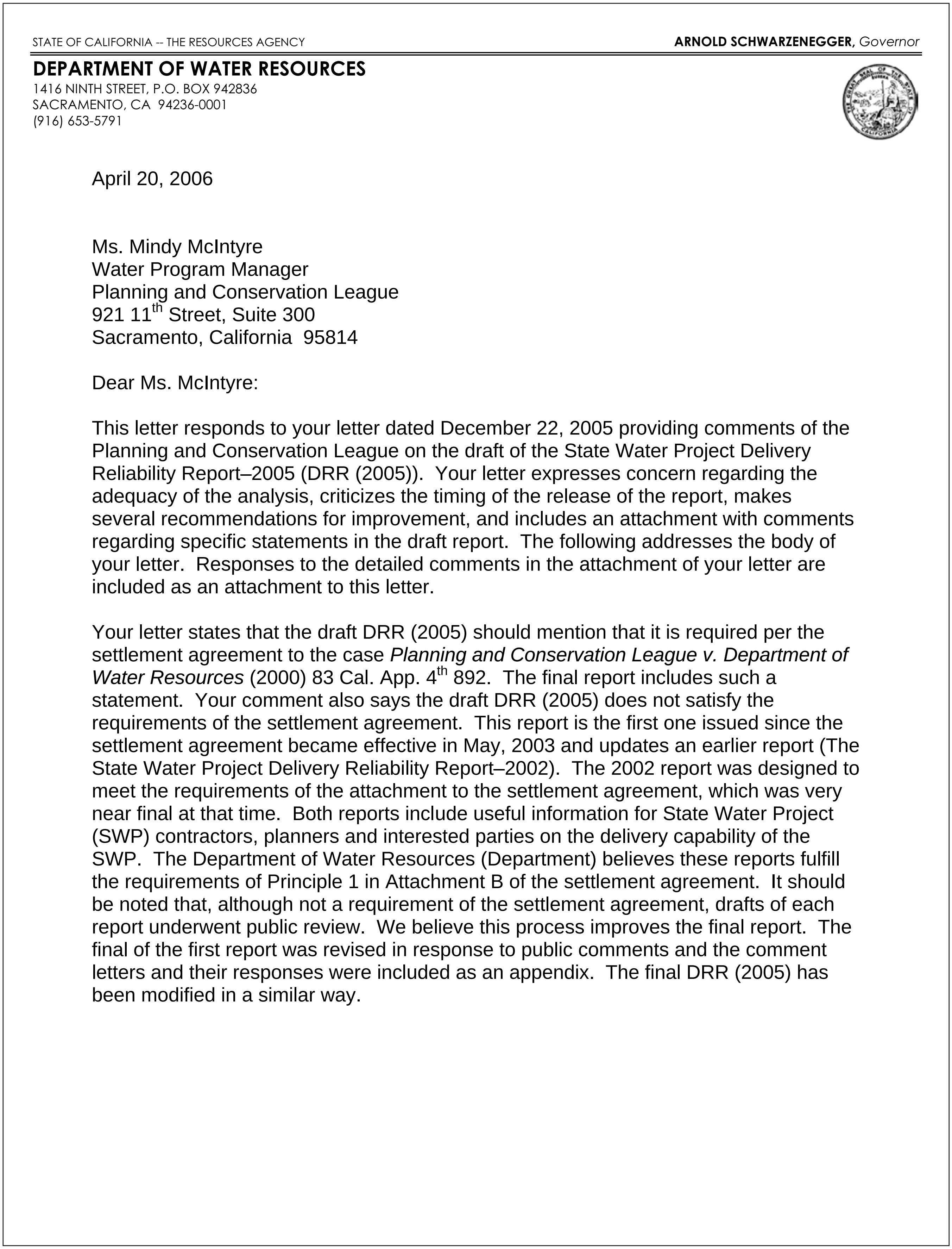

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April 20, 2006

Ms. Mindy McIntyre
Water Program Manager
Planning and Conservation League
921 11th Street, Suite 300
Sacramento, California 95814

Dear Ms. McIntyre:

This letter responds to your letter dated December 22, 2005 providing comments of the Planning and Conservation League on the draft of the State Water Project Delivery Reliability Report–2005 (DRR (2005)). Your letter expresses concern regarding the adequacy of the analysis, criticizes the timing of the release of the report, makes several recommendations for improvement, and includes an attachment with comments regarding specific statements in the draft report. The following addresses the body of your letter. Responses to the detailed comments in the attachment of your letter are included as an attachment to this letter.

Your letter states that the draft DRR (2005) should mention that it is required per the settlement agreement to the case *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892. The final report includes such a statement. Your comment also says the draft DRR (2005) does not satisfy the requirements of the settlement agreement. This report is the first one issued since the settlement agreement became effective in May, 2003 and updates an earlier report (The State Water Project Delivery Reliability Report–2002). The 2002 report was designed to meet the requirements of the attachment to the settlement agreement, which was very near final at that time. Both reports include useful information for State Water Project (SWP) contractors, planners and interested parties on the delivery capability of the SWP. The Department of Water Resources (Department) believes these reports fulfill the requirements of Principle 1 in Attachment B of the settlement agreement. It should be noted that, although not a requirement of the settlement agreement, drafts of each report underwent public review. We believe this process improves the final report. The final of the first report was revised in response to public comments and the comment letters and their responses were included as an appendix. The final DRR (2005) has been modified in a similar way.

You comment that the use of CalSim-II as the sole tool for determining reliability is inappropriate due to the lack of calibration and other deficiencies as identified in comments on the draft 2002 report and due to inadequacies mentioned in the peer-review report, *A Strategic Review of CalSim-II and its Use for Water Planning, Management, and Operations in Central California* (Close and others 2003). The final 2002 report includes thorough responses to the comments received on the draft 2002 report. Updated responses to the issues regarding CalSim-II mentioned in your letter are included in Attachment 2 to this letter. As mentioned in the draft DRR (2005), several studies have been conducted analyzing the ability of CalSim-II to simulate water project operations. The results support the conclusion that CalSim-II is a useful and appropriate tool for assessing the delivery capability of the SWP. You also comment that the peer reviewers should be reconvened to review the Department's written response to their review. The peer review of CalSim-II was an intensive and expensive effort involving many staff hours to develop the background information for the reviewers and handle the administrative details for the participation of the panel members and the two-day public meeting of the review itself. Some of the panel members, as well as other experts who were not on the panel, are and will continue to be a great resource to both the Department and Bureau of Reclamation modeling staff. We do not, however, believe conducting a peer review of the response is an effective use of the Department's staff resources.

Several of the concerns within your letter relate to the uncertainty in future conditions that may affect water supplies, such as levee failures in the Delta, climate change, or declines in the population of Delta fishes. Information relevant to these factors is evolving rapidly but has not reached a level at which it can be quantitatively incorporated into delivery projections of the SWP. The Department is working on two projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. The first is the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes; evaluate the consequences of levee failure; and develop recommendations to manage the risk. The second is a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to recreation, land use, water supply, transportation, energy, and environmental health. This Delta Vision process incorporates the requirements of AB 1200, passed by the legislature and signed by the Governor in 2005. None of these efforts will be completed before release of the next Reliability Report, but they may yield some preliminary results and conclusions in time for the next report, and will be fully incorporated into subsequent Reliability Reports.

Ms. Mindy McIntyre
April 20, 2006
Page 3

As directed in the Governor's Executive Order S-3-05, the potential impacts of climate change are being analyzed. This effort and the results referenced in your letter are broad brush estimates of the potential impact upon the SWP 50 to 100 years into the future if no additional conveyance facilities or upstream reservoirs are built. This information is helpful in developing strategies for the future management and development of the State's water resources, including improvements to the SWP. The Department does not want to leave any reader of DRR (2005) with the impression that this developing information is being ignored. Therefore, the final report has been modified accordingly.

You comment that information planned to be used in the draft DRR (2005) should not have been given to the State Water Contractors in the spring of 2005 for incorporation into their Urban Water Management Plans. The Department provided the contractors results of the analyses planned to be used in the draft report because they were the best information available at that time. The information was conveyed in the Notice to State Water Project Contractors No. 05-08 as an excerpt from the draft technical chapter of an incomplete draft report. There was no intent of the Department to exclude this information from the public. This notice was not announced on the Department's Home page but all State Water Project Contractors' Notices are available at http://www.swpao.water.ca.gov/deliveries/. As soon as the Department learned that you wanted a copy of this information, it was provided to you. It is the Department's responsibility to provide the best available information to water supply contractors of the SWP.

You make the point that the report should be available to the public as a draft and finalized prior to deadlines for local agency Urban Water Management Plans. The Department agrees with this comment. It is unfortunate that the review of the draft report and completion of the final report could not be done in late 2004 or early 2005 for full incorporation into Urban Water Management Plans. The objectives of the Department for the Reliability Report are to encourage public discussion and understanding of the estimation of the SWP delivery capability, meet the conditions of the settlement agreement, and provide the best available quantification of SWP deliveries. Given the situation, the Department chose to provide the information to the contractors, as described above, and to delay the completion of the report to allow public review of a draft. The next time the Reliability Report is due in the same year as the Urban Water Management Plans, the Department will strive to complete it as early in the year as possible.

Your letter also makes the observation that the percentage of time the assumed demand is met decreases as the level of demand increases. This is correct. The results contained in the draft DRR (2005) are shown as percentages of the maximum Table A amount so the information can be easily interpreted by SWP contractors and incorporated into their analyses. Presenting the information as a percentage of the assumed demand would require additional calculations and would increase the potential for misinterpretation. For example, with the data presented as a percentage of the maximum Table A amount, a contractor can take this percentage and apply it to the specific maximum Table A amount for his or her district to determine how much water would be available to the district. If the information were presented as a percent of the demand, the amount of water that it equates to must be determined by referencing the assumed demand for a specific year and then calculating the amount of water associated with it. Attachment 1 is a plot of the results of the draft DRR (2005) as percentages of the assumed demand. It confirms your observation that the percentage of time the assumed demand is met decreases as the level of demand increases.

Your letter recommends the report include scenarios for future SWP demands that reflect the approach taken in the current California Water Plan. The Water Plan includes estimates for California's water demands which assume a continuation of current trends, a less intensive use of water, and a more intensive use of water. As noted in the Water Plan, the scenarios presented there are for demonstration of the kind of scenarios that should be looked at in more detail once the analytic tools are developed. The Department will undertake an effort to define a range of future demand scenarios for the SWP. This effort will not only provide information for future delivery reliability reports but also for the next Water Plan. As a point of clarification, your letter refers to the Tulare Lake hydrologic region analyzed in the Water Plan as an SWP service area. A few of the SWP agricultural contractors are in the Tulare Lake hydrologic region. Their service areas occupy a portion of the hydrologic region. The region is much larger than these service areas and includes the cities of Fresno, Visalia, and Bakersfield.

You express a concern about the consistency of the studies in the draft DRR (2005) with the description of the operation of the SWP in the Operations Criteria and Plan (OCAP), upon which the current biological opinions for the SWP and Central Valley Project are based. Studies 4 and 5 of the draft DRR (2005) use the same version of CalSim-II as the OCAP analyses and are, therefore, consistent with the OCAP project description. The Table A and Article 21 demands of the studies are within the range of the OCAP project description. If regulatory standards are modified in the future, the model will be updated to include any modified standards.

Your letter states that Article 21 should not be recommended as a supply to be integrated as a firm annual supply in planning documents. This comment is regarding the examples shown in Chapter 6 which illustrate how to calculate water supplies from the information presented in the report. In response to your concern, a footnote alerting the reader to the variability of Article 21 deliveries and referring back to the discussion in Chapter 5 has been added to the tables addressing average values. Chapter 5 thoroughly discusses the limitations of Article 21 supply.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments and recommendations. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim-II modeling studies. He may be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Original signed by

Katherine F. Kelly, Chief
Bay-Delta Office

Attachments

cc: (See attached list.)

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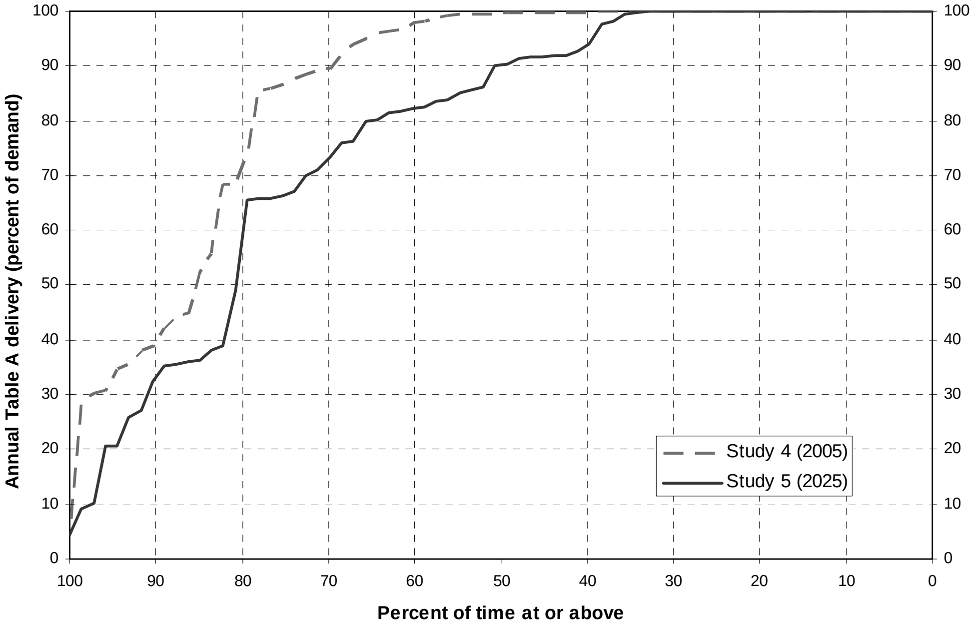
Attachment 1
Planning and Conservation League

SWP Delta Table A delivery probability for studies 4 and 5 as percent of Table A demand



Study 4 simulates a variable Table A demand of 2.3 – 3.9 million acre-feet (MAF) per year, dependent upon water-year type.

Study 5 simulates a variable Table A demand of 3.9 – 4.1 MAF/year, dependent upon water-year type.

Attachment 2
Response to PCL

Responses to comments from Planning and Conservation League (December 22, 2005) on Draft State Water Project Delivery Reliability Report – 2005

Responses to comments on the adequacy of CalSim-II

Comment: **CalSim-II has not been calibrated or validated.**

Response: CalSim-II is essentially a continuous accounting model, supplemented by a linear programming module to optimize the monthly operation of the system without foresight about the conditions in the next period. The primary physical law governing the simulation procedure is conservation of mass, maintaining a mass balance from one period to the next, while optimizing allocations of the available water in that period without foresight about the future periods of simulation. Models such as CalSim-II are inherently different from models that simulate hydrologic processes based on the physical laws governing the precipitation-runoff and the physical routing of water through a system of channels with defined geometry, roughness, streambed slope, etc. The classical model calibration process is difficult to apply to planning models, such as CalSim-II, that are primarily used to predict operations and water availability for a fixed level of development in the future. Continuing development of new supplies, along with changes in demands and the regulatory environment have all resulted in considerable changes to the management of the Central Valley Project (CVP)/State Water Project (SWP) system in the past 35 years. Project operations to meet future demands are often predicated on operation rules, storage and conveyance facilities, and demand levels which are necessarily different from historical conditions.

Although classical approach to model calibration can not be applied to models like CalSim-II, calibration of some of the important components of the model is possible, and has been done. For instance, one of the most important components of the model, its hydrologic component, has been calibrated by including closure terms in the form of local surface water accretions from every depletion study area (DSA) of the model network to match the historically available stream gage records. The routine used to determine the Sacramento River flows and the corresponding Delta exports that meet Delta water quality standards, is an Artificial Neural Network (ANN) model that is trained using the calibrated Delta Simulation Model (DSM2) prior to being used in CalSim-II simulation runs. Also, a revised groundwater-surface water interaction module is currently being developed that uses groundwater-surface water response functions produced by the simulation of the historical groundwater pumping

Attachment 2
Response to PCL

amounts that match the available historical data on groundwater levels and stream gage data. The above components of CalSim-II, that are either directly or indirectly calibrated, are three of the most important components of the model that have the most significant impacts on the simulation results, and as such, it would be inaccurate to claim that CalSim-II has not been calibrated. In the absence of a classical approach to calibration applicable to complex models like CalSim-II, the next best approach is generally to set model parameters for a simulation run relying on experience and then verifying the results of the simulation run by comparing to historical operations. To verify model results, the Department of Water Resources (DWR) conducted a 24-year simulation using historical input from 1975 to 1998. The results of this study showed remarkable matching of the simulated values of the major components of system operation to historical values. Components such as stream flows at key locations and the net Delta outflow index showed little difference between simulated and historical values. Therefore, it would be inaccurate to claim that CalSim-II has not been validated. For detailed examination of the validation study the reader is referred to *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report*, November 2003.

Comment: **It is unclear whether CalSim-II incorporates limitations to groundwater use in the Sacramento Valley.**

Response: The issue of over-estimation of the water available in the Delta as a result of excessive pumping of groundwater in the Sacramento Valley was examined in the *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report*, November 2003, and addressed in the *Peer Review Response* report of August 2004. The results of the simulation indicated that CalSim-II, in fact, under-estimates the long-term contribution of the groundwater when compared to the historical groundwater pumping in the Valley, and only slightly over-estimates this contribution in extended drought periods. The *Peer Review Response* report states:

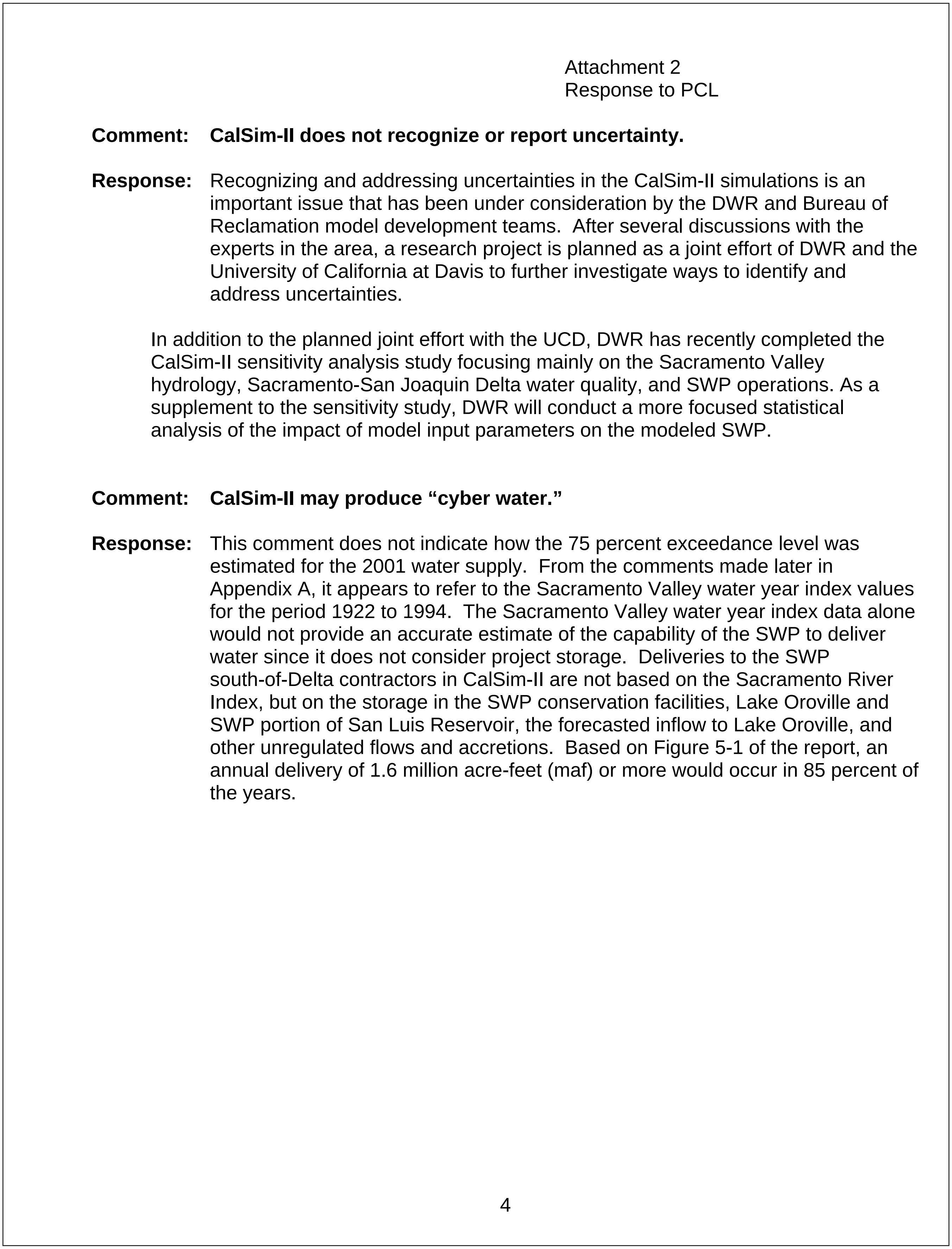
> "The mix of surface water and groundwater used by the model to meet Sacramento Valley consumptive demands depends primarily on project water allocation decisions and levels of minimum groundwater pumping that are specified in the model. Over the 24-year period average annual net groundwater extraction in CalSim-II as compared to estimates based on the Central Valley Groundwater Surface Water Model (CVGSM) is lower by 378 thousand acre-feet (taf). The average annual net stream inflow from groundwater in CalSim-II is 190 taf greater than estimated by the CVGSM for the same period. The combined effect of dynamically modeling groundwater operations in CalSim-II (pumping, recharge and stream-aquifer interaction) leads to 188 taf per year less water being available to the Delta. For the 1987-92 period the combined effect results

> in 46 taf per year additional water being available to the Delta. Thus the Historical Operations Study concludes that the current representation of groundwater in CalSim-II results, on average, in an under-estimation of water available at the Delta."

For more details on how groundwater-surface water interaction is modeled in CalSim-II, the reader is referred to pages A-2 and A-3 of the *Peer Review Response* report. As mentioned above, a revised groundwater-surface water interaction module is currently being developed and will be implemented in CalSim-III to use groundwater-surface water response functions produced by the simulation of the historical groundwater pumping amounts that match the available historical data on groundwater levels and stream gage data.

Comment: **The CalSim-II model should not be used to make absolute predictions, such as those incorporated into the Reliability Report.**

Response: It is true that a planning model like CalSim-II is best used in the comparative mode, when a "without project" scenario is compared with a "with project" scenario. However, this does not preclude the use of this model in studies like the ones used in the Delivery Reliability Report, provided that the users are sufficiently aware of the model assumptions and how to use the output data that CalSim-II simulations provide. The conversion of raw output data to usable information in planning studies requires judgment by the user. As discussed earlier, in the response to comments on the validation efforts by the Historical Operation Study, CalSim-II does very well in mimicking historical operations as evident by the comparisons made on the key system operation components. Furthermore, the reader is referred to the general comments made by the CALFED peer review panel in the executive summary of their December 2003 report. The panel proposes the following question: "Is the general CalSim modeling approach appropriate for predicting the performance of the general facilities and for use in allocation planning, assessing water supply reliabilities and for carrying out operational studies?" The panel's answer to this question is: "We believe the use of an optimization engine for simulating the hydrology and for making allocation decisions is an appropriate approach and is in fact the approach many serious efforts of this kind are using. It is a substantial improvement of the previous modeling approaches and provides a basis for consensus among federal and state interests. The modeling approach addresses many of the complexities of the CVP/SWP system and its water management decisions."



Attachment 2
Response to PCL

Comment: **CalSim-II does not recognize or report uncertainty.**

Response: Recognizing and addressing uncertainties in the CalSim-II simulations is an important issue that has been under consideration by the DWR and Bureau of Reclamation model development teams. After several discussions with the experts in the area, a research project is planned as a joint effort of DWR and the University of California at Davis to further investigate ways to identify and address uncertainties.

In addition to the planned joint effort with the UCD, DWR has recently completed the CalSim-II sensitivity analysis study focusing mainly on the Sacramento Valley hydrology, Sacramento-San Joaquin Delta water quality, and SWP operations. As a supplement to the sensitivity study, DWR will conduct a more focused statistical analysis of the impact of model input parameters on the modeled SWP.

Comment: **CalSim-II may produce "cyber water."**

Response: This comment does not indicate how the 75 percent exceedance level was estimated for the 2001 water supply. From the comments made later in Appendix A, it appears to refer to the Sacramento Valley water year index values for the period 1922 to 1994. The Sacramento Valley water year index data alone would not provide an accurate estimate of the capability of the SWP to deliver water since it does not consider project storage. Deliveries to the SWP south-of-Delta contractors in CalSim-II are not based on the Sacramento River Index, but on the storage in the SWP conservation facilities, Lake Oroville and SWP portion of San Luis Reservoir, the forecasted inflow to Lake Oroville, and other unregulated flows and accretions. Based on Figure 5-1 of the report, an annual delivery of 1.6 million acre-feet (maf) or more would occur in 85 percent of the years.

Attachment 2
Response to PCL

Responses to Comments in Appendix A

First comment regarding page 7 of the draft report

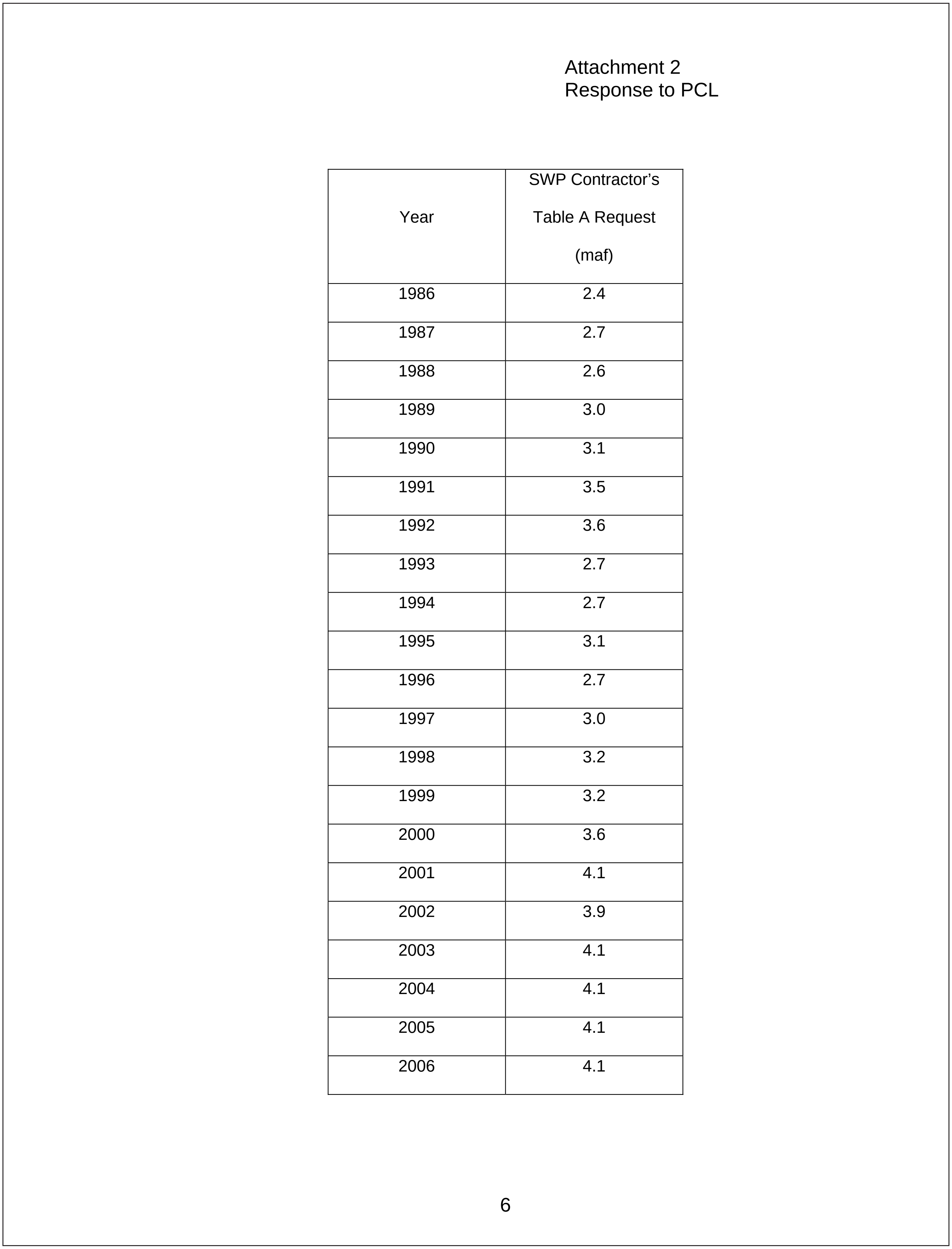
The report should highlight the weaknesses in the analysis and put the referenced statement in a text box.

The final Report (2005) has been modified to expound upon uncertainties associated with the analyses. Many of these modifications have been done in response to the comments of the PCL. We believe the final report sufficiently addresses the uncertainties associated with the projections.

Second comment regarding page 7 of the draft report

What analysis of current or future demand patterns is used to justify the assumption of a demand for full Table A allotments?

As stated on page 15 of the draft report, "The assumed demands for studies 4 and 5 were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with the environmental documentation for the Monterey Agreement." SWP contractor's Table A requests for the real-time operations are developed and submitted to DWR by contracting agencies and their consultants. Examination of the historical requests show an increasing trend and they reach the full Table A request of 4.1 maf in 2001. As the following table indicates, contractors' requests were at full Table A amounts in 5 out of the 6 recent years.



Attachment 2
Response to PCL

Year	SWP Contractor's Table A Request (maf)
1986	2.4
1987	2.7
1988	2.6
1989	3.0
1990	3.1
1991	3.5
1992	3.6
1993	2.7
1994	2.7
1995	3.1
1996	2.7
1997	3.0
1998	3.2
1999	3.2
2000	3.6
2001	4.1
2002	3.9
2003	4.1
2004	4.1
2005	4.1
2006	4.1

Attachment 2
Response to PCL

Third comment regarding page 7 of the draft report

Statement: The following statement should be clarified or removed.

"Conversely, the current or projected delivery capability of the a water project would be less if (1) demand for water from a water project was at its maximum level for many years, (2) no new facilities were built, and (3) the supply of the main sources of water was recently reduced because another entity with a prior water right increased its use of that source."

The statement is revised as follows:
"Conversely, the projected deliveries of a water project would be less than the past if the water project had been operated at its maximum ability for many years, no new facilities were planned to be built, and the annual supply from one of its main sources of water was recently reduced and would remain at the reduced level."

Comment regarding page 8 of the draft report

The results of sensitivity analysis are not included in the report.
(See response to the last comment in this appendix.)

Response to comments regarding page 11 and page 74 of the draft report

Historical Operation Study as a means to validate CalSim-II

An objection is raised in Appendix A of the letter to the Department's claim that the results of the Historical Operation Study validate the CalSim-II model as an appropriate tool for planning studies. The specific objection seems to be to the statement in the Delivery Reliability Report, page 11 that states "The simulated deliveries in Figure 3-1 were adjusted for any differences between the historical and simulated carryover storage in the SWP system reservoirs, Lake Oroville and SWP's portion of San Luis Reservoir." The letter from the Planning and Conservation League raises the objection that "If the storage levels in SWP reservoirs were not faithfully reproduced and had to be adjusted in some unexplained way to generate the results in Figure 3-1, then the Technical Memorandum should not be used to build the credibility of the CalSim-II."

Attachment 2
Response to PCL

The detailed explanation of how and for what purpose the deliveries were adjusted to produce Figure 3-1 was deemed to be out of the scope of the 2005 update of the Delivery Reliability Report and the reader is referred to the Technical Memorandum Report, pages 18 and 19, for further detail. In summary, the resulting simulated annual deliveries during the 6-year drought of 1987-92 were adjusted by post-processing to account for the differences between the historical and simulated initial and end-of-year storages in the SWP system reservoirs. The adjustments were made to show the resulting year-to-year deliveries had the model's delivery for that particular year reflected identical use of stored water from the SWP reservoirs. In both the adjusted and the unadjusted case, however, the average annual delivery during the 6-year drought was 1,930 taf per year. The following table and the attached charts (Figure 1 for the unadjusted simulated deliveries, and Figure 2 for the resulting deliveries after adjustments) should clarify the post-processing procedure.

Calendar Year	Simulated SWP SOD Deliv (TAF)	Simulated January 1 Storage (TAF)	Simulated December 31 Storage (TAF)	Simulated Storage Withdrawal (TAF)	Historical Storage Withdrawal (TAF)	Storage Withdrawal Adjustment (Historical-Simulated) (TAF)	Adjusted Delivery (TAF)
1987	2567	4120*	2634	1486*	1182*	-304	2263
1988	1903	2634	2026	608	1050	442	2345
1989	2350	2026	2635	-609	-597	12	2362
1990	1851	2635	1738	897	1512	615	2466
1991	1266	1738	1730	8	-682	-690	576
1992	1652	1730	1748	-18	-110	-92	1560
Average**	**1930**						**1930**

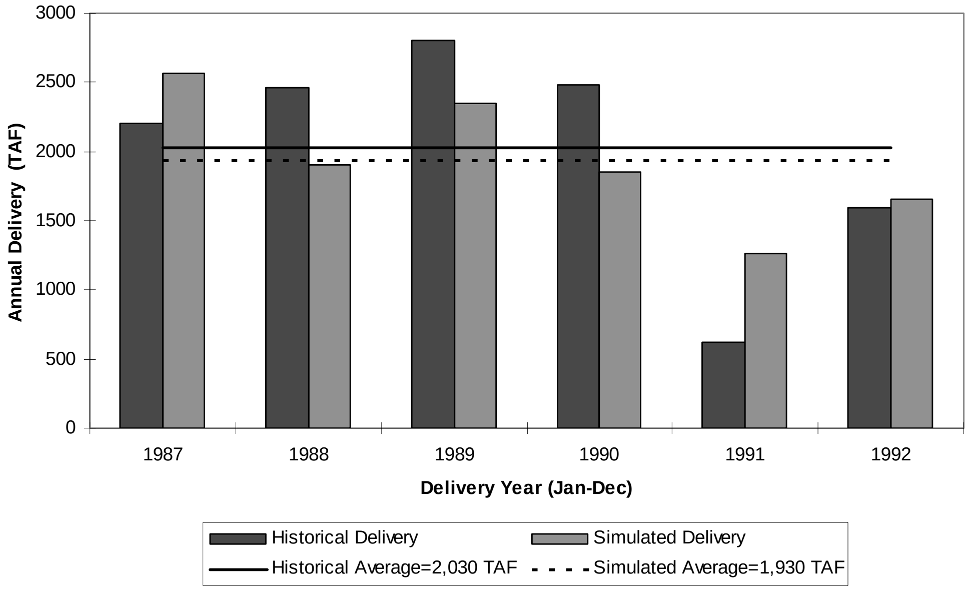
* This storage and the corresponding withdrawals are from April 1, 1987 to December 1987, because the 6-year drought is assumed to have started from April 1, 1987, the last month before the onset of the drought in which the system's reservoirs were full.

** Rounded off to the nearest 10 taf.

8

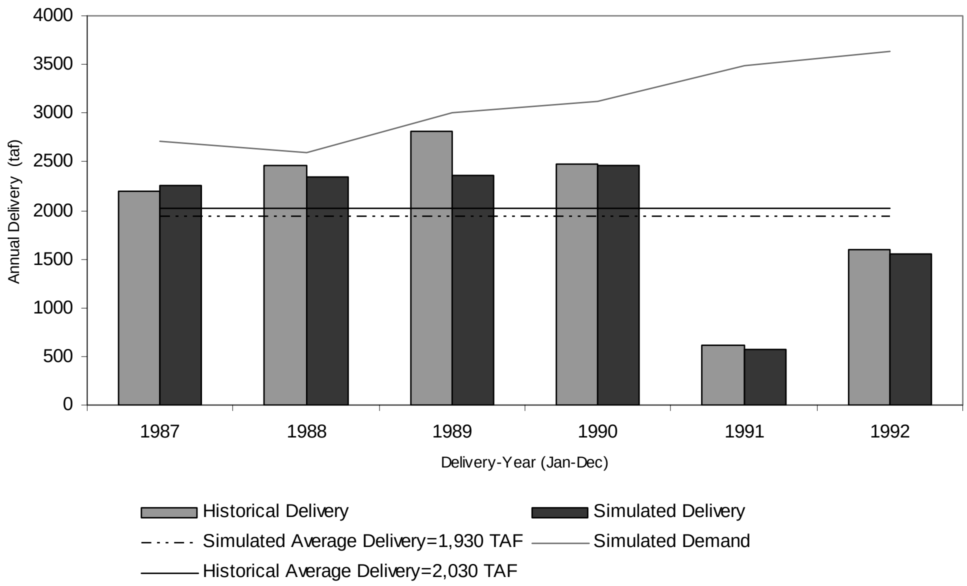
Attachment 2
Response to PCL

Figure 1
Historical versus Simulated SWP Table A Delivery (Unadjusted)
1987-1992 Dry Period



Attachment 2
Response to PCL

Figure 2
Historical versus Simulated SWP Table A Delivery (Adjusted)
1987-1992 Dry Period



The simulated month-to-month operation of the system may vary substantially from the actual historical operation, although the long-term average flows and deliveries are typically close. Therefore, post-processing of some of the raw data resulting from the simulation run is sometimes necessary to account for some of the unavoidable differences between the historical and simulated results. Some of the factors that could contribute to these differences in the month-to-month operation are:

- Delivery versus carryover storage rules
- Delta outflow requirements to comply with SWRCB standards
- South-of-Delta demand assumptions
- Level of north-of-Delta groundwater pumping
- Rule curves to transfer water from north-of-Delta reservoirs to San Luis Reservoir
- Crop consumptive use of applied water and agricultural water use efficiency
- Assumptions on historical land use, and project versus non-project demands
- Stream-aquifer interactions

- Historical operation based on decisions that are made in shorter time resolutions that the monthly simulation model captures, such as flood control operations, hydropower operations, export curtailments due to fish take limits, system scheduled and unscheduled outages, etc.
- CVP reservoirs balancing north of Delta
- Compliance with the provisions of the Coordinated Operations Agreement
- Drought water bank and water transfers

The following summary should be helpful in determining how well the Historical Operation Study was able to reproduce the actual historical records on the key components of the system operation. Figure 10 on page 46 of the Technical Memorandum Report shows that the simulated long-term average SWP delivery to the south-of-Delta contractors exceeded the historical average delivery by only 1.1 percent. Figure 12 on page 48 (same as Figure 2 in this response) shows that the simulated average annual delivery in the 1987-92 drought was less than the historical average delivery by 4.9 percent. Figure 26 on page 62 shows that the total project exports from the Delta during the 6-year drought was less than the historical average by only 0.2 percent. Figures 31 through 35 on pages 67 through 71 show that the simulated average annual flows in various key locations along the Sacramento River vary from the historical values by 0.5 percent to 4.5 percent. Figure 37 on page 73 shows that the simulated long-term average annual net Delta outflow index is less than the historical value by 3.1 percent. There were many other simulated variables that were compared to their historical values in the Technical Memorandum Report that reflect a more complete picture of how well CalSim-II was able to mimic historical operations. These results, of course, should be examined carefully with an eye on what caused the variation, and how significant the variations were. In other words, how close is close enough to validate CalSim-II as an appropriate model in long-term planning applications, and whether the model reflects the historical record on important system performance measures with sufficient accuracy.

Response to comment regarding page 16 of the draft report

Updated Article 21 demand should be explained.

The demand for Article 21 water is submitted to DWR by the contracting agencies and the increase of 50 taf in December through March is due to the increased requests submitted to DWR by the Metropolitan Water District of Southern California.

Attachment 2
Response to PCL

<u>Responding to comment regarding page 25 of the draft report</u>

There is nothing special about the thresholds used to reference the curve in Figure 5-2. They should be changed as recommended.

The percentages of 75, 50, and 25 are chosen as simple examples to illustrate how to read the curve. These percentages are at or near the mid-range of the curve and the results are surrounded by several data points. Using the end points of the curve for an illustration is not as effective and, in the case of the lowest delivery value, focuses on the result for a single year.

<u>Response to comment regarding page 26 of the draft report</u>

DWR's attempt at post-processing 1976-77 deliveries is not valid

As stated on page 25 of the draft report, CalSim-II is a planning model and is best used for estimating SWP performance over long periods of time. Considerable judgment should be applied when evaluating CalSim-II results for shorter periods of time. This is especially true for estimates for the single driest year on record in a 73-year sequence.

<u>Response to comment regarding page 49 of draft report</u>

It is inappropriate to speculate on what deliveries will be with new facilities.

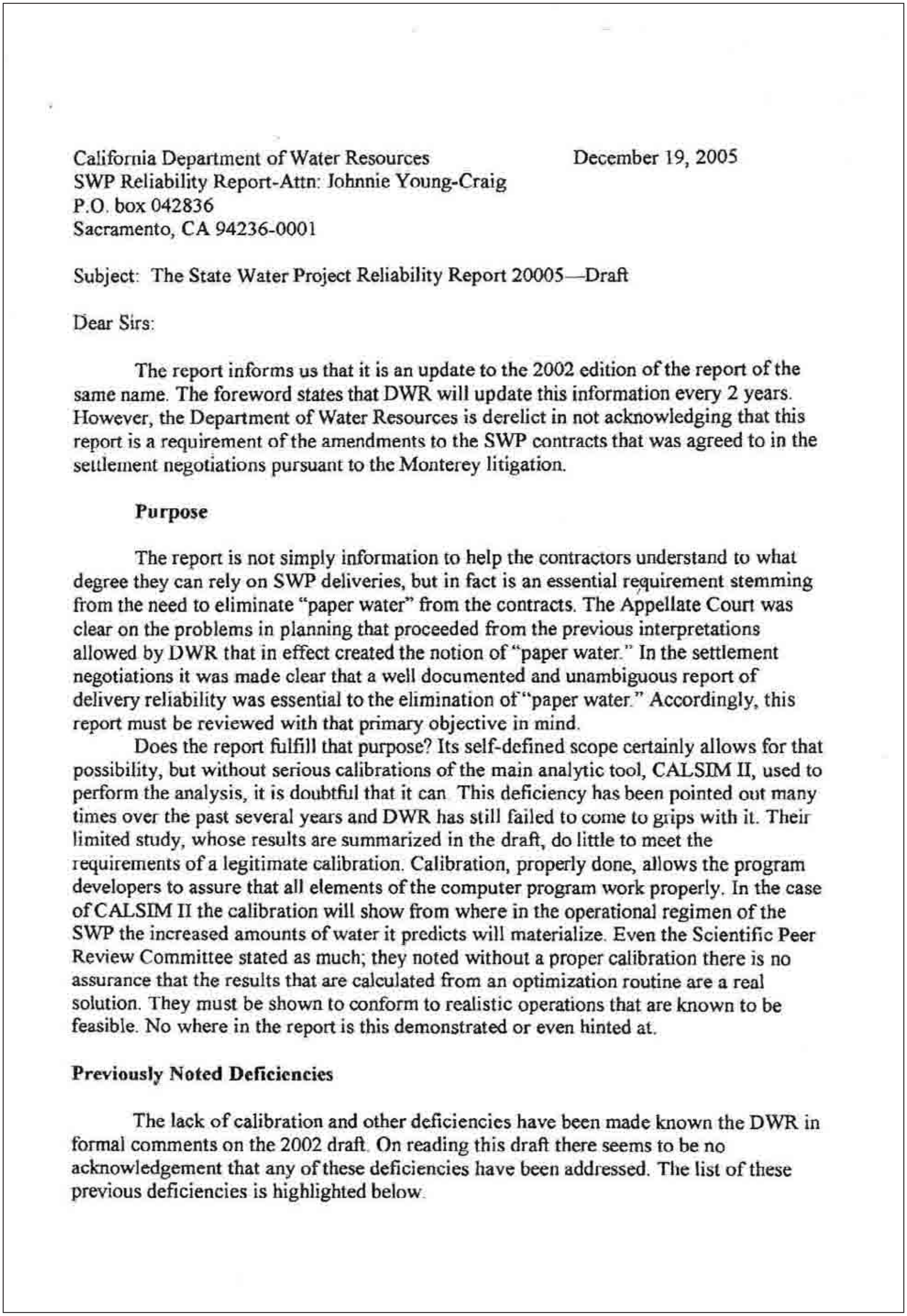
The paragraph is deleted.

<u>Response to comment regarding page 78 of the draft report</u>

Results of the sensitivity analysis should be applied to interpreting the results of the reliability analysis.

The Sensitivity Analysis Study is discussed in the draft report to inform the reader of the status of DWR's commitment to conducting such a study. The sensitivity study will be further analyzed in view of the SWP Delta deliveries and the results of that analysis will be incorporated as appropriate in the next Reliability Report.

It should be noted that the summary results on SI and EI shown in the Table E-1 are strictly applicable to the long-term (1922-1994) performance of the project. It is not appropriate to apply these results to a single year. In addition, these results should be applied with caution since they are applicable only within the investigated range of variation of the input parameters. The sensitivity study analyzed the response of the SWP total and Delta delivery for a 5 percent reduction in the Banks pumping capacity and ±5 percent variation in Oroville inflow.



California Department of Water Resources December 19, 2005
SWP Reliability Report-Attn: Johnnie Young-Craig
P.O. box 042836
Sacramento, CA 94236-0001

Subject: The State Water Project Reliability Report 20005—Draft

Dear Sirs:

The report informs us that it is an update to the 2002 edition of the report of the same name. The foreword states that DWR will update this information every 2 years. However, the Department of Water Resources is derelict in not acknowledging that this report is a requirement of the amendments to the SWP contracts that was agreed to in the settlement negotiations pursuant to the Monterey litigation.

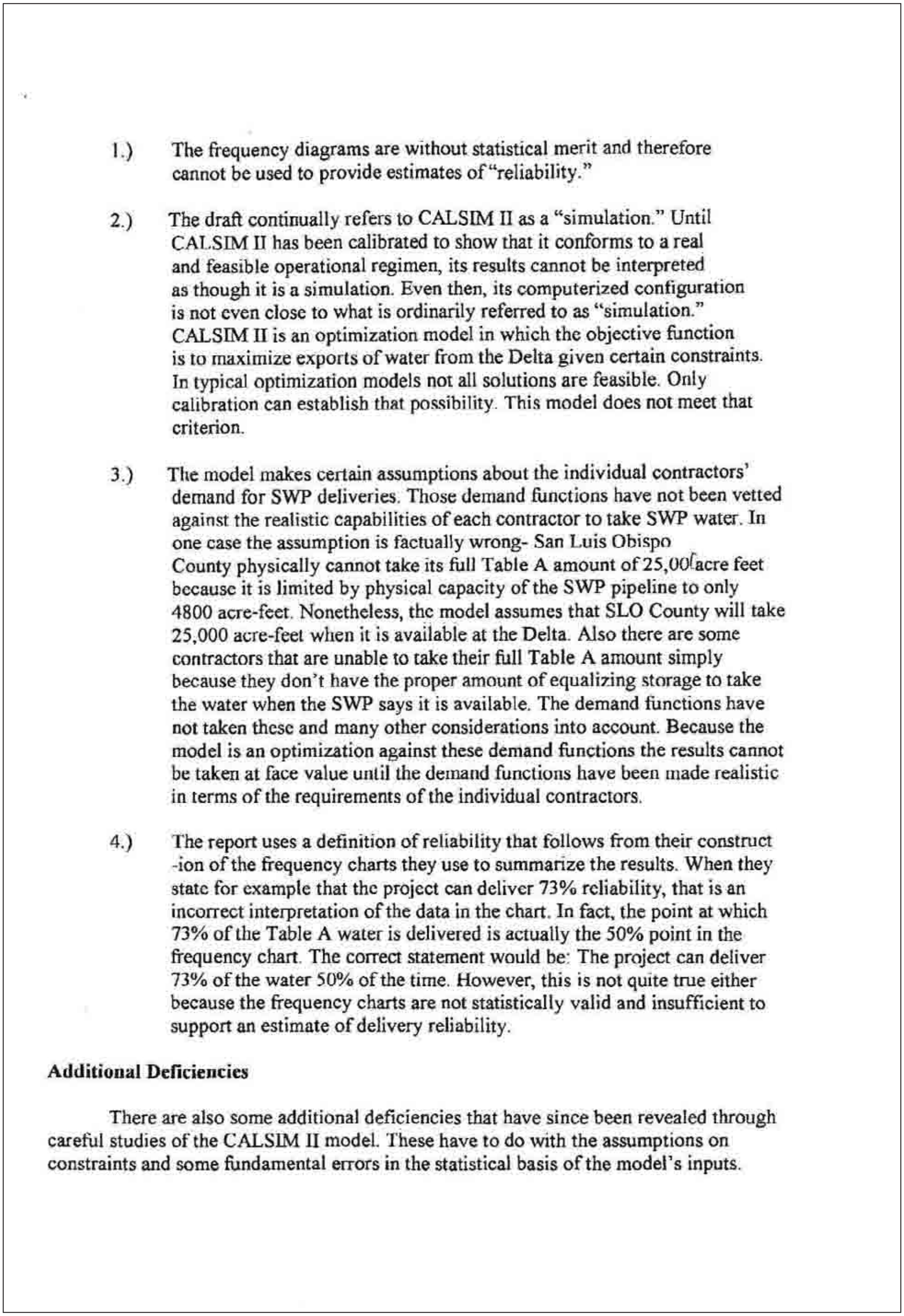
Purpose

The report is not simply information to help the contractors understand to what degree they can rely on SWP deliveries, but in fact is an essential requirement stemming from the need to eliminate "paper water" from the contracts. The Appellate Court was clear on the problems in planning that proceeded from the previous interpretations allowed by DWR that in effect created the notion of "paper water." In the settlement negotiations it was made clear that a well documented and unambiguous report of delivery reliability was essential to the elimination of "paper water." Accordingly, this report must be reviewed with that primary objective in mind.

Does the report fulfill that purpose? Its self-defined scope certainly allows for that possibility, but without serious calibrations of the main analytic tool, CALSIM II, used to perform the analysis, it is doubtful that it can This deficiency has been pointed out many times over the past several years and DWR has still failed to come to grips with it. Their limited study, whose results are summarized in the draft, do little to meet the requirements of a legitimate calibration. Calibration, properly done, allows the program developers to assure that all elements of the computer program work properly. In the case of CALSIM II the calibration will show from where in the operational regimen of the SWP the increased amounts of water it predicts will materialize. Even the Scientific Peer Review Committee stated as much; they noted without a proper calibration there is no assurance that the results that are calculated from an optimization routine are a real solution. They must be shown to conform to realistic operations that are known to be feasible. No where in the report is this demonstrated or even hinted at.

Previously Noted Deficiencies

The lack of calibration and other deficiencies have been made known the DWR in formal comments on the 2002 draft. On reading this draft there seems to be no acknowledgement that any of these deficiencies have been addressed. The list of these previous deficiencies is highlighted below.



1.) The frequency diagrams are without statistical merit and therefore cannot be used to provide estimates of "reliability."

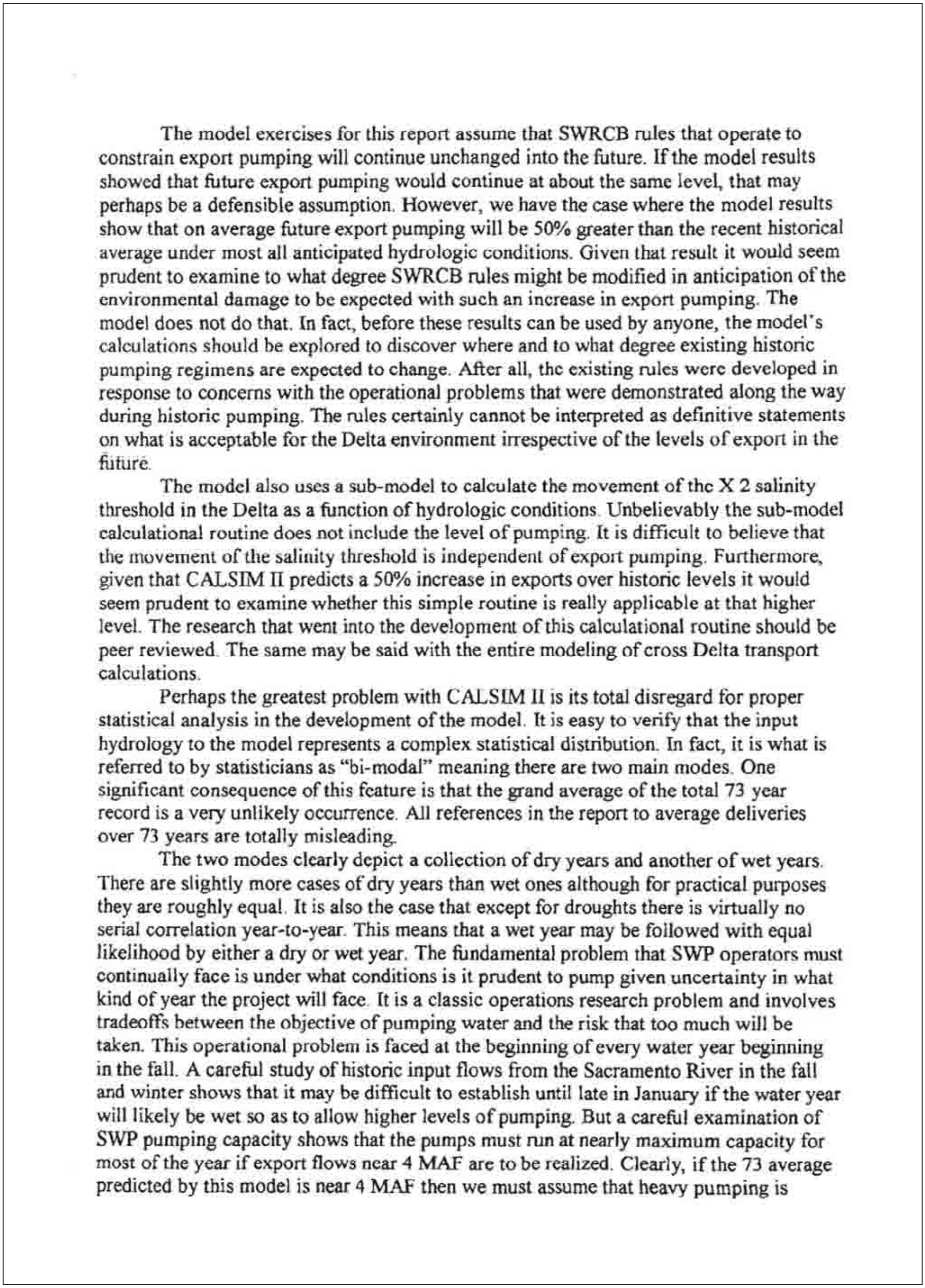
2.) The draft continually refers to CALSIM II as a "simulation." Until CALSIM II has been calibrated to show that it conforms to a real and feasible operational regimen, its results cannot be interpreted as though it is a simulation. Even then, its computerized configuration is not even close to what is ordinarily referred to as "simulation." CALSIM II is an optimization model in which the objective function is to maximize exports of water from the Delta given certain constraints. In typical optimization models not all solutions are feasible. Only calibration can establish that possibility. This model does not meet that criterion.

3.) The model makes certain assumptions about the individual contractors' demand for SWP deliveries. Those demand functions have not been vetted against the realistic capabilities of each contractor to take SWP water. In one case the assumption is factually wrong- San Luis Obispo County physically cannot take its full Table A amount of 25,000 acre feet because it is limited by physical capacity of the SWP pipeline to only 4800 acre-feet. Nonetheless, the model assumes that SLO County will take 25,000 acre-feet when it is available at the Delta. Also there are some contractors that are unable to take their full Table A amount simply because they don't have the proper amount of equalizing storage to take the water when the SWP says it is available. The demand functions have not taken these and many other considerations into account. Because the model is an optimization against these demand functions the results cannot be taken at face value until the demand functions have been made realistic in terms of the requirements of the individual contractors.

4.) The report uses a definition of reliability that follows from their construction of the frequency charts they use to summarize the results. When they state for example that the project can deliver 73% reliability, that is an incorrect interpretation of the data in the chart. In fact, the point at which 73% of the Table A water is delivered is actually the 50% point in the frequency chart. The correct statement would be: The project can deliver 73% of the water 50% of the time. However, this is not quite true either because the frequency charts are not statistically valid and insufficient to support an estimate of delivery reliability.

Additional Deficiencies

There are also some additional deficiencies that have since been revealed through careful studies of the CALSIM II model. These have to do with the assumptions on constraints and some fundamental errors in the statistical basis of the model's inputs.

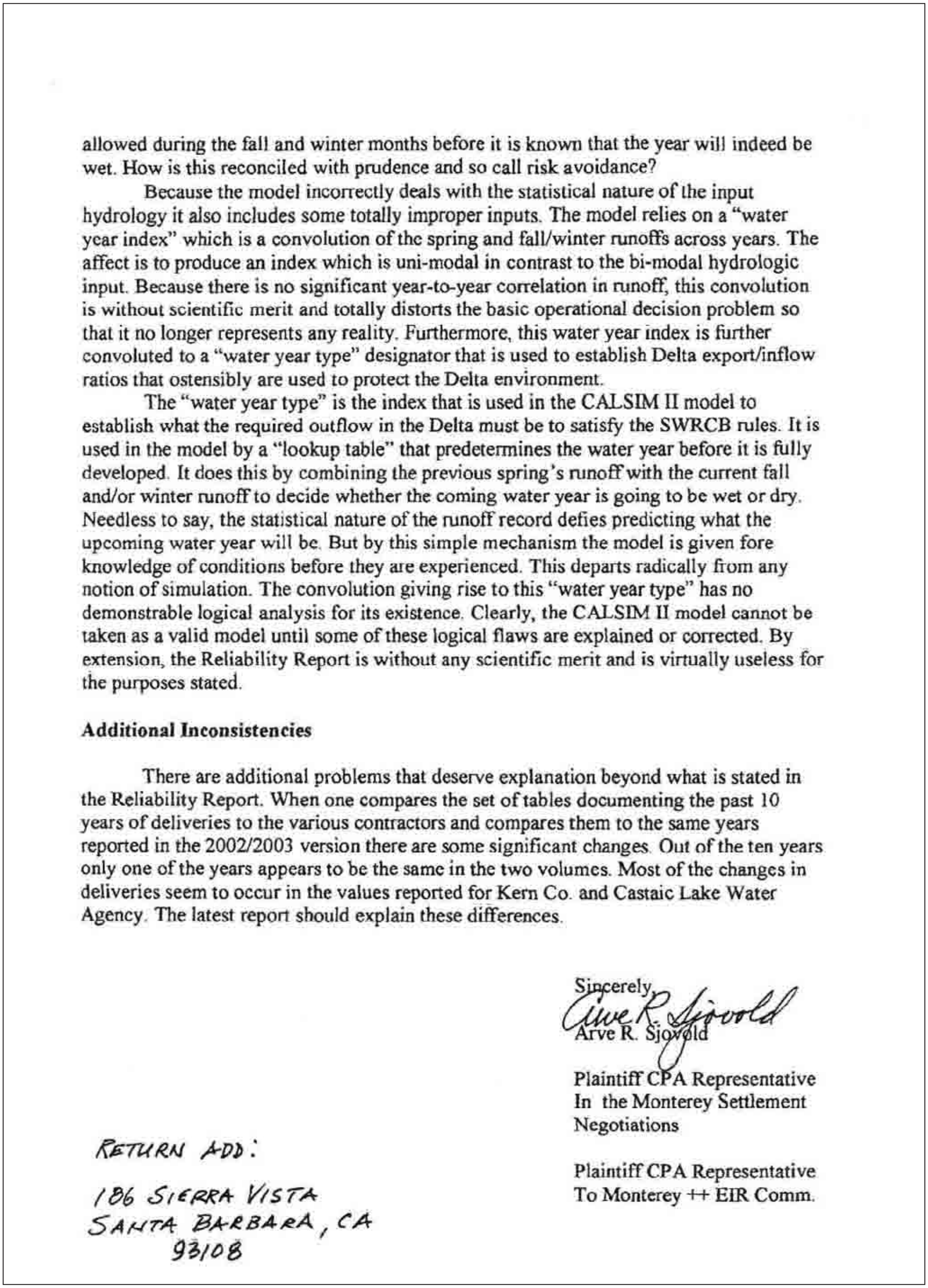


The model exercises for this report assume that SWRCB rules that operate to constrain export pumping will continue unchanged into the future. If the model results showed that future export pumping would continue at about the same level, that may perhaps be a defensible assumption. However, we have the case where the model results show that on average future export pumping will be 50% greater than the recent historical average under most all anticipated hydrologic conditions. Given that result it would seem prudent to examine to what degree SWRCB rules might be modified in anticipation of the environmental damage to be expected with such an increase in export pumping. The model does not do that. In fact, before these results can be used by anyone, the model's calculations should be explored to discover where and to what degree existing historic pumping regimens are expected to change. After all, the existing rules were developed in response to concerns with the operational problems that were demonstrated along the way during historic pumping. The rules certainly cannot be interpreted as definitive statements on what is acceptable for the Delta environment irrespective of the levels of export in the future.

The model also uses a sub-model to calculate the movement of the X 2 salinity threshold in the Delta as a function of hydrologic conditions. Unbelievably the sub-model calculational routine does not include the level of pumping. It is difficult to believe that the movement of the salinity threshold is independent of export pumping. Furthermore, given that CALSIM II predicts a 50% increase in exports over historic levels it would seem prudent to examine whether this simple routine is really applicable at that higher level. The research that went into the development of this calculational routine should be peer reviewed. The same may be said with the entire modeling of cross Delta transport calculations.

Perhaps the greatest problem with CALSIM II is its total disregard for proper statistical analysis in the development of the model. It is easy to verify that the input hydrology to the model represents a complex statistical distribution. In fact, it is what is referred to by statisticians as "bi-modal" meaning there are two main modes. One significant consequence of this feature is that the grand average of the total 73 year record is a very unlikely occurrence. All references in the report to average deliveries over 73 years are totally misleading.

The two modes clearly depict a collection of dry years and another of wet years. There are slightly more cases of dry years than wet ones although for practical purposes they are roughly equal. It is also the case that except for droughts there is virtually no serial correlation year-to-year. This means that a wet year may be followed with equal likelihood by either a dry or wet year. The fundamental problem that SWP operators must continually face is under what conditions is it prudent to pump given uncertainty in what kind of year the project will face. It is a classic operations research problem and involves tradeoffs between the objective of pumping water and the risk that too much will be taken. This operational problem is faced at the beginning of every water year beginning in the fall. A careful study of historic input flows from the Sacramento River in the fall and winter shows that it may be difficult to establish until late in January if the water year will likely be wet so as to allow higher levels of pumping. But a careful examination of SWP pumping capacity shows that the pumps must run at nearly maximum capacity for most of the year if export flows near 4 MAF are to be realized. Clearly, if the 73 average predicted by this model is near 4 MAF then we must assume that heavy pumping is



allowed during the fall and winter months before it is known that the year will indeed be wet. How is this reconciled with prudence and so call risk avoidance?

Because the model incorrectly deals with the statistical nature of the input hydrology it also includes some totally improper inputs. The model relies on a "water year index" which is a convolution of the spring and fall/winter runoffs across years. The affect is to produce an index which is uni-modal in contrast to the bi-modal hydrologic input. Because there is no significant year-to-year correlation in runoff, this convolution is without scientific merit and totally distorts the basic operational decision problem so that it no longer represents any reality. Furthermore, this water year index is further convoluted to a "water year type" designator that is used to establish Delta export/inflow ratios that ostensibly are used to protect the Delta environment.

The "water year type" is the index that is used in the CALSIM II model to establish what the required outflow in the Delta must be to satisfy the SWRCB rules. It is used in the model by a "lookup table" that predetermines the water year before it is fully developed. It does this by combining the previous spring's runoff with the current fall and/or winter runoff to decide whether the coming water year is going to be wet or dry. Needless to say, the statistical nature of the runoff record defies predicting what the upcoming water year will be. But by this simple mechanism the model is given fore knowledge of conditions before they are experienced. This departs radically from any notion of simulation. The convolution giving rise to this "water year type" has no demonstrable logical analysis for its existence. Clearly, the CALSIM II model cannot be taken as a valid model until some of these logical flaws are explained or corrected. By extension, the Reliability Report is without any scientific merit and is virtually useless for the purposes stated.

Additional Inconsistencies

There are additional problems that deserve explanation beyond what is stated in the Reliability Report. When one compares the set of tables documenting the past 10 years of deliveries to the various contractors and compares them to the same years reported in the 2002/2003 version there are some significant changes. Out of the ten years only one of the years appears to be the same in the two volumes. Most of the changes in deliveries seem to occur in the values reported for Kern Co. and Castaic Lake Water Agency. The latest report should explain these differences.

Sincerely,

Arve R. Sjovold

Arve R. Sjovold

Plaintiff CPA Representative
In the Monterey Settlement
Negotiations

Plaintiff CPA Representative
To Monterey ++ EIR Comm.

RETURN ADD:

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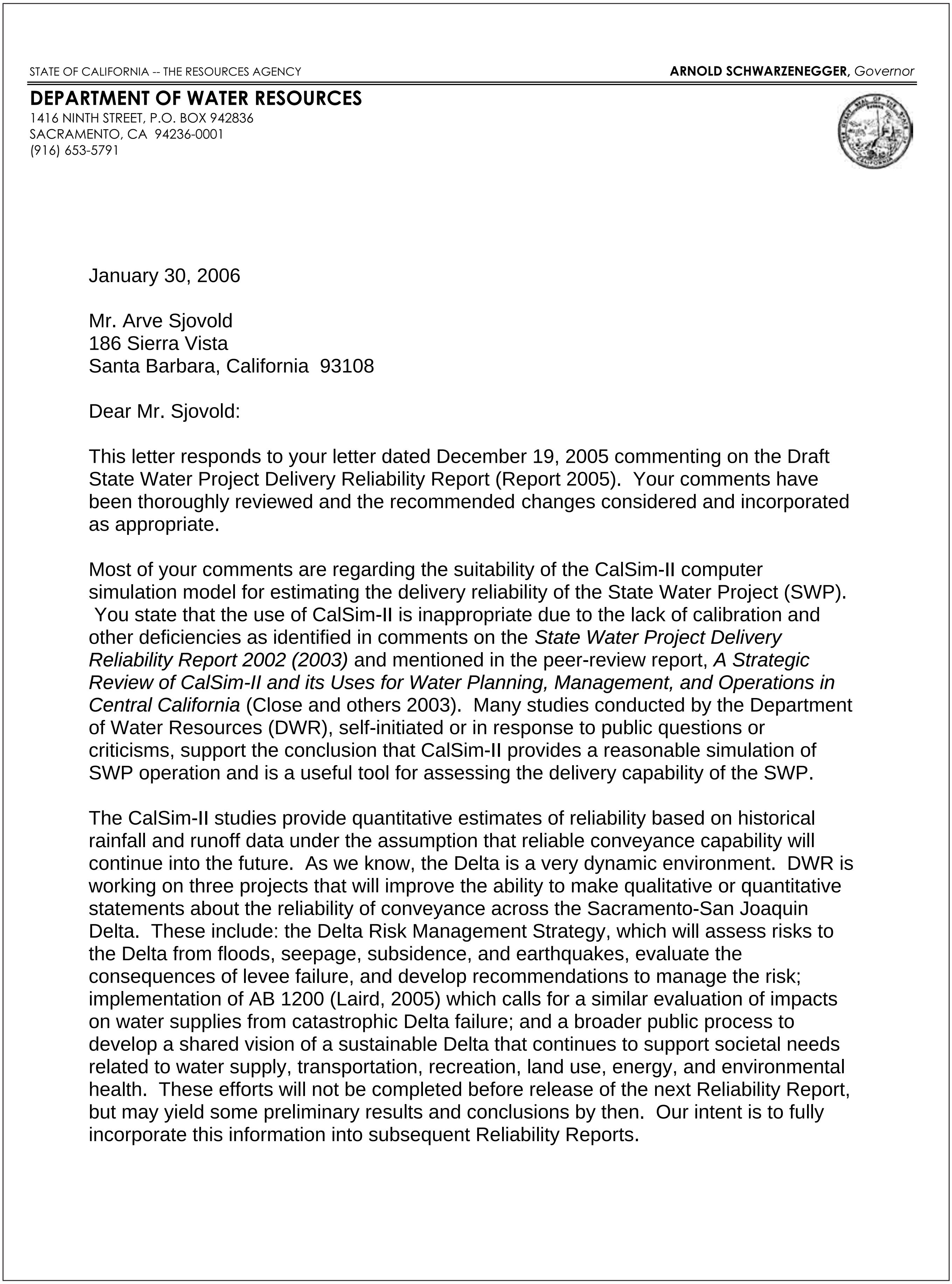
SANTA BARBARA, CA
93108



STATE OF CALIFORNIA -- THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

January 30, 2006

Mr. Arve Sjovold
186 Sierra Vista
Santa Barbara, California 93108

Dear Mr. Sjovold:

This letter responds to your letter dated December 19, 2005 commenting on the Draft State Water Project Delivery Reliability Report (Report 2005). Your comments have been thoroughly reviewed and the recommended changes considered and incorporated as appropriate.

Most of your comments are regarding the suitability of the CalSim-II computer simulation model for estimating the delivery reliability of the State Water Project (SWP). You state that the use of CalSim-II is inappropriate due to the lack of calibration and other deficiencies as identified in comments on the *State Water Project Delivery Reliability Report 2002 (2003)* and mentioned in the peer-review report, *A Strategic Review of CalSim-II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003). Many studies conducted by the Department of Water Resources (DWR), self-initiated or in response to public questions or criticisms, support the conclusion that CalSim-II provides a reasonable simulation of SWP operation and is a useful tool for assessing the delivery capability of the SWP.

The CalSim-II studies provide quantitative estimates of reliability based on historical rainfall and runoff data under the assumption that reliable conveyance capability will continue into the future. As we know, the Delta is a very dynamic environment. DWR is working on three projects that will improve the ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These include: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. These efforts will not be completed before release of the next Reliability Report, but may yield some preliminary results and conclusions by then. Our intent is to fully incorporate this information into subsequent Reliability Reports.

Mr. Arve Sjovold
January 30, 2006
Page 2

The final Report 2005 includes a discussion of these uncertainties and a commitment to incorporate the above-mentioned information as it evolves. The final report also includes a statement regarding the report being required per the settlement agreement to the case *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892.

Responses to the specific technical comments you make regarding CalSim-II are attached.

The final report will be available soon and will include an appendix containing copies of all commenting letters accompanied with the Department's responses. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim-II modeling studies. He may be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Katherine F. Kelly, Chief
Bay-Delta Office

Attachment

cc: Francis Chung, Chief
Modeling Support Branch
Bay-Delta Office
1416 Ninth Street, Room 252-6
Sacramento California 95814

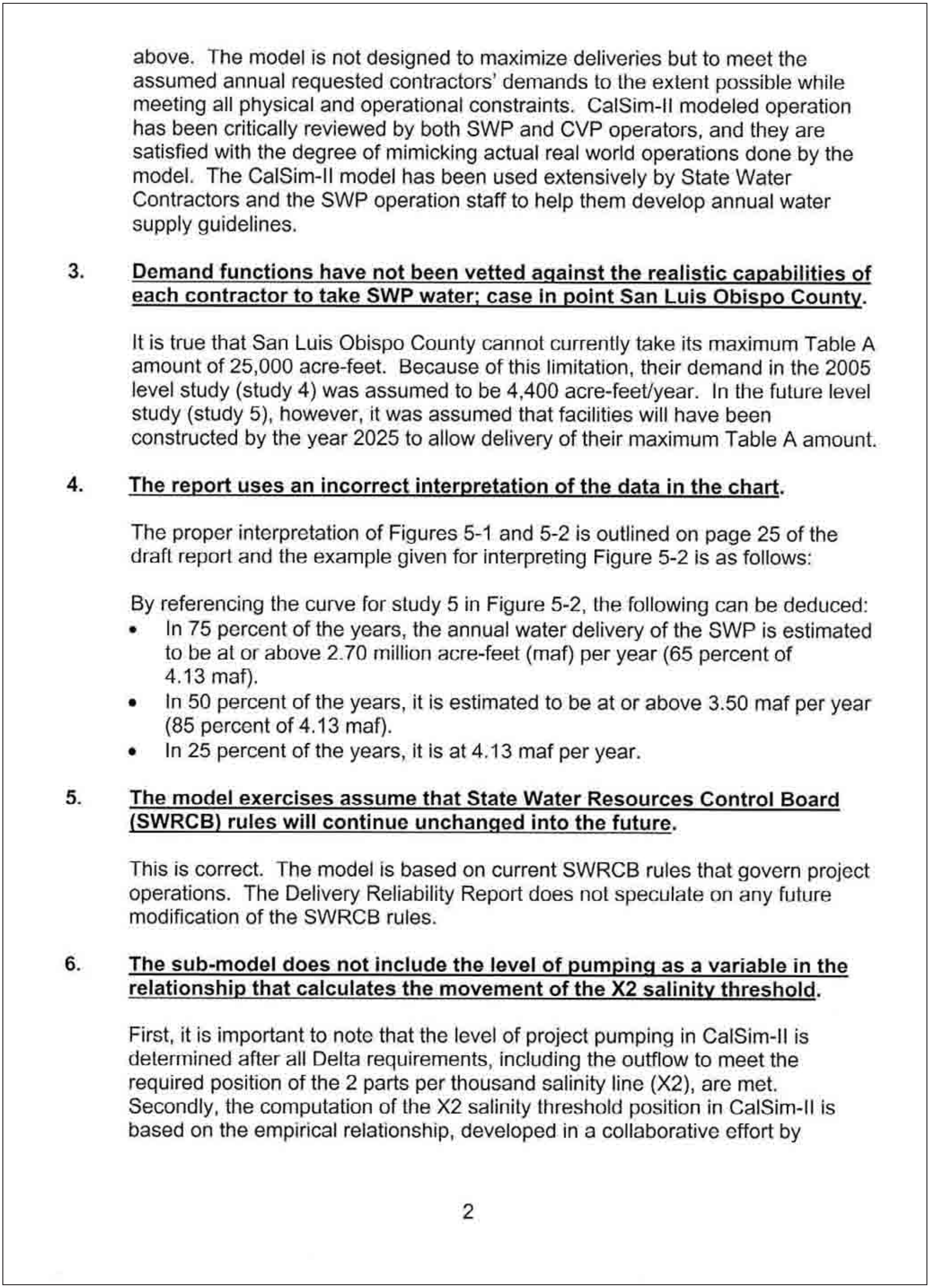
1. **CalSim-II has not been calibrated or validated.**

Models such as CalSim-II are inherently different from models that simulate hydrologic processes based on the physical laws governing the process that is being modeled. Although a classical approach to model calibration can not be applied to models like CalSim-II, calibration of some of the important components of the model is possible, and has been done. For instance, one of the most important components of the model, its hydrologic component, has been calibrated by including closure terms in the form of local surface water accretions from every depletion study area of the model network to match the historically available stream gage records. The routine used to determine the Sacramento River flows and the corresponding Delta exports that meet Delta electrical conductivity standards is an Artificial Neural Network (ANN) model that is trained using the calibrated Delta Simulation Model (DSM2) prior to being used in CalSim-II simulation runs. Also, a revised groundwater-surface water interaction module is being developed that uses groundwater-surface water response functions produced by the simulation of the historical groundwater pumping amounts. The above components of CalSim-II, which are either directly or indirectly calibrated, are three of the most important components of the model that have the most significant impacts on the simulation results. It is, therefore, inaccurate to assert that CalSim-II has not been calibrated.

In the absence of a classical approach to calibration, the next best approach is to set model parameters for a simulation run relying on experience and then verify the results of the simulation run by comparing them to historical operations. To verify model results, DWR conducted a 24-year simulation using historical input from 1975 to 1998. The results of this study showed the simulated values of the major components of system operation matched the historical values very well. Components such as stream flows at key locations and the net Delta outflow index showed little difference between simulated and historical values. For detailed examination of the validation study the reader is referred to *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report*, November 2003.

2. **CalSim-II is an optimization model that has not been calibrated.**

CalSim-II is a simulation model of the Central Valley Project (CVP)/State Water Project (SWP) system. It is a continuous accounting model, supplemented by a linear programming module to optimize the operation of the system for the current period of simulation (a month) subject to physical, operational, and institutional constraints of the system without foresight about the conditions in the next period. It should be noted that although a linear programming module is used as a tool to allocate water subject to all the constraints of the system in that particular month, CalSim-II does not attempt to optimize the overall operation of the system over the 73-year study period, and therefore it is not an optimization model. The issue of calibration of the model has been addressed in item 1,



above. The model is not designed to maximize deliveries but to meet the assumed annual requested contractors' demands to the extent possible while meeting all physical and operational constraints. CalSim-II modeled operation has been critically reviewed by both SWP and CVP operators, and they are satisfied with the degree of mimicking actual real world operations done by the model. The CalSim-II model has been used extensively by State Water Contractors and the SWP operation staff to help them develop annual water supply guidelines.

3. **Demand functions have not been vetted against the realistic capabilities of each contractor to take SWP water; case in point San Luis Obispo County.**

It is true that San Luis Obispo County cannot currently take its maximum Table A amount of 25,000 acre-feet. Because of this limitation, their demand in the 2005 level study (study 4) was assumed to be 4,400 acre-feet/year. In the future level study (study 5), however, it was assumed that facilities will have been constructed by the year 2025 to allow delivery of their maximum Table A amount.

4. **The report uses an incorrect interpretation of the data in the chart.**

The proper interpretation of Figures 5-1 and 5-2 is outlined on page 25 of the draft report and the example given for interpreting Figure 5-2 is as follows:

By referencing the curve for study 5 in Figure 5-2, the following can be deduced:

- In 75 percent of the years, the annual water delivery of the SWP is estimated to be at or above 2.70 million acre-feet (maf) per year (65 percent of 4.13 maf).
- In 50 percent of the years, it is estimated to be at or above 3.50 maf per year (85 percent of 4.13 maf).
- In 25 percent of the years, it is at 4.13 maf per year.

5. **The model exercises assume that State Water Resources Control Board (SWRCB) rules will continue unchanged into the future.**

This is correct. The model is based on current SWRCB rules that govern project operations. The Delivery Reliability Report does not speculate on any future modification of the SWRCB rules.

6. **The sub-model does not include the level of pumping as a variable in the relationship that calculates the movement of the X2 salinity threshold.**

First, it is important to note that the level of project pumping in CalSim-II is determined after all Delta requirements, including the outflow to meet the required position of the 2 parts per thousand salinity line (X2), are met. Secondly, the computation of the X2 salinity threshold position in CalSim-II is based on the empirical relationship, developed in a collaborative effort by

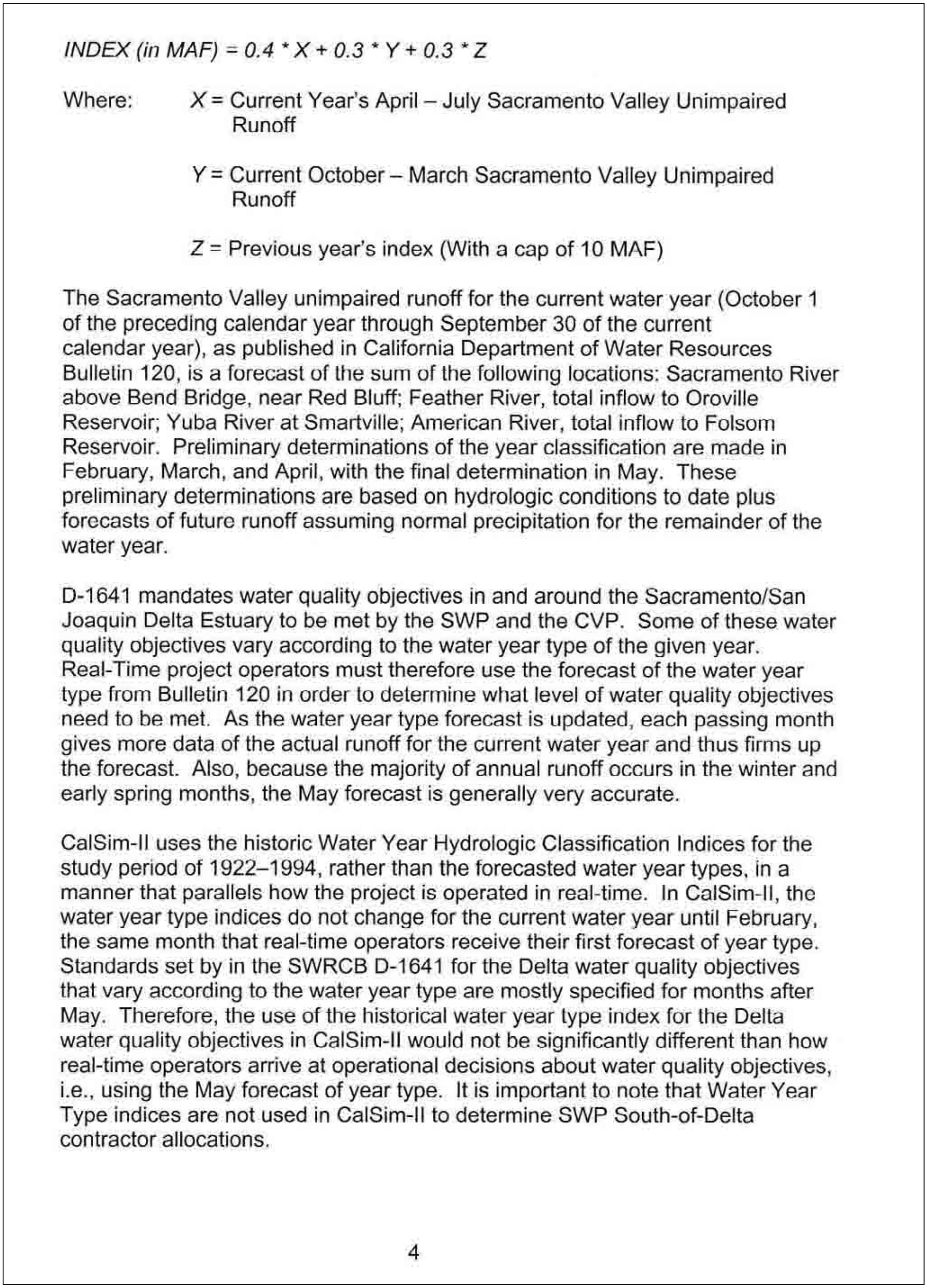
Wim Kimmerer of BioSystems and Steve Monismith of Stanford University, which is based on observed data. The development process of this relationship and the back-up data were presented and thoroughly examined in the SWRCB hearing process that lead to the Board adopting 1995 Water Quality Control Plan (SWRCB Water Rights Decision 1641). The position of the X2 line in any given month in this empirical model is presented as a function of its location in the previous month and the current month's net Delta outflow. Net Delta Outflow, by definition, includes the total CVP and SWP diversions from the Delta. This relationship has been confirmed to be a good predictor of the movement and position of the X2 line. For more information on this subject, you may refer to the May 18, 1992 memorandum report to the San Francisco Estuary Project by Kimmerer and Monismith, titled *"Revised Estimates of Position of 2 PPT Salinity,"* and Chapter 10 of the June 1994 *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, 15th Annual Progress Report to the State Water Resources Control Board,* titled "Two Part per Thousand Isohaline Equation Analysis."

7. **The pumps must run at nearly maximum capacity for most of the year if export flows near 4 MAF are to be realized.**

Model results for study 5 show that annual SWP pumping at Banks Pumping Plant would exceed 4 maf in 15 percent of the years. These higher pumping amounts generally only occur in wet years and the average annual SWP pumping at Banks for study 5 is 3.17 maf. The permitted pumping capacity of Banks Pumping Plant is normally 6,680 cfs, although additional pumping above this limit is allowed from December 15 to March 15 whenever the San Joaquin River flow at the Vernalis gage exceeds 1,000 cubic feet per second (cfs). The maximum pumping rate during this 3-month period is 8,500 cfs. Year-round pumping at the lower rate of 6,680 cfs would result in total annual pumping of approximately 4.8 maf. It should also be noted that export pumping is limited to actual demand for water and/or the amount needed to refill storage reservoirs.

8. **Use of the water-year type look-up table predetermines the water year before it is fully developed and this departs radically from any notion of simulation.**

Water Year Type Indices for the Sacramento River basin and San Joaquin River basin are defined in the SWRCB Water Rights Decision 1641. The definition of the Sacramento Valley Water Year Hydrologic Classification is the computation of the following equation:



$$\mathit{INDEX}\ (\mathit{in\ MAF}) = 0.4 * X + 0.3 * Y + 0.3 * Z$$

Where: X = Current Year's April – July Sacramento Valley Unimpaired Runoff

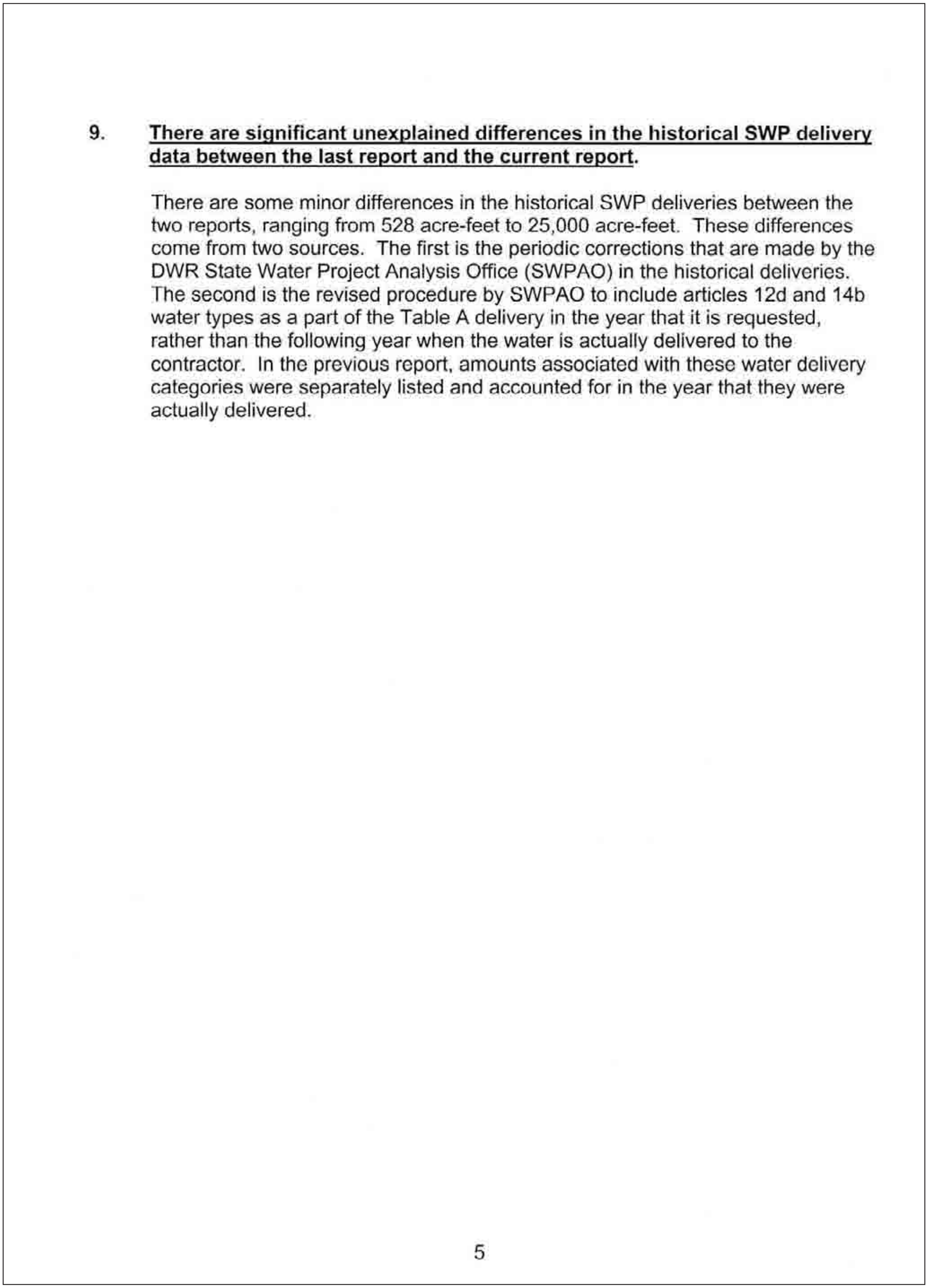
Y = Current October – March Sacramento Valley Unimpaired Runoff

Z = Previous year's index (With a cap of 10 MAF)

The Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of the year classification are made in February, March, and April, with the final determination in May. These preliminary determinations are based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

D-1641 mandates water quality objectives in and around the Sacramento/San Joaquin Delta Estuary to be met by the SWP and the CVP. Some of these water quality objectives vary according to the water year type of the given year. Real-Time project operators must therefore use the forecast of the water year type from Bulletin 120 in order to determine what level of water quality objectives need to be met. As the water year type forecast is updated, each passing month gives more data of the actual runoff for the current water year and thus firms up the forecast. Also, because the majority of annual runoff occurs in the winter and early spring months, the May forecast is generally very accurate.

CalSim-II uses the historic Water Year Hydrologic Classification Indices for the study period of 1922–1994, rather than the forecasted water year types, in a manner that parallels how the project is operated in real-time. In CalSim-II, the water year type indices do not change for the current water year until February, the same month that real-time operators receive their first forecast of year type. Standards set by in the SWRCB D-1641 for the Delta water quality objectives that vary according to the water year type are mostly specified for months after May. Therefore, the use of the historical water year type index for the Delta water quality objectives in CalSim-II would not be significantly different than how real-time operators arrive at operational decisions about water quality objectives, i.e., using the May forecast of year type. It is important to note that Water Year Type indices are not used in CalSim-II to determine SWP South-of-Delta contractor allocations.



9. **<u>There are significant unexplained differences in the historical SWP delivery data between the last report and the current report</u>.**

There are some minor differences in the historical SWP deliveries between the two reports, ranging from 528 acre-feet to 25,000 acre-feet. These differences come from two sources. The first is the periodic corrections that are made by the DWR State Water Project Analysis Office (SWPAO) in the historical deliveries. The second is the revised procedure by SWPAO to include articles 12d and 14b water types as a part of the Table A delivery in the year that it is requested, rather than the following year when the water is actually delivered to the contractor. In the previous report, amounts associated with these water delivery categories were separately listed and accounted for in the year that they were actually delivered.

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12/23/05

Lester Snow, Director
Department of Water Resources
c/o ddeanda@water.ca.gov

cc: Joe Grindstaff, Chief Deputy Director
Department of Water Resources
c/o lcooper@water.ca.gov

Katherine Kelly, Chief, Office of SWP Planning
Department of Water Resources
kkelly@water.ca.gov

RE: Comments on DWR's Draft Report "The State Water Project Delivery Reliability Report 2005"

Dear Lester,

I appreciate the opportunity to comment on the department's Draft Report: "The State Water Project Delivery Reliability Report 2005" dated November 16, 2005. I am commenting as an interested citizen, and not on behalf of any institution or organization.

Overview

An accurate assessment of the actual amounts of water the SWP can reliably deliver to users under various future conditions is important to the state. This draft report is DWR's second effort to characterize the reliability of the SWP. One might have expected that in light of current discussions (including your own statements) regarding levee failures (by whatever cause), impacts of climate change, vulnerability to "perturbations" ranging from earthquakes to terrorism, and budget and financing challenges, DWR staff would have made further efforts to characterize the range of risks and vulnerabilities affecting the reliability of the SWP. Unfortunately, the reliability report once again places inappropriate confidence in a single computer model as the sole basis for its findings, and it summarily dismisses analysis of these other factors. As such, it does not provide a reasonable representation of the reliability of the SWP for decision-making purposes.

Importance of the Issue

Why is an accurate and comprehensive assessment of SWP reliability important? Significant public and private investments are being made in water system infrastructure. More will be needed, as you have argued. Billions of dollars devoted to water systems have recently been approved by voters in bond funding, and more is anticipated in the future. Thoughtful proposals for revenue streams to service this investment have been advanced, including your own ideas. All of these water system investments are linked to substantial private and public investments requiring reliable water supplies.

As voters weigh the options before them, it is critical that they have an accurate and reasonably complete understanding of the risks as well as the benefits of different options. The report fails to provide the information and analysis needed to properly assess the reliability of the SWP system.

Risk and Reliability

The reliability of SWP system deliveries in the future is of course impossible to predict perfectly. It is possible, however, to identify important factors that may impact system performance. The reliability of SWP deliveries will clearly be impacted by issues such as the following:

- Amounts and patterns (time, place, and form – rain/snow) of precipitation and runoff
- Climate change (e.g. impacting flows, timing, temperature, and dam operations for flood control)
- SWP operations impacts on ecosystems and listed species such as the delta smelt
- Reduction of flows into the basin, such as the Trinity River, and changes of flows within the basin
- FERC re-licensing (of Oroville and other facilities)
- Levee failures (due to floods, earthquakes, or other causes)
- Earthquakes impacting key pumping, storage, and conveyance facilities
- Operations of federal and other facilities to meet legal requirements for environmental factors

Issues have also been raised regarding factors that will influence SWP system reliability such as:

- "Take" permits for impacted species
- SWP water rights (vs. extraction and export of "surplus" flows)
- Delta ecosystem impacts

It is not clear that Calsim II is capable of providing a robust and reasonably complete assessment of system reliability, notwithstanding the numerous assertions on the model's behalf provided in the draft report. (I will refrain from reiterating key questions raised in the peer review and elsewhere with regard to Calsim II. Notwithstanding a steadfast assertion by DWR staff that the model is OK, serious problems remain with its use for this type of application.) Some of the issues listed above are factored into the Calsim II analysis at certain levels, others are not. Where they are included, the implications for system reliability are in many cases difficult to determine. It *is clear* that a robust reliability analysis should use more than one method and tool, and that the tools should be properly applied. Additional tools are in fact available to develop a more complete understanding of system reliability.

To suggest that these factors be taken into consideration does not imply that anyone expects DWR to have a crystal ball. Understanding a range of potential reliability factors is useful, and doable. It does not imply a perfect prediction. For example, climate scenarios can provide important information regarding a range of reliability levels under possible future conditions. (Indeed, researchers have undertaken just such studies, including recent ones with Calsim II as the key model for supply reliability analysis. These should be included in the report.)

Disturbingly, in addition to ignoring climate change, the report fails to discuss a number of current issues including: levee integrity and risks related to failure; environmental impacts and issues relating to delta water extractions impacting listed species; and vulnerability of key SWP system components. Nor does it comment on recent decisions in various courts invalidating EIR/Ss dealing with SWP contracts and delta operations. The implications of these decisions, and the eventual environmental analyses, may include important constraints on system operations which would in turn impact system reliability.

A Comment on Timing

The 2002 reliability report was "finalized" in 2003. The 2005 report will presumably be finalized in 2006 (comments are due on December 23, 2005). There are two problems with this timing.

The first problem is that the Urban Water Management Plans (UWMPs), required every five years by law, are due in December 2005. Thus, the final SWP reliability report is not available to water managers as input into this important process to evaluate imported water reliability to the retail agencies served by the state contractors. (Though a draft document was reportedly provided to contractors in May 2005, the public and other interested parties – including land-use decision-makers concerned with water supply reliability – were not provided with a draft until mid-November 2005.) Clearly, the information from this report has not been readily available for use in the preparation of the 2005 UWMPs. To the extent that assertions of the SWP reliability may be in question, all of the UWMPs relying on SWP supplies for any portion of their water will be flawed. It is most unfortunate that DWR did not release the draft report much earlier (e.g. at least in May when it was provided to contractors) in order for the accuracy and validity of the report to be discussed.

This relates to the second problem, which is that the report is supposed to be provided every two years. The two-year cycle is not being met.

Conclusion

The 2002 reliability report acknowledged for the first time that the SWP cannot deliver full "Table A" volumes. This was an important step towards a more honest and accurate assessment of system reliability. It too, however, was strongly criticized for its over-reliance on the Calsim II model. The current draft report begins its defense of Calsim II in the *Forword* and continues it at tedious length throughout the document. Rather than mounting a protracted defense of an imperfect model, the SWP should be subjected to a credible reliability analysis with outside peer review. DWR staff should be directed to develop an open process that begins to account for the range of factors that will likely impact system reliability.

Sincerely,

Robert C. Wilkinson

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

March 24, 2006

Robert C. Wilkinson, Ph.D.
1428 West Valerio
Santa Barbara, California 93101

Dear Dr. Wilkinson:

This is in response to your letter of December 23, 2005 commenting on the draft State Water Project Delivery Reliability Report–2005 (Report 2005).

In your letter, you state that the Report 2005 does not provide an accurate assessment of the delivery ability of the State Water Project (SWP) because it does not incorporate future uncertainties associated with such things as climate change, earthquakes, terrorism, etc. You also point out that the timing of Report 2005 is problematic because it was not released early enough to be publicly reviewed prior to being incorporated into Urban Water Management Plans and does not meet the two-year interval required for updating this information.

The estimates contained in the Report 2005 are the best quantifications available of the delivery ability of the SWP. These estimates are limited, however, because of the uncertainty of future conditions. The Department of Water Resources (DWR) will continue to use the CalSim model as appropriate for analyses but other information is being developed that will help us analyze, understand, and prepare for our uncertain future. Per the Governor's directive (Executive Order S-3-05), the potential impacts of climate change on the State's resources, including water supply, are being evaluated. Preliminary estimates have been done, using CalSim-II, of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. As these estimates become more refined, they will be helpful in guiding strategies for the management and development of the State's water resources, including improvements to the SWP.

In addition, DWR is working on two projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. They are: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to land use, recreation, water supply, transportation, energy, and environmental health. The Delta Vision process incorporates the requirements of AB 1200 passed by the legislature and signed by the Governor in 2005. Although none of these efforts will be completed before release of the next Reliability Report, some preliminary results and conclusions may be completed in time for inclusion. Subsequent Reliability Reports will fully incorporate this information.

DWR does not want to leave any reader of the Report 2005 with the impression that this developing information is being ignored. Therefore, the final report includes a discussion of these uncertainties, the efforts to quantify them, and a commitment to incorporate the above-mentioned information as it is developed and refined.

You make the point that the report is supposed to be updated every two years and this condition has not been met. In addition, you state that the report should be available to the public as a draft and finalized prior to deadlines for local agency Urban Water Management Plans. I agree that the report should be available to the public as a draft and finalized prior to deadlines for local agency UWMPs. It is unfortunate that the review and completion of the Report 2005 could not be done in early 2005 for incorporation into UWMPs and well within the two-year interval specified in the settlement agreement (*Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892). The objectives of DWR for the Reliability Report are to encourage public discussion and understanding of the estimation of the SWP delivery capability, meet the conditions of the settlement agreement, and provide the best available quantification of SWP deliveries. Given the situation this year, DWR chose to provide the information to the SWP water contractors as a memorandum in May, 2005 and to delay the completion of the final Report 2005 to allow public review of a draft. Public review of the draft is not a requirement of the settlement agreement but the review encourages public discussion of the issue and improves the final report.

The final Report 2005 will be issued soon and will include an appendix containing the comment letters on the draft report and DWR's responses. Thank you for your comments and recommendations. If you wish to discuss this further, please contact Gerald Johns, DWR's Deputy Director at (916) 653-8045 or jjohns@water.ca.gov.

Sincerely,

Original signed by

Lester A. Snow
Director

cc: P. Joseph Grindstaff, Acting Director
California Bay-Delta Authority
650 Capitol Mall, Fifth Floor
Sacramento, California 95814

Water Supply Contracts Between the State of California Department of Water Resources and CLWA including Amendment No. 18 (41,000 Acre-Feet Water Transfer)

UPPER SANTA CLARA VALLEY WATER AGENCY

Location and Size

The Agency is located in Los Angeles County about 40 miles northwest of the city of Los Angeles. The Agency, as of July 1, 1964, encompassed an area of 86,100 acres and had an estimated population of 26,000.

Water Supply and Utilization

The entire water supply utilized within the Agency is obtained from underlying ground water basins. There are no streams within the Agency on which a dependable surface water supply could be developed. Water requirements in excess of the safe yield of the local ground water supply will be met with water from the State Water Project. Primary use of water in 1960 was for irrigated agriculture but by 1970 and thereafter the primary use is expected to be for municipal and industrial purposes.

Items of Contract Information Unique to Agency

Date of Contract - Preamble

April 30, 1963

Agency's Principal Place of Business - Preamble

Newhall

Estimated Year of Initial Water Delivery - Article 6(a)

1972

Date of Request as to Delivery Structures - Article 10(b)

June 30, 1963

Limit on Instantaneous Rate of Delivery - Article 12(c)

42 cfs (Increased by Amendment No. 2 to 48 cfs.)

E. SPECIAL PROVISIONS AND TABLES

45. SPECIAL PROVISIONS

(a) On or before June 30, 1963, the Agency shall furnish to the State its written request specifying the year in which the first delivery of project water from the West Branch Aqueduct as defined in Table H of this contract shall be made to the Agency. The timing of first deliveries of project water from said Branch Aqueduct shall be as so requested by the Agency: *Provided*, That in the event said request is, in the judgment of the State, incompatible with similar requests received from other contractors to be served from or through said Branch Aqueduct, which contractors have executed contracts with the State on or before June 30, 1963, the timing of first deliveries of project water to the Agency and such other contractors from said Branch Aqueduct shall be as established by mutual agreement among the State, the Agency, and said contractors: *Provided further*, That if such agreement has not been reached on or before December 31, 1963, the State may then construct said Branch Aqueduct in accordance with such construction schedules as, in the judgment of the State, will best serve the interests of all those contractors whose service areas are located south of the South Portal of the Tehachapi Tunnels and which have executed contracts with the State on or before June 30, 1963.

(b) The State shall provide sufficient capacity in the transportation facilities, subject to the provisions of Article 17(b), to deliver 11 percent of the Agency's annual entitlement in each of four months in each year. Subject to the foregoing limitation, in scheduling deliveries under Article 12(a) the State will provide for up to 1/9 of the Agency's annual entitlement to be delivered in excess of a rate of 8 1/3 percent of the annual entitlement per month.

(c) The annexations to the Agency, authorized by Ordinance No. 3 of the Agency dated March 13, 1963, are deemed to be approved by the department within the meaning of Article 15(b) and are generally described as the Val Verde–Hasley Canyon Area annexation, comprising approximately 7,280 acres, situated westerly of the Agency.

TABLE H

PROJECT TRANSPORTATION FACILITIES
UPPER SANTA CLARA VALLEY WATER AGENCY

A San Joaquin Valley–Southern California Aqueduct extending to Castaic Reservoir on the West Branch Aqueduct defined below, to the extent such aqueduct is determined by the State to be required for water transportation.

> "West Branch Aqueduct" shall mean that portion of the San Joaquin Valley–Southern California Aqueduct specified in Section 12934(d) (2) of the Water Code extending from the Junction of East and West Branches to a terminus in the vicinity of Newhall, Los Angeles County.

IN WITNESS WHEREOF, the parties hereto have executed this contract on the date first above written.

Approved as to legal form and sufficiency:

P.A. Towner

Chief Counsel
Department of Water Resources
P. O. Box 388
Sacramento, California

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By William E. Warne
Director

Attest:

Helen L. Thompson

Secretary
P.O. Box 328
Newhall, California

UPPER SANTA CLARA VALLEY WATER AGENCY

By Wm. H. Bonelli, Jr.
President

Approved as to form and execution:

Stanley C. Lagerlof

Counsel

By Everett W. Nichols
Director

By Earl Schmidt
Director

By
Director

By Robert L. Essick
Director

By Roger C. Morey
Director

By E. Ray. Fisher
Director

WHEREAS, the State and the Agency are desirous of making certain changes and additions to the above-mentioned contract, while otherwise continuing the contract in full force and effect;

NOW THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's water supply contract with the State:

Article 46 is added to the contract to read as follows:

46. Amendatory Provisions

a. Surplus Water

Notwithstanding other provisions of this contract, surplus water for agricultural and ground water replenishment use shall be offered to contractors on the following basis. Before surplus water is sold for other than agricultural and ground water replenishment use, each contractor shall have the right, subject to the ability of the State to deliver such water, to contract for agricultural and ground water replenishment use for a portion of the total amount of surplus water available in any year, in an amount which bears the same ratio to the total amount of surplus water available in that year as the sum of the annual entitlements delivered to the contractor for agricultural and ground water replenishment use during the preceding three years bears to the total amount of the annual entitlements delivered for agricultural and ground water replenishment use during the preceding three years of all contractors requesting surplus water: Provided, That if its proportion of such surplus water is not required by or cannot be delivered to any contractor, such amount of additional surplus water shall be offered to other contractors for agricultural and under the provisions of Article 21.

As used in this subdivision "ground water replenishment use" shall mean the use of project water exclusively by direct application to spreading basins, streambeds, or through other means of direct artificial recharge for the purpose of replenishing overdrawn ground water basins.

b. Surcharge Credit

Notwithstanding other provisions of this contract, the State may include provisions in water supply contracts allowing a credit to a contractor not to exceed the surcharge to be paid by such contractor: Provided, That such credit shall be utilized to reduce the cost of water for agricultural use on other than excess land at a uniform rate per acre-foot not to exceed two dollars ($2) per acre-foot. Any contract including provisions pursuant to this subdivision shall assure that the reductions in the contractors' obligations authorized by this subdivision are made available exclusively for the benefit of agricultural use on land other than excess land and are not directly or indirectly made available for the benefit of agricultural use on excess land.

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 2 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UPPER SANTA CLARA VALLEY WATER AGENCY

THIS CONTRACT, made this 22nd day of December 1964, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Upper Santa Clara Valley Water Agency, a public agency in the State of California, duly organized, existing, and acting pursuant to the laws thereof with its principal place of business in Newhall, California, herein referred to as the "Agency",

WITNESSETH, That:

WHEREAS, the State is authorized to construct and operate facilities for the storage and conveyance of water, certain of which facilities will make water available to the Agency; and

WHEREAS, the State and the Agency have entered into a water supply contract, dated April 30, 1963, as amended November 15, 1963, providing that the State shall supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

1. Subdivision (k) of Article 1 is amended to read as follows:

(k) <u>Minimum Project Yield</u>

"Minimum project yield" shall mean the dependable annual supply of project water to be made available, estimated to be 4,230,000 acre-feet per year, said amount to be determined by the State on the basis of coordinated operation studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon:

(1) The estimated relative proportion of deliveries for agricultural use to deliveries for municipal use for the year 1990, and the characteristic distributions of demands for these two uses throughout the year.

(2) An allowable reduction in the agricultural use portion of the minimum project yield, due to drought, of not to exceed fifty percent (50%) in any one year, nor a total of one hundred percent (100%) of one year's supply in any series of seven consecutive years.

(3) Agreements now in effect or as hereafter amended or supplemented between the State and the United States and others regarding the diversion or utilization of waters of the Delta or streams tributary thereto.

2. Table A of the contract entitled "Annual Entitlements Upper Santa Clara Valley Water Agency" is amended to read as follows:

4. Subdivision (a) of Article 16 is amended to read as follows:

(a) Limit on Total of All Maximum Annual Entitlements

The Agency's maximum annual entitlement hereunder, together with the maximum annual entitlements of all other contractors, shall aggregate no more than the minimum project yield as defined herein and in no event more than 4,230,000 acre-feet of project water.

5. Subdivision (b) of Article 45 is amended to read as follows:

(b) The State shall provide sufficient capacity in the transportation facilities, subject to the provisions of Article 17(b), to deliver 11 percent of the Agency's annual entitlement in each of eight and one half months in each year. Subject to the foregoing limitation, in scheduling deliveries under Article 12(a) the State will provide for up to 22 2/3 percent of the Agency's annual entitlement to be delivered in excess of a rate of 8 1/3 percent of the annual entitlement per month.

6. Article 46 is amended to read as follows:

46. Amendatory Provisions

(a) Surplus Water

Notwithstanding other provisions of this contract, surplus water for agricultural and ground water replenishment use shall be offered to contractors on the following basis. Before surplus water is sold for other than agricultural and ground water replenishment use, each contractor shall have the right, subject to the ability of the State to deliver such water and to the contractor shall furnish certified copies of such records and data concerning the use of water within its boundaries as the State may request.

The provisions of this paragraph shall be applicable only to contractors in the San Joaquin Valley Service Area, contractors in the Southern California Service Area, and contractors in the Central Coastal Service Area. Before surplus water is sold for other than agricultural and ground water replenishment use, each such contractor shall have the right, subject to the ability of the State to deliver such water, to contract for agricultural and ground water replenishment use in accordance with the following formula: contractors in the San Joaquin Valley Service Area shall have a right to contract for sixty-nine percent (69%) of the surplus water available at the Mile 18 Pumping Plant; contractors in the Southern California Service Area shall have a right to contract for twenty-nine percent (29%) of such water; and contractors in the Central Coastal Service Area shall have a right to contract for two percent (2%) of such water: Provided, That within each of these service areas, each contractor shall have the right to contract for agricultural and ground water replenishment use for a portion of the total amount of surplus water available to that service area in any year, in an amount which bears the same ratio to the total amount of surplus water available to the service area in that year as the sum of the annual entitlements, set forth in Table A of this contract, delivered to the contractor for agricultural and ground water replenishment use during the preceding three years bears to the and Ventura County Flood Control District; "contractors in the Central Coastal Service Area" shall mean: San Luis Obispo County Flood Control and Water Conservation District and Santa Barbara County Flood Control and Water Conservation District.

The provision of this paragraph shall be applicable only to a contractor to which the delivery of project water for municipal use as of 1990 is estimated by the State to be in excess of fifty percent (50%) of such contractor's maximum annual entitlement. For the purpose of fixing such contractor's right to delivery of surplus water, water from a watershed not tributary to the contractor's area which is delivered within the contractor's boundaries for agricultural or ground water replenishment use shall be deemed to be part of the contractor's annual entitlement delivered for such use in computing the quantity of surplus water to which the contractor is entitled under this subdivision: Provided, That the contractor shall not be deemed to have used more than its annual entitlement, as set forth in Table A, for such use. Surplus water shall be deemed to be used by the contractor for agricultural or ground water replenishment use if an equal quantity of water imported from a watershed not tributary to the contractor's area is delivered within the contractor's boundaries for such use.

In providing for the delivery of surplus water to contractors pursuant to this subdivision, the State shall refuse to deliver such surplus water to any contractor to the extent that the State determines that such delivery would tend to encourage the development of an economy within the area served by such contractor which would be dependent upon the sustained delivery of under the provisions of Article 21. Nothing in this subdivision shall limit the right of the Agency to increase its annual entitlements as otherwise provided in this contract.

As used in this subdivision "ground water replenishment use" shall mean the use of project water exclusively by direct application to spreading basins, streambeds, or through other means of direct artificial recharge for the purpose of replenishing overdrawn ground water basins.

(b) Surcharge Credit

Notwithstanding other provisions of this contract, the State may allow a credit to each contractor not to exceed the surcharge paid by such contractor.

For the purpose of this contract, the surcharge credit shall be determined and applied in the following manner:

(1) The State shall, in each year after the year of initial water delivery, allow a credit to the Agency in the amount of the surcharge forwarded by the Agency to the State in the preceding year.

(2) The Agency shall not establish water rates, or tax or assessment rates, so as to cause the surcharge credit to be passed on to water users in a manner which will bring about a greater reduction in the cost per acre-foot of project water put to use on excess land than such cost of project water put to use on other than excess land.

This subdivision 46(b) shall be separable from all other provisions in this contract, and in the event that any or all of the provisions of this subdivision are in any manner or to any extent

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 3 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UPPER SANTA CLARA VALLEY WATER AGENCY

THIS CONTRACT, made this 24th day of January 1966, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Upper Santa Clara Valley Water Agency, a public agency in the State of California, duly organized, existing, and acting pursuant to the laws thereof with its principal place of business in Newhall, California, herein referred to as the "Agency",

WITNESSETH, That:

WHEREAS, the State is authorized to construct and operate facilities for the storage and conveyance of water, certain of which facilities will make water available to the Agency; and

WHEREAS, the State and the Agency have entered into a water supply contract, dated April 30, 1963, as amended

TABLE A
Annual Entitlements
Upper Santa Clara Valley Water Agency

Year	Total Annual Amount In Acre-Feet
1	1,600
2	3,700
3	5,700
4	7,500
5	9,500
6	11,400
7	13,400
8	15,300
9	17,700
10	20,100
11	22,100
12	24,600
13	26,900
14	29,100
15	30,900
16	32,900
17	35,300
18	37,400
19	39,300
20	41,500
And each succeeding year thereafter, for the term of this contract:	41,500

3. Subdivision (c) of Article 12 is amended to read as follows:

(c) <u>Limit on Rate of Delivery to Agency</u>

In no event shall the State be obligated to deliver water to the Agency through all delivery structures at a total combined instantaneous rate of flow exceeding seventy-six (76) cubic feet per second, except as this rate of flow may be revised by amendments of this article after submission to the State of the Agency's requests with respect to maximum flow capacities to be provided in said delivery structures, pursuant to Article 10.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 4 TO WATER SUPPLY CONTRACT
BETWEEN THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES AND
UPPER SANTA CLARA VALLEY WATER AGENCY

THIS CONTRACT, made this 31st day of December, 1969, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Upper Santa Clara Valley Water Agency,

herein referred to as the "Agency";

WITNESSETH, That

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, Article 22(b) of such water supply contract provides that for each year through the year 1969 the Delta Water Charge shall be the product of $3.50 and the Agency's annual entitlement for the respective year and that beginning in the year 1970, the Delta Water Charge shall be the sum of the capital cost component, minimum operation, maintenance, power and replacement component, and

Thermalito power facilities through Central Valley Project Revenue Bonds and may finance other portions of the project facilities through additional revenue bond issues, bonds issued under other authority granted by the Legislature or the voters, bonds issued by other state agencies, advances from contractors, and other methods under which the financing costs relate to interest rates that may exceed the interest rate of the bonds issued under the Bond Act; and

WHEREAS, either the State or contractors making advances to the State may be subject to interest rates, or other financing costs that relate to interest rates, which will be greater than the "project interest rate" as presently defined in the contracts; and

WHEREAS, the parties desire that (1) the interest costs hereafter incurred by or on behalf of the State in financing the construction of project facilities by means other than the use of moneys provided under the Bond Act will be reflected in appropriate adjustments of the "project interest rate" (excepting the interest costs incurred for the Central Valley Project Revenue Bonds issued prior to the date of this amendment); (2) appropriate credit will be given to any contractor having made an advance of funds to the State corresponding to the bond service obligation payable by such contractor by reason of such advance or if bonds were not used to obtain funds for such advance, then to the net interest cost which would have resulted if the contractor had sold bonds for the purpose of funding the advance; and (3) if any sources of funds other than those provided under the Bond Act are employed to finance the construction of specific project facilities and the interest or other costs of such financing are greater than the cost would have been if bonds issued under the Bond Act had been used, appropriate

"Project interest rate" shall mean the weighted average interest rate of (1) through (6) below computed by dividing (i) the total interest cost required to be paid or credited by the State during the life of the indebtedness or advance by (ii) the total of the products of the various principal amounts and the respective terms in years of all such amounts:

(1) general obligation bonds issued by the State under the Bond Act,

(2) revenue bonds issued by the State under the Central Valley Project Act after May 1, 1969,

(3) bonds issued by the State under any other authority granted by the Legislature or the voters,

(4) bonds issued by any agency, district, political subdivision, public corporation, or non-profit corporation of this State,

(5) funds advanced by any contractor without the actual incurring of bonded debt therefor, for which the net interest cost and terms shall be those which would have resulted if the contractor had sold bonds for the purpose of funding the advance, as determined by the State, and

(6) funds borrowed from the General Fund or other funds in the Treasury of the State of California, for which the total interest cost shall be computed at the interest rate earned over the period of such borrowing

construction of specific project facilities, any additional costs incurred because of such financing will not be charged to the contractors, except for adjustments to the "project interest rate".

Approved as to legal form and
sufficiency:

C. Towner
Chief Counsel
Department of Water Resources
P. O. Box 388
Sacramento, California

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

By W R Gianelli
Director

Approved as to form and
execution:

Counsel

UPPER SANTA CLARA VALLEY
WATER AGENCY

By Carl Schmidt
Pres

1971 the Delta Water Charge shall be the sum of the capital cost component, minimum operation, maintenance, power and replacement component, and variable operation, maintenance, power and replacement component computed in accordance with Articles 22(c) and (d) of the water supply contract; and

WHEREAS, Articles 22(e) and (g) of such water supply contract provide that the Delta Water Charge as computed in accordance with Articles 22(c) and (d) shall include all projected costs of additional project and supplemental conservation facilities commencing in the years in which the State first incurs capital costs for such facilities after the facilities are authorized; and

WHEREAS, the parties desire that all water supply contracts be amended to postpone inclusion of the projected costs of any authorized additional project and supplemental conservation facilities in the computation of the Delta Water Charge until after the year 1971 and to fix the rate for computing the Delta Water Charge for the year 1971 at $7.24;

NOW, THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's water supply contract with the State:

1. Subdivision (b) of Article 22 is amended to read as follows:

For each contractor receiving project water in any year through December 31, 1969, the Delta Water Charge shall be the product of $3.50 and the contractor's annual entitlement to project water for the respective year. For each contractor receiving project water in the year 1970, the Delta Water Charge shall be the

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 6 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made this 27th day of December, 1971, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WITNESSETH, That:

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, Article 22(b) of such water supply contract, as amended, provides that for each year through the year 1969 the Delta Water Charge shall be the product of $3.50 and the Agency's annual entitlement for the respective year, that for the year 1970 the Delta Water Charge shall be the product of $6.65 and the

the Delta Water Charge shall be determined on the basis of an allocation to project purposes, by the separable cost-remaining benefits method, of all actual and projected costs of all those initial project conservation facilities located in and above the Delta, and upon an allocation to the purposes of water conservation and water transportation, by the proportionate use of facilities method, of all actual and projected costs of the following project facilities located below the Delta: The aqueduct intake facilities at the Delta, Pumping Plant I (Delta Pumping Plant), the aqueduct from the Delta to San Luis Forebay (O'Neill Forebay), San Luis Forebay (O'Neill Forebay), and San Luis Reservoir: Provided, That all of the actual and projected costs properly chargeable to the generation and transmission of electrical energy in connection with operation of project conservation facilities shall be allocated to the purpose of water conservation in, above, and below the Delta: Provided further, That allocations to purposes the cost of which are to be paid by the United States shall be as determined by the United States.

Commencing in the year in which the State first awards a major construction contract for construction of a major feature of additional project conservation facilities, or first commences payments under a contract with a federal agency in the event a major feature of additional project conservation facilities is constructed by such federal agency under an agreement requiring the State to pay all or part of the costs of such construction, the Delta Water Charge shall be determined on the basis of the which are allocated to the purpose of water conservation, in, above, and below the Delta pursuant hereto. Commencing in the year in which the State first awards a major construction contract for construction of a major feature of any supplemental conservation facilities, or first commences payments under a contract with a federal agency in the event a major feature of supplemental conservation facilities is constructed by such federal agency under an agreement requiring the State to pay all or part of the costs of such construction, the Delta Water Charge shall be determined on the basis of the allocations made pursuant to subdivision (e) of this article, and upon an allocation to project purposes, by the separable costs-remaining benefits method and subject to provisos corresponding to those contained in said subdivision (e), of all projected costs of such feature of the supplemental conservation facilities. Commencing in the same year, the computation of the rates to be used in determining the components of the Delta Water Charge shall include the annual entitlements to water under all contracts for supplemental water. If the repayment period of any bonds sold to construct supplemental conservation facilities or the repayment period under any agreement with a federal agency for repayment of the costs of supplemental conservation facilities constructed by such federal agency extends beyond the repayment period of the contract, the Delta Water Charge shall be determined and redetermined on the basis of such extended repayment period as the State determines to be appropriate: Provided, That if the agreement with such federal agency allows repayment of costs

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 7 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made as of the 15th day of October, 1972, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WITNESSETH, That:

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract, dated April 30, 1963 (herein referred to as the "Amended Contract") providing that the State shall supply certain quantities of water to the Agency, and that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, the Amended Contract provides for a surcharge equivalent to the power credit per acre-foot of water to be charged to water users, other than the United States or the State of California, for each acre-foot of project water determined to have been put to agricultural or manufacturing uses on excess land, for collection by the Agency either itself or through a

1. Article 30 entitled "Surcharge for Project Water Used on Excess Land".

2. The next-to-the-last sentence of the fifth paragraph of subdivision (a) of Article 46, entitled "Surplus Water", which sentence reads as follows:

> "A surcharge shall be added to the rate for surplus water furnished to excess land in an amount and under the conditions specified in Article 30 of this contract".

3. Subdivision (b) of Article 46 entitled "Surcharge Credit".

IN WITNESS WHEREOF, the parties hereto have executed this contract amendment on the date first above written.

Approved as to legal form
and sufficiency:

By P. A. Towner
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By WRGianelli
Director

Attest:

By____________________
(Title)

CASTAIC LAKE WATER AGENCY

By Earl Schmidt
(Title) President

Approved as to form
and execution:

By____________________
(Title)

interest rate, and all other factors which are determinative of such charges; and

WHEREAS, Article 28 also provides that each such redetermination shall include an adjustment of the components of the Transportation Charge to be paid by the Agency for succeeding years which shall account for differences, if any, between projections used by the State in determining the amounts of such components for all preceding years and actual costs incurred by the State during such years, but does not specify the computational details or the method of payment of such adjustments; and

WHEREAS, the State has been including such adjustments as "one-shot" credits or additional charges to be subtracted from or added to the Transportation Charge to be paid by the Agency in the year following the redetermination; and

WHEREAS, the magnitude of such adjustments together with changes in other determinants of charges may be significantly different in comparison with the amounts projected by the State under previous determinations and could impair the planned fiscal operations of the Agency, depending on the method of payment, and the parties desire to amend the contract to provide a method of amortizing the payment of the amounts of such differences over two or more years, depending on the magnitude of the differences; and

WHEREAS, bookkeeping will be simplified if the amortization of the payments of the amounts of such differences is the State. Such adjustment shall be computed by the State and paid by the Agency or credited to the Agency's account in the manner described in (b) and (c) below.

(b) Adjustment: Transportation Charge-Capital Cost Component

Adjustments for prior underpayments or overpayments of the capital cost component of the Transportation Charge to the Agency, together with accrued interest charges or credits thereon computed at the then current project interest rate on the amount of the underpayment or overpayment and compounded annually for the number of years from the year the underpayment or overpayment occurred to and including the year following the redetermination, shall be paid in the year following the redetermination: Provided, That the Agency may elect to exercise the option whereby when the redetermined Transportation Charge for the following year, with adjustments, including adjustments of the operation, maintenance, power, and replacement components provided for in subdivision (c) of this article, is more or less than the last estimate of the Charge provided pursuant to Article 27 for the corresponding year, without adjustments, an amount equal to the total of such difference shall be deducted from or added to the adjusted capital cost component for that year and paid or credited in accordance with the following schedule:

Percent that Transportation Charge differs from last estimate (+ or -)	Period, in years, for amortizing the difference in indicated charge
for 10% or less	no amortization
more than 10%, but not more than 20%	2
more than 20%, but not more than 30%	3
more than 30%, but not more than 40%	4
more than 40%.	5

the Transportation Charge for the year in which the option is to become effective.

Such option, once having been exercised, shall be applicable for all of the remaining years of the project repayment period.

IN WITNESS WHEREOF, the parties hereto have executed this contract on the date first above written.

Approved as to legal form
and sufficiency:

By
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By
Director

Attest:

By Betty L. Castleberry
(Title) Secretary

CASTAIC LAKE WATER AGENCY

By
(Title) President

Approved as to form
and execution:

By
(Title) Counsel

delivery of all of its annual entitlement for 1972 on a reasonable schedule; and

WHEREAS, the State has developed a proposed adjustment of the Agency's 1972 entitlement taking into consideration the monthly distribution of 1972 project water deliveries as requested in its five-year delivery schedule submitted to the State in 1967; and

WHEREAS, the Agency has requested that its annual entitlement for the first year of water deliveries be decreased accordingly; and

WHEREAS, the State has determined that a decrease from 1,600 acre-feet to 1,236 acre-feet is justified and that allowing such a decrease in the Agency's 1972 annual entitlement will not impair the financial feasibility of the project facilities;

NOW THEREFORE, it is mutually agreed as follows:

Table A entitled "Annual Entitlements Castaic Lake Water Agency" is amended to read as follows:

TABLE A

ANNUAL ENTITLEMENTS
CASTAIC LAKE WATER AGENCY

Year	Total Annual Amount in acre-feet
1	1,236
2	3,700
3	5,700
4	7,500
5	9,500
6	11,400
7	13,400
8	15,300
9	17,700
10	20,100
11	22,100
12	24,600
13	26,900

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 10 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made as of the 28th day of August, 1974, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WITNESSETH, That:

WHEREAS, the State and the Agency entered into a contract whereby the State will deliver and the Agency will purchase a supply of water to be made available from project facilities constructed by the State; and

WHEREAS, the State and the Agency included in such contract a subarticle, hereinafter referred to as the agricultural and ground water replenishment provision, which entitles the Agency to obtain from the State a supply of surplus water for agricultural and ground water replenishment use when available; and

WHEREAS, Article 21 of such contract also provides for the sale by the State of a supply of surplus water when available; and

(iii) Operational requirements regarding recreation and fish and wildlife uses;

(iv) Generation of power by the System or furnishing of project water required by power contracts;

(v) The exchange of water and the filling, retention, and release of storage in System reservoirs necessary for operational flexibility and to meet the requirements of paragraphs (i) through (iv) of this subdivision.

(vi) Losses of water due to evaporation, leakage, seepage, or other causes to meet the requirements of paragraphs (i) through (v) of this subdivision.

(3) "Ground water replenishment use" shall mean the use of project water exclusively for recharge of ground water basins by direct application to spreading basins, streambeds, or through other means of direct artificial recharge.

(4) "Contractors in the San Joaquin Service Area" shall mean those contractors which are furnished water through delivery structures from the California Aqueduct between Dos Amigos Pumping Plant and the South Portal of the Carley V. Porter Tunnel and from the Coastal Branch, California Aqueduct, from its junction with the California Aqueduct to the site for Devil's Den Pumping Plant.

(5) "Contractors in the Southern California Service Area" shall mean contractors for which water is delivered from the California Aqueduct downstream from the South Portal of the Carley V. Porter Tunnel.

(1) First, the quantity of surplus water to be delivered to noncontractors shall be limited to the quantity available in excess of the requests under the first priority and the second priority.

(2) Second, if there is not sufficient surplus water in excess of the requests under the first priority to meet the requests of contractors under the second priority, the quantity of water to be delivered under the second priority shall be limited to the quantity available in excess of the requests under the first priority and that quantity shall be apportioned in proportion to the amounts of the contractors' current annual entitlements that are to be used for purposes other than agricultural and ground water replenishment uses as determined by the State. If any contractor decides not to use the surplus water available to it under this provision, such surplus water shall be offered on a similar basis to other contractors for such uses.

(3) If there is not sufficient surplus water to meet the requests of contractors under the first priority, the quantity of water to be delivered under that priority shall be limited to the quantity available, and such quantity shall be apportioned to areas upstream and downstream from Dos Amigos Pumping Plant in proportion to the contractors' current annual entitlements that are to be used in such areas for agricultural and ground water replenishment purposes as determined by the State. The quantity of such water available upstream from Dos Amigos Pumping Plant shall be apportioned to contractors upstream from Dos Amigos Pumping Plant in proportion to the amounts of the contractors' current annual entitlements that are to be used for agricultural and ground water

in the judgment of the State to furnish surplus water to it, the contractor shall have a prior right to have such power utilized for furnishing surplus water otherwise available to it pursuant to this article at a cost no higher than that which the State is obligated to pay at the time it orders such power, but it shall have no greater right or priority to receive surplus water. A contractor's commitment may be for any part of the six-year period of its schedule, and the contractor will become bound by such commitment and become entitled to the prior right provided for in the preceding sentence only when the State, after consultation with the contractor, notifies the contractor in writing that it has ordered power based on the contractor's commitment.

(e) Rates.

(1) Surplus water (except further surplus water as described in subdivision (e)(4) of this article) shall be furnished to a contractor for agricultural use and for ground water replenishment use at rates which will return to the State all power costs as defined in subdivision (f) of this article and all incremental operation, maintenance, and replacement costs, and any other incremental costs, incurred in the conservation and transportation of such surplus water as determined by the State, which rates shall include an administrative charge to be determined by the State for each acre-foot of surplus water scheduled for delivery during the year. The amount of such administrative charge shall be credited to general operating costs of the System prior to the allocation of such costs. Incremental costs shall mean those costs which would not be incurred if surplus water were not scheduled for or delivered to the contractor.

article to any contractor which, under Table A of its contract, is scheduled to receive its maximum annual entitlement prior to 1978 and every year thereafter.

(5) Any revenues in excess of operation, maintenance, power and replacement costs and the administrative charge derived from sales of surplus water shall be credited as follows: The Delta water rate or portion thereof paid in accordance with subdivisions (e)(2), (e)(3), or (e)(4) of this article shall be credited to the cost of project conservation facilities, and the balance of such excess revenues, if any, shall be apportioned and credited, as appropriate, to the capital and to the minimum operation, maintenance, power and replacement costs of reaches of the transportation facilities of the System utilized for conveying such water to the purchasers.

(6) The rates and charges for surplus water shall be subject to redetermination by the State to reflect actual costs incurred and the difference shall be promptly credited or debited to the contractor that purchased such surplus water.

(f) Power Costs. Power costs for pumping surplus water shall consist of the cost of capacity, energy and additional transmission service required for the delivery of surplus water, including but not limited to the following:

(1) To the extent utilized for pumping surplus water:

(i) The cost of power purchased for pumping entitlement water,

(ii) The value of project recovery plant generation scheduled for pumping entitlement water, and contract (disregarding any amendments reducing such Table A executed after July 1, 1974) is first scheduled and unless all of its deferred entitlements are first scheduled: Provided, That at the request of the contractor surplus water may be scheduled in lieu of deferred entitlements and the right to receive such deferred entitlements shall be reduced accordingly. If at the end of any year delivery of scheduled surplus water has prevented any annual entitlement or deferred entitlement from being delivered during that year, then for the purpose of charging for water delivered, deliveries during the year shall be considered first as annual entitlement water to the extent of the annual entitlement, and the balance as deferred entitlement or surplus water in accordance with the option of the contractor previously exercised pursuant to the first sentence of this subdivision.

(3) Before a contractor can receive surplus water under its contract in an amount greater than its annual entitlement for the year as shown in its Table A, it shall first increase its annual entitlement for such year to an amount equivalent to the surplus water scheduled, but it shall not be required to increase its annual entitlement to an amount in excess of 75 percent of its maximum annual entitlement.

(4) The State shall not sell surplus water to a contractor or noncontractor for use directly or indirectly within the boundaries of any other contractor without the written consent of such other contractor, nor shall the State authorize any contractor to supply surplus water for use outside such contractor's boundaries and within the boundaries of any other contractor without the written consent of such other contractor: Provided, That where

and data concerning the use of water within its boundaries as the State may request.

(j) <u>Contracts</u>.

(1) To obtain a supply of surplus water, any contractor or noncontractor shall execute a fuether contract with the State which shall be in conformity with this article and will include at least the following: Further provisions concerning the scheduling of surplus water and provisions as to times and methods of payment.

(2) The State shall not contract to sell surplus water to noncontractors for periods in excess of five years.

IN WITNESS WHEREOF, the parties hereto have executed this contract amendment as of the date first above written.

Approved as to legal form
and sufficiency:

By ______________________
Acting Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By ______________________
Director

CASTAIC LAKE WATER AGENCY

By ______________________
(Title) PRESIDENT

(t) Project Repayment Period

"Project repayment period" shall mean that period of years commencing on January 1, 1961, and extending until December 31, 2035; Provided, that whenever construction of any project facilities is financed by a bond issue with maturity dates later than December 31, 2035, whether the bonds are issued pursuant to the Bond Act or other authority, repayment of the costs of such facilities shall be extended to end on the date of the latest maturities of the bonds with which construction of such facilities is financed.

2. Article 2 of the Agency's Water Supply Contract with the State is amended to read as follows:

(2) Term of Contract

This contract shall become effective on the date first above written and shall remain in effect for the longest of the following:

1. The project repayment period
2. 75 years
3. The period ending with the latest maturity date of any bond issue used to finance the construction costs of project facilities.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 12 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND THE CASTAIC LAKE WATER AGENCY

THIS CONTRACT, made this 12th day of January, 1983, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency";

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment; and

WHEREAS, the State and the Agency desire to make certain changes and additions to such contract, while otherwise continuing the contract in full force and effect;

NOW, THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's water supply contract with the State:

1. Article 1(e) is amended to read:

construction at the same time of alternative new water supply sources which are either reservoirs located north of the Delta or off-Aqueduct storage reservoirs located south or west of the Delta designed to supply water to the California Aqueduct. The following facilities and programs shall hereinafter be referred to as "Local Projects":

(A) On-stream and off-stream surface storage reservoirs not provided for in Section 12938 of the Water Code, that will produce project water for the System for a period of time agreed to by the sponsoring contractor;

(B) Ground water storage facilities that will produce project water for the System for a period of time agreed to by the sponsoring contractor;

(C) Waste water reclamation facilities that will produce project water for the System for a period of time agreed to by the sponsoring contractor;

(D) Water and facilities for delivering water purchased by the State for the System for a period of time agreed to by the sponsoring contractor; provided that the economic test specified herein shall be applied to the cost of these facilities together with the cost of the purchased water; and

(E) Future water conservation programs and facilities that will reduce demands by the sponsoring contractor for project water from the System for a period of time agreed to by the sponsoring contractor and will thereby have the effect of increasing project water available in the Delta for distribution.

(B) All contractors within whose boundaries any portion of such Local Project is located, and who are not sponsoring contractors for such Local Project give their written approval of such Local Project.

(5) "Sponsoring contractor" as used in this Article 1(h) shall mean the contractor or contractors who either will receive the yield from facilities described in 2(A), (B), (C), or (D) above, or agree to reduce demands for project water from the System pursuant to 2(E) above.

(6) In the event of a shortage in water supply within the meaning of Article 18(a), the determination of whether to count, in whole or in part, the yield from facilities described in 2(A), (B), (C), or (D) above, or the reduced demand from future conservation programs described in 2(E) above in the allocation of deficiencies among contractors will be based on a project-by-project evaluation taking into consideration such factors as any limitation on the use of the water from such facilities and whether the sponsoring contractor has access to project water from the Delta as an alternate to such facilities.

3. Article 1(i)(2) is amended to read:

(2) Facilities for the generation and transmission of electrical energy of the following types:

(A) Hydroelectric generating and transmission facilities, whose operation is dependent on the transportation of project water, or on releases to channels downstream of project facilities defined under (1) above. Such facilities shall be called "project aqueduct power recovery plants."

(5) funds advanced by any contractor without the actual incurring of bonded debt therefor, for which the net interest cost and terms shall be those which would have resulted if the contractor had sold bonds for the purpose of funding the advance, as determined by the State, and

(6) funds borrowed from the General Fund or other funds in the Treasury of the State of California, for which the total interest cost shall be computed at the interest rate earned over the period of such borrowing by moneys in the Pooled Money Investment Account of such Treasury invested in securities,

to the extent the proceeds of any such bonds, advances or loans are for construction of the State Water Facilities defined in Section 12934(d) of the Water Code, the additional project conservation facilities, and the supplemental conservation facilities, (except off-aqueduct power facilities and advances for delivery structures, measuring devices and excess capacity) and without regard to any premiums received on the sale of bonds under item (1) above. The "project interest rate" shall be computed as a decimal fraction to five places.

5. Subdivision (h) is added to Article 22 to read:

(h) The determination of the rate for water under the Delta Water Charge shall be made by including the appropriate costs and quantities of water, calculated in accordance with subdivisions (c), (d) and (e) above, for all additional project conservation facilities as defined in Article 1(h) hereinabove. In the event a Local Project as defined in Article 1(h)(2) will,

(d) Notwithstanding the provisions of subdivisions (a) and (b) of this article, or of Article 1(s), the costs of off-aqueduct power facilities shall be determined and allocated as follows:

(1) The off-aqueduct power costs shall include all annual costs the State incurs for any off-aqueduct power facility, which shall include, but not be limited to, power purchases, any annual principal and interest payments on funds borrowed by or advanced to the State, annual principal and interest on bonds issued by the State or other agency, or under revenue bond financing contracts, any requirements for coverage, deposits to reserves, and associated operation and maintenance costs of such facility, less any credits, interest earnings, or other monies received by the State in connection with such facility. In the event the State finances all or any part of an off-aqueduct power facility directly from funds other than bonds or borrowed funds, in lieu of such annual principal and interest payments, the repayment of capital costs as to that part financed by such other funds shall be determined on the basis of the schedule that would have been required under Article 24.

(2) The annual costs of off-aqueduct power facilities as computed in (1) above shall initially be allocated among contractors in amounts which bear the same proportions to the total amount of such power costs that the total estimated electrical energy (kilowatt hours) required to pump through project transportation facilities the desired delivery amounts of annual entitlements for that year, as submitted pursuant to

reallocation shall include appropriate interest at the project interest rate.

9. Subdivision (e) is added to Article 25 to read:

(e) The total minimum operation, maintenance, power and replacement component due that year from each contractor shall be the sum of the allocations made under the proportionate use of facilities method provided in subdivision (b) of this article and the allocations made pursuant to subdivision (d) of this article for each contractor.

10. Subdivision (b) of Article 32 is amended to read:

(b) Interest on Overdue Payments

Upon every amount of money required to be paid by the Agency to the State pursuant to this contract which remains unpaid after it becomes due and payable, interest shall accrue at an annual rate equal to that earned by the Pooled Money Investment Fund, as provided in Government Code Sections 16480, et seq. calculated monthly on the amount of such delinquent payment from and after the due date until it is paid, and the Agency hereby agrees to pay such interest: provided, that no interest shall be charged to or be paid by the Agency unless such delinquency continues for more than thirty (30) days.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 13 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS CONTRACT is made this 6th day of June, 1987, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency".

WHEREAS, the State and the Agency have entered into and subsequently amended a water supply contract providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment;

WHEREAS, the State and the Agency wish to provide financing for project facilities with water system revenue bonds and provide for repayment of water system revenue bonds;

WHEREAS, the State and the Agency wish to clarify the definition of the project interest rate without changing the interpretation of Article 1(r), except for the addition of item (7), and to specify that financing costs of water system facilities and East Branch Enlargement facilities shall not be included in calculating the project interest rate; and

(2) Revenue bonds issued by the State under the Central Valley Project Act after May 1, 1969,

(3) Bonds issued by the State under any other authority granted by the Legislature or the voters,

(4) Bonds issued by any agency, district, political subdivision, public corporation, or nonprofit corporation of this State,

(5) Funds advanced by any contractor without the actual incurring of bonded debt therefor, for which the net interest cost and terms shall be those which would have resulted if the contractor had sold bonds for the purpose of funding the advance, as determined by the State,

(6) Funds borrowed from the General Fund or other funds in the Treasury of the State of California, for which the total interest cost shall be computed at the interest rate earned over the period of such borrowing by moneys in the Surplus Money Investment Fund of such Treasury invested in securities, and

(7) Any other financing capability available in the Treasury of the State of California at whatever interest rate and other financing costs are provided in the law authorizing such borrowing. However, the use of other financing from the State Treasury is intended to involve only short term borrowing at interest rates and other financing costs no greater than those charged to other State agencies during the same period until such time as the Department can sell bonds and reimburse the source of the short term borrowing from the proceeds of the bond sale.

between the State and The Metropolitan Water District of Southern California, dated July 2, 1984, and May 15, 1985, which increased the East Branch Aqueduct capacity beyond that set forth in Table B-2 as shown in State Bulletin 132-70;

(5) That portion of Reach 24 (Silverwood Lake) to be determined by reallocation of Reach 24 to reflect the additional use to be made of that reach as a result of the East Branch Enlargement operation; and

(6) That portion of Reach 25 (San Bernardino Tunnel) to be determined by an allocation of total delivery capacity of Reach 25 between the basic East Branch facilities and the East Branch Enlargement as a result of East Branch Enlargement operation.

4. Article 1 (hh) is added to read:

(hh) "Water System Facilities" shall mean the following facilities to the extent that they are financed with water system revenue bonds or to the extent that other financing of such facilities is reimbursed with proceeds from water system revenue bonds:

(1) The North Bay Aqueduct,

(2) The Coastal Branch Aqueduct,

(3) Delta Facilities, including Suisun Marsh facilities, to serve the purposes of water conservation in the Delta, water supply in the Delta, transfer of water across the Delta, and mitigation of the environmental effects of project facilities, and to the extent presently authorized as project purposes, recreation and fish and wildlife enhancement,

(4) Local projects as defined in Article 1(h)(2) designed to develop no more than 25,000 acre-feet of project yield from each project,

shall be calculated in accordance with provisions in Article 5. of this contract.

6.5. Article 28(e) of the Agency's water supply contract with the State is added to read:

28(e) Notwithstanding the provisions of Article 28(b), adjustments for prior overpayments and underpayments shall be repaid beginning in the year following the redetermination by application of a unit rate per acre-foot which, when paid for the projected portion of the Agency's annual entitlement will return to the State, during the project repayment period, together with interest thereon computed at the project interest rate and compounded annually, the full amount of the adjustments resulting from financing after January 1, 1987, from all bonds, advances, or loans listed in Article 1(r) except for Article 1(r)(3) and except for bonds issued by the State under the Central Valley Project Act after January 1, 1987 for facilities not listed among the water system facilities in Article 1(hh). Notwithstanding the immediately preceding exception, such amortization shall also apply to any adjustments in this component charge resulting from a change in the project interest rate due to any refunding after January 1, 1986 of bonds issued under the Central Valley Project Act. However, amortization of adjustments resulting from items 1(r)(4) through (7) shall be limited to a period which would allow the Department to repay the debt service on a current basis until such time as bonds are issued to reimburse the source of such funding. In no event shall this amortization period be greater than the project repayment period.

credits are determined by the State to be available, such credits shall be promptly provided to the contractors and shall be in proportion to the payments under this article from each contractor. Reserves, bond debt service coverage, interest, and other earnings may be used in the last year to retire the bonds.

(b) Annual charges to recover water system revenue bond financing costs shall consist of two elements.

(1) The first element shall be an annual charge to the Agency for repayment of capital costs of water system facilities as determined under Articles 22 and 24 of this contract with interest at the project interest rate. For conservation facilities, the charge shall be a part of the capital cost component of the Delta Water Charge in accordance with Article 22. For transportation facilities, the charge shall be a part of the capital cost component of the Transportation Charge in accordance with Article 24.

(2) The second element shall be the Agency's share of a Water System Revenue Bond Surcharge to be paid in lieu of a project interest rate adjustment. The total annual amount to be paid by all contractors under this element shall be the difference between the total annual charges under the first element and the annual financing costs of the water system revenue bonds. The amount to be paid by each contractor shall be calculated annually as if the project interest rate were increased to the extent necessary to produce revenues from all contractors sufficient to pay such difference for that year. In making that calculation, adjustments in the Agency's Transportation capital cost component charges for prior overpayments and underpayments shall be determined as if amortized over the remaining years of the project repayment period.

of any water system revenue bond issuances and the form of any necessary resolutions or supplements.

(h) Defaults. (1) If a contractor defaults partially or entirely on its payment obligations calculated under this article and sufficient insurance or other security protecting the non-defaulting contractors is not provided under Article 50(f), the State shall allocate a portion of the default to each non-defaulting contractor. The Agency's share of the default shall be equal to an amount determined by multiplying the total default amount to be charged to all non-defaulting contractors by the ratio that the Agency's maximum Table A entitlement bears to the maximum Table A entitlements of all non-defaulting contractors. However, such amount shall not exceed in any year 25 percent of the Water System Revenue Bond financing costs that are otherwise payable by the Agency in that year. The amount of default to be charged to non-defaulting contractors shall be reduced by any receipts from insurance protecting non-defaulting contractors and bond debt service coverage from a prior year and available for such purpose.

(2) If a contractor defaults partially or entirely on its payment obligations under this article, the State shall also pursuant to Article 20, upon six months' notice to the defaulting contractor, suspend water deliveries under Article 20 to the defaulting contractor so long as the default continues. The suspension of water deliveries shall be proportional to the ratio of the default to the total water system revenue bond payments due from the defaulting contractor. However, the State may reduce, eliminate, or not commence suspension of deliveries pursuant to this subparagraph if it determines suspension in the amounts otherwise required is likely to impair the

coverage, such increase shall be handled in the same manner as provided in Article 50(a).

(7) Action taken pursuant to this subarticle shall not deprive the State of or limit any remedy provided by this contract or by law for the recovery of money due or which may become due under this contract.

(i) Power of Termination.

(1) The Department and the Agency agree to negotiate in good faith the development of a means to provide adequate protection for the Department's cash flow into priorities one and two for revenues under Water Code Section 12937(b) with the goal of obtaining agreement by April 1, 1987. The Department and the Agency agree to continue negotiations beyond April 1, 1987 if necessary to meet their common goal of arriving at agreement.

(2) If such an agreement has not been reached by April 1, 1987, and if the Director of Water Resources determines that adequate progress has not been made toward such an agreement, the Director may give notice to the Agency and other contractors that he intends to exercise the power to terminate provided in this subarticle 50(i). The Director's authority to give such a notice shall terminate on July 1, 1988.

(3) After six months from the date of issuing the notice of intent to terminate, but in no event later than January 1, 1989, the Director may terminate the authority of the Department to issue additional series of water system revenue bonds using the repayment provisions of Article 50. The Department shall promptly notify the Agency and other contractors that the Director has exercised the power of termination.

IN WITNESS WHEREOF, the parties have executed this contract on the date first above written.

Approved as to legal form
and sufficiency:

By
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By
Director

Attest:

By Betty L. Castleberry
(Title)
Secretary

CASTAIC LAKE WATER AGENCY

By
General Manager

to the extent the proceeds of any such bonds, advances or loans are for construction of the State Water Facilities defined in Section 12934(d) of the Water Code, the additional project conservation facilities, and the supplemental conservation facilities, (except off-aqueduct power facilities and advances for delivery structures, measuring devices and excess capacity) and without regard to any premiums received on the sale of bonds under item (1) above. The "project interest rate" shall be computed as a decimal fraction to five places.

WHEREAS, the State and the Agency desire to amend the provisions of such contract related to the delivery and scheduling of entitlement water to allow, under certain conditions, the carry-over of a portion of the Agency's entitlement deliveries from a respective year into the first three months of the next calendar year.

WHEREAS, the carry-over of entitlement by the Agency is not intended to adversely impact current or future project operations.

WHEREAS, the State Water Project contractors and the Department are aware that the carry-over of entitlement water from one year into the next may increase or decrease the costs to other SWP contractors in either year. The tracking of those costs may be too complex and expensive and does not warrant special accounting procedures to be established; however, any significant identifiable cost shall be charged to those contractors causing such cost, as determined by the Department;

WHEREAS, the carry-over of entitlement water is not to affect the payment provisions of the contract.

NOW THEREFORE, it is mutually agreed that the following changes and additions are hereby made to the Agency's Water Supply Contract with the State:

1. Article 1(ii) is added to read:

"Carry-over Entitlement Water" shall mean water from a contractor's annual entitlement for a respective year which is made available for delivery by the State in the next year pursuant to Article 12(e).

conditions consistent with this Article 12(e) that would govern the delivery of the Carry-over Entitlement Water.

The Agency agrees to pay all significant identifiable costs associated with its Carry-over Entitlement Water, as determined by the State.

All scheduling and delivery of Carry-over Entitlement Water shall be carried out pursuant to the provisions of this contract.

The Agency agrees to forego the delivery of any Carry-over Entitlement Water that is lost because of project operations or is not delivered by March 31 of the next year.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 15 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS AMENDMENT to the Water Supply Contract is made this 11th day of APRIL, 1991, pursuant to the provisions of the California Water Resources Development Bond Act, the State Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency".

RECITALS:

WHEREAS, the State and the Agency entered into a contract whereby the State will deliver and the Agency will purchase a supply of water to be made available from project facilities constructed by the State;

WHEREAS, the State and the Agency included in such contract an article which entitles the Agency to obtain from the State deliveries of surplus water when available;

WHEREAS, the State and the Agency desire to amend the provisions of such contract related to the deliveries of surplus water; and

3. Article 21(f) of the Agency's water supply contract with the State is amended to read:

(f) Power Costs.

(1) Beginning January 1, 1991, the Agency shall pay power charges for pumping surplus water as follows:

(A) If during a calendar month it is either not necessary to purchase power for pumping surplus water, or it is necessary to purchase power for pumping surplus water and the purchased power rate is less than or equal to the Melded Power Rate (defined as the average unit charge for pumping entitlement water during the calendar year for all power resources, including on-aqueduct power resources, off-aqueduct power resources, and any other power resources), then the monthly charges to the Agency for the Net Power (gross power used to pump the surplus water less power generated by the surplus water) used to pump surplus water to the Agency shall be determined using the Melded Power Rate.

(2) By receiving surplus or unscheduled water under this Article 21(f), the Agency accepts the responsibility to indemnify, defend, and hold harmless the State, its officers, employees and agents from all liability, expenses, defense costs, attorney fees, claims, actions, liens, and lawsuits of whatever kind, arising out of or related to this article.

(3) Effective January 1, 1991, power charges for delivery of unscheduled water to the Agency shall be calculated in the same manner as provided in this Article 21(f).

4. This Amendment shall take effect on January 1, 1991, only if, by January 31, 1991 an Amendment substantially the same as this one is executed by contractors that together have maximum annual entitlements totaling at least 3,796,007 acre-feet. By February 15, 1991, the State will inform the Agency of whether sufficient contractors had executed the Amendment to cause the Amendment to take effect.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AGREEMENT RELATING TO CONSOLIDATION AND TERMINATION OF THE WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA AND DEVIL'S DEN WATER DISTRICT BEING AMENDMENT NO. 16 TO WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS CONTRACT is made this 3rd day of January, 1991, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State", and Castaic Lake Water Agency, herein referred to as the "Agency", and Devil's Den Water District, herein referred to as "Devil's Den".

RECITALS:

WHEREAS, the State and the Agency (formerly Upper Santa Clara Water Agency) have entered into and subsequently amended a water supply contract dated April 30, 1963, providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment;

WHEREAS, the State and the Agency desire to make certain changes to the Agency's mentioned contract, while otherwise continuing the Agency's contract in full force and effect.

AGREEMENT:

NOW, THEREFORE, the parties agree that the following changes are made to the Agency's water supply contract with the State, effective January 1, 1992.

1. Table A is amended to read as follows:

TABLE A
ANNUAL ENTITLEMENTS
CASTAIC LAKE WATER AGENCY

Calendar Year		Total Annual Amount in Acre-Feet
1968		3,700
1969		5,000
1970		5,700
1971		6,700
1972	1	8,936
1973	2	12,400
1974	3	15,400
1975	4	18,200
1976	5	21,200
1977	6	24,100
1978	7	24,762
1979	8	28,000
1980	9	30,400
1981	10	32,800
1982	11	34,800
1983	12	37,300
1984	13	39,600
1985	14	41,800
1986	15	43,600
1987	16	45,600
1988	17	48,000
1989	18	50,100
1990	19	52,000
1991	20	54,200
1992	21	54,200
And each succeeding year thereafter, for the term of this contract		54,200

4. Article 12(c) of the Agency's contract with the State is amended to read:

(c) **Limit on Rate of Delivery to Agency**

(1) In no event shall the State be obligated to deliver water to the Agency from Castaic Lake at a total combined instantaneous rate of flow exceeding ninety-nine (99) cubic feet per second, except as this rate of flow may be revised by amendment of this article after submission to the State of the Agency's requests with respect to maximum flow capacities to be provided in said delivery structures, pursuant to Article 10.

(2) In no event shall the State be obligated to deliver water to the Agency through the delivery structure at Devil's Den from Reach 31A at a total combined instantaneous rate of flow exceeding thirty-eight (38) cubic feet per second.

5. The proportionate use of facilities factors in the Agency's Table B will be revised to include:

(a) Additional capacity in the California Aqueduct from the Sacramento-San Joaquin Delta through Reach 31A of the Coastal Aqueduct for transporting 12,700 acre-feet with no more than a total amount in any one month of any year of project water greater than eighteen (18) percent of that portion of the Agency's annual entitlement for that year,

8. Pursuant to Article 15(a), the State consents to the Agency annually taking delivery of up to 12,700 acre-feet of the Agency's Table A annual entitlement water at the turnout to Devil's Den in Reach 31A consistent with Article 5(a) above. In any year when the Department determines that sufficient water is available, Article 12(d), surplus, and unscheduled water may also be delivered to the Agency in Reach 31A based upon the amount of the Agency's Table A annual entitlement requested for delivery in that reach.

9. The Agency agrees to indemnify, defend, and hold harmless the State from any liability, expenses, defense costs, attorney fees, claims, actions, liens and lawsuits of any kind arising out of or related to the actions implementing this amendment.

10. Covenants Between the State and Devil's Den:

The State and Devil's Den agree, in consideration of the assumption hereunder by the Agency and the State of new duties under the Castaic Lake Water Agency contract, that the Devil's Den Contract is terminated effective January 1, 1992, and the State and Devil's Den are discharged, effective January 1, 1992, from their respective duties under the Devil's Den Contract.

IN WITNESS WHEREOF, the parties hereto have executed this contract on the date first above written.

Approved as to legal form
and sufficiency:

Acting Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

for Director

CASTAIC LAKE WATER AGENCY

E. G. "Jerry" Gladbach
President E. G. "Jerry" Gladbach

Betty L. Castleberry
Secretary Betty L. Castleberry

DEVIL'S DEN WATER DISTRICT

Robert L. Larson
President Robert L. Larson

Laurie Foster
Secretary Laurie Foster

WHEREAS, the contractors and the State have negotiated an amendment to the water supply contracts to implement provisions of the Monterey Agreement (the "Monterey Amendment"); and

WHEREAS, the State and the Agency desire to implement such provisions by incorporating this Monterey Amendment into the water supply contract;

NOW, THEREFORE, IT IS MUTUALLY AGREED that the following changes and additions are hereby made to the Agency's water supply contract with the State:

1. **Article 1(d) is amended to read:**

(d) **Contractor**

"Contractor" shall mean any entity that has executed, or is an assignee of, a contract of the type published in Department of Water Resources Bulletin No. 141 dated November 1965, with the State for a dependable supply of water made available by the System, except such water as is made available by the facilities specified in Section 12934(d)(6) of the Water Code.

2. **Article 1(k) is amended to read:**

(k) **Minimum Project Yield**

"Minimum project yield" shall mean the dependable annual supply of project water to be made available, estimated to be 4,185,000 acre-feet per year, said amount to be determined by the State on the basis of coordinated operation studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon:

(5) Land acquisition prior to December 31, 1995, for the Kern Fan Element of the Kern Water Bank,

(6) Additional pumps at the Banks Delta Pumping Plant,

(7) The transmission line from Midway to Wheeler Ridge Pumping Plant,

(8) Repairs, additions, and betterments to conservation or transportation facilities existing as of January 1, 1987, and to all other facilities described in this subarticle (hh) except for item (5),

(9) A project facilities corporation yard, and

(10) A project facilities operation center.

4. Article 1(jj) is added to read:

(jj) **Interruptible water**

"Interruptible water" shall mean project water available as determined by the State that is not needed for fulfilling contractors' annual entitlement deliveries as set forth in their water delivery schedules furnished pursuant to Article 12 or for meeting project operational requirements, including storage goals for the current or following years.

5. Article 1(kk) is added to read:

(kk) **Nonproject water**

"Nonproject water" shall mean water made available for delivery to contractors that is not project water as defined in Article 1(j).

Other terms and conditions of the continued service shall be reasonable and equitable and shall be mutually agreed upon. In the event that said terms and conditions provide for continued service for a limited number of years only, the Agency shall have the same option to receive continued service here provided for upon the expiration of that and each succeeding period of continued service.

8. Article 7(a) is amended to read:

(a) **Changes in Annual Entitlements**

The Agency may, at any time or times during the term of this contract, by timely written notice furnished to the State, request that project water be made available to it thereafter in annual amounts greater or less than the annual entitlements designated in Table A of this contract. Subject to approval by the State of any such request, the State's construction schedule shall be adjusted to the extent necessary to satisfy the request, and the requested increases or decreases in said annual entitlements shall be incorporated in said Table A by amendment thereof. Requests for changes in annual entitlements for more than one year shall be approved by the State: *Provided,* That no change shall be approved if in the judgment of the State it would impair the financial feasibility of project facilities.

9. The title of Article 12 is amended to read "Priorities, Amounts, Times and Rates of Deliveries".

Fourth, project water previously stored pursuant to Articles 12(e) and 56.

Fifth, nonproject water to fulfill contractors' annual entitlements for that year not met by the first two priorities.

Sixth, additional interruptible water delivered to contractors in excess of their annual entitlements for that year.

Seventh, additional nonproject water delivered to contractors in excess of their annual entitlements for that year.

13. Article 14 is amended to read:

Curtailment of Delivery

(a) **State May Curtail Deliveries**

The State may temporarily discontinue or reduce the delivery of project water to the Agency hereunder for the purposes of necessary investigation, inspection, maintenance, repair, or replacement of any of the project facilities necessary for the delivery of project water to the Agency, as well as due to outages in, or reductions in capability of, such facilities beyond the State's control or unuseability of project water due to an emergency affecting project facilities. The State shall notify the Agency as far in advance as possible of any such discontinuance or reduction, except in cases of emergency, in which case notice need not be given.

(b) **Agency May Receive Later Delivery of Water Not Delivered**

In the event of any discontinuance or reduction of delivery of project water pursuant to subdivision (a) of this article, the Agency may elect to receive the amount of annual entitlement which otherwise would have been delivered to it during such period under contractors for domestic supply, fire protection, or sanitation during the year. If a contractor is allocated more water than it requested, the excess water shall be reallocated among the other contractors in proportion to their annual entitlements as provided for above. The foregoing provisions of this subdivision shall be inoperative to the extent necessary to comply with subdivision (c) of this article and to the extent that a contractor's annual entitlement for the respective year reflects established rights under the area of origin statutes precluding a reduction in deliveries to such contractor.

(b) - Deleted

(c) **Permanent Shortage; Contracts for Areas-of-Origin**

In the event that the State, because of the establishment by a party of a prior right to water under the provisions of Sections 11460 through 11463 of the Water Code, enters into a contract with such party for a dependable supply of project water, which contract will cause a permanent shortage in the supply of project water to be made available to the Agency hereunder:

(1) The State shall: (i) equitably redistribute the costs of all transportation facilities included in the System among all contractors for project water, taking into account the diminution of the supply to the Agency and other prior contractors in accordance with the terms of their contracts, and (ii) revise the Agency's annual entitlements and maximum annual entitlement, by amendment of Table A of this contract to correspond to the reduced supply of project water to be made available to the Agency: *Provided*, That such redistribution of costs of transportation facilities shall not be made until there has been reasonable

(d) **Reinstatement of Entitlements**

If after any revision of annual entitlements and maximum annual entitlements pursuant to subdivision (c) of this article, circumstances arise which, in the judgment of the State, justify a revision upward of the same, the State shall, with the consent of the affected contractor, reinstate proportionately the previously reduced entitlements of such contractor to the extent deemed justified, and shall equitably redistribute the costs of the project transportation facilities if inequities would otherwise occur as a result of such reinstatement of entitlements.

(e) **Advance Notice of Delivery Reductions**

The State shall give the Agency written notice as far in advance as possible of any reduction in deliveries to it which is to be made under subdivision (a) of this article and, to the extent possible, shall give the Agency written notice five (5) years in advance of any reduction in its annual entitlements and maximum annual entitlement under subdivision (c) of this article. Reports submitted to the Agency pursuant to Article 16(c) may constitute such notices.

(f) **No Liability for Shortages**

Neither the State nor any of its officers, agents, or employees shall be liable for any damage, direct or indirect, arising from shortages in the amount of water to be made available for delivery to the Agency under this contract caused by drought, operation of area of origin statutes, or any other cause beyond its control.

off-aqueduct, and any other power) incurred in the transportation of such water as if such interruptible water were entitlement water, as well as all incremental operation, maintenance, and replacement costs, and any other incremental costs, as determined by the State. The State shall not include any administrative or contract preparation charge. Incremental costs shall mean those nonpower costs which would not be incurred if interruptible water were not scheduled for or delivered to the contractor. Only those contractors not participating in the repayment of the capital costs of a reach shall be required to pay any use of facilities charge for the delivery of interruptible water through that reach.

(c) **Contracts**

To obtain a supply of interruptible water, a contractor shall execute a further contract with the State which shall be in conformity with this article and shall include at least provisions concerning the scheduling of deliveries of interruptible water and times and methods of payment.

17. Article 22(j) is amended to read:

(j) Notwithstanding provisions of Article 22(a) through (i), the capital cost component and the minimum OMP&R component of the Delta Water Charge shall include an annual charge to recover the Agency's share of the conservation portion of the water system revenue bond financing costs. Charges to the Agency for these costs shall be calculated in accordance with provisions in Article 50 of this contract. Charges for the conservation portion of the water system revenue bond financing costs shall not be affected by any reductions in payments pursuant to Article 51.

subdivision shall be controlling as to allocations of capital costs to the Agency. Proportionate use of facilities factors for prior years shall not be adjusted by the State in response to changes or transfers of entitlement among contractors unless otherwise agreed by the State and the parties to the transfer and unless there is no impact on past charges or credits of other contractors.

19. Article 24(g) is amended to read:

(g) Notwithstanding provisions of Article 24(a) through (d), the capital cost component of the Transportation Charge shall include an annual charge to recover the Agency's share of the transportation portion of the water system revenue bond financing costs. Charges to the Agency for these costs shall be calculated in accordance with the provisions of Article 50 of this contract. Charges for the transportation portion of the water system revenue bond financing costs shall not be affected by any reductions in payments pursuant to Article 51.

20. Article 25(d)(3) is amended to read:

(3) An interim adjustment in the allocation of the power costs calculated in accordance with (2) above, may be made in May of each year based on April revisions in approved schedules of deliveries of project and nonproject water for contractors for such year. A further adjustment shall be made in the following year based on actual deliveries of project and nonproject water for contractors provided, however, in the event no deliveries are made through a pumping plant, the adjustments shall not be made for that year at that plant.

the charges for the year before that for obligations under subdivisions (c)(2)(ii) and (iii) of this article.

(b) **State Water Facilities Capital Account**

(1) The State shall establish a State Water Facilities Capital Account to be funded from revenues available under Water Code section 12937(b)(4). Through procedures described in this article and as limited by this article, the State may consider as a revenue need under subdivision (c)(2)(v) of this article and may deposit in the State Water Facilities Capital Account the amounts necessary to pay capital costs of the State Water Facilities for which neither general obligation bond nor revenue bond proceeds are available, including but not limited to planning, reconnaissance and feasibility studies, the San Joaquin Valley Drainage Program and, through the year 2000, the CALFED Bay-Delta Program.

(2) The Director of the Department of Water Resources shall fully consult with the contractors and consider any advice given prior to depositing funds into this account for any purposes. Deposits into this account shall not exceed the amounts specified in subdivision (c)(2)(v) of this article plus any amounts determined pursuant to subdivision (e)(1)(iii) of this article.

(3) The State shall use revenue bonds or other sources of moneys rather than this account to finance the costs of construction of any major capital projects.

(c) **Calculation of Financial Needs**

(1) Each year the State shall calculate in accordance with the timing provisions of Articles 29 and 31 the amounts that would have been charged (but for this article) to each contractor as provided in other provisions of this contract.

(3) Subject to the provisions of subdivision (e) of this article, the State shall reduce the annual charges in the aggregate for all contractors by the amounts by which the hypothetical charges calculated pursuant to subdivision (c)(1) above exceed the revenue needs determined pursuant to subdivision (c)(2) above. The reductions under this article shall be apportioned among the contractors as provided in subdivisions (d), (e), (f) and (g) of this article. Reductions to contractors shall be used to reduce the payments due from the contractors on each January 1 and July 1; *Provided*, however, that to the extent required pursuant to subdivision (h) of this article, each Agricultural Contractor shall pay to the Agricultural Rate Management Trust Fund an amount equal to the reduction allocated to such Agricultural Contractor. Any default in payment to the trust fund shall be subject to the same remedies as any default in payment to the State under this contract.

(4) The State may submit a supplemental billing to the Agency for the year in an amount not to exceed the amount of the prior reductions for such year under this article if necessary to meet unanticipated costs for purposes identified in Water Code section 12937(b)(1) and (2) for which the State can issue billings under other provisions of this contract. Any supplemental billing made to the Agency for these purposes shall be in the same proportion to the total supplemental billings to all contractors for these purposes as the prior reduction in charges to the Agency in that year bears to the total reductions in charges to all contractors in that year and shall be treated as reducing the amount of the reduction made available for that year to the Agency by the amount of the supplemental bill to the Agency.

Agricultural Contractors, and the remaining reductions shall be apportioned among the Urban Contractors.

(iii) In 1999 reductions in the amount of $32 million are projected to be available and shall be applied as follows: the first $10 million of reductions shall be apportioned among the Agricultural Contractors, and the remaining reductions shall be apportioned among the Urban Contractors.

(iv) In 2000 reductions in the amount of $33 million are projected to be available and shall be applied as follows: the first $10 million of reductions shall be apportioned among the Agricultural Contractors, and the remaining reductions shall be apportioned among the Urban Contractors.

(3)(i) In the event that the aggregate amount of reductions in any of the years 1997 through 2000 is less than the respective amount projected for such year in subdivision (d)(2) above, the shortfall shall be taken first from reductions that would have been provided to Urban Contractors. Only after all reductions to Urban Contractors have been eliminated in a given year shall the remaining shortfall be taken from reductions scheduled for Agricultural Contractors. Any projected reductions not made available due to such shortfalls in the years 1997 through 2000 shall be deferred with interest at the project interest rate to the earliest subsequent years when reductions in excess of those projected for those years are available. Such deferred reductions with interest at the project interest rate shall be applied to the charges of the contractors whose reductions have been deferred.

(ii) In the event that the aggregate amount of reductions available in any of the years 1997 through 2000 is

(5) Annual charges to a contractor shall only be reduced prospectively from and after the date it executes the Monterey Amendment to this contract. Apportionments of reductions shall be calculated on the assumption that all contractors have executed such amendment.

(e) **Review of Financial Requirements**

(1) In 2001 and every fifth year thereafter the Director of the Department of Water Resources, in full consultation with the contractors, will review the financial requirements of the State Water Resources Development System and determine the following:

(i) The amount of revenues that are needed for State Water Resources Development System purposes in addition to those needed for the purposes specified in subdivisions (c)(2)(i), (ii), (iii), and (iv) of this article;

(ii) If the aggregate amount that would have been charged to all contractors in any year but for this article exceeds the sum of (A) the amount of revenues needed for the purposes specified in subdivisions (c)(2)(i), (ii), (iii) and (iv), plus (B) $40.5 million, plus (C) the amount determined pursuant to subdivision (c)(2)(v) of this article, the amount of such excess.

(iii) The amount of the excess determined in subdivision (e)(1)(ii) above that should be collected by the State for additional State Water Resources Development System purposes and the amount of such excess that should be used for further annual charge reductions.

(2) After making the determinations required above, the State may collect the revenues for additional State Water Resources

account in excess of this requirement shall be returned to general project revenues.

(vi) Sixth, remaining amounts if any shall be used for reductions divided on a 24.7% - 75.3% basis between the Agricultural Contractors and the Urban Contractors respectively.

(f) **Apportionment of Reductions among Urban Contractors.** Reductions in annual charges apportioned to Urban Contractors under subdivisions (d) and (e) of this article shall be further allocated among Urban Contractors pursuant to this subdivision. The amount of reduction of annual charges for each Urban Contractor shall be based on each Urban Contractor's proportionate share of total allocated capital costs as calculated below, for both project conservation and project transportation facilities, repaid by all Urban Contractors over the project repayment period.

(1) The conservation capital cost component of the reduction allocation shall be apportioned on the basis of maximum annual entitlement. Each Urban Contractor's proportionate share shall be the same as the percentage of that contractor's maximum annual entitlement to the total of all Urban Contractors' maximum annual entitlements.

(2) The transportation capital cost component of the reduction allocation shall be apportioned on the basis of transportation capital cost component repayment obligations, including interest over the project repayment period. Each Urban Contractor's proportionate share shall be the same as the percentage that the contractor's total transportation capital cost component repayment obligation is of the total of all Urban Contractors' transportation capital cost component repayment obligations.

calculated in subdivision (f)(2) of this article by seventy percent (70%).

(iii) A total, weighted capital cost percentage shall be calculated for each Urban Contractor by adding the weighted conservation capital cost component percentage to their weighted transportation capital cost component percentage.

(4) The total amount of the annual charges to be reduced to Urban Contractors in each year shall be allocated among them by multiplying the total amount of annual charges to be reduced to the Urban Contractors by the total, weighted capital cost percentages for each such contractor. If the amount of the reduction to an Urban Contractor is in excess of that contractor's payment obligation to the Department for that year, such excess shall be reallocated among the other Urban Contractors.

(5) In the case of a permanent transfer of urban entitlement, the proportionate share of annual charge reductions associated with that entitlement shall be transferred with the entitlement to the buying contractor. In the case of an entitlement transfer by either Santa Barbara County Flood Control and Water Conservation District or San Luis Obispo County Flood Control and Water Conservation District, the reductions in annual charges to that agency shall be allocated (a) on the basis of that entitlement being retained by that agency which bears Coastal Branch Phase II transportation costs, (b) on the basis of that entitlement being retained by that agency which does not bear Coastal Branch Phase II transportation costs, and (c) on the basis of the balance of that agency's entitlement which also does not bear Coastal Branch Phase II transportation costs.

Transportation Charge (excluding off-aqueduct power charges) and Water Revenue Bond Surcharge shall be totaled for the years 1997 through 2035.

(iii) Kern County Water Agency and Dudley Ridge Water District totaled costs shall be reduced for the 45,000 acre-feet of annual entitlement being relinquished by them.

(iv) Any reductions in an Agricultural Contractor's totaled costs resulting from the transfer of any of the 130,000 acre-feet of annual entitlement shall be re-added to that contractor's costs.

(v) Each Agricultural Contractor's proportionate share shall be computed by dividing that contractor's total costs by the total costs for all Agricultural Contractors determined pursuant to subparagraphs (ii), (iii) and (iv) above.

(2) The reductions in annual charges, for 1997 through 2001, shall be calculated using the method described in subdivision (g)(1) of this article.

(3) The allocation shall be recalculated using the same method described in subdivision (g)(1) of this article every five years beginning in 2002, if any Agricultural Contractor requests such a recalculation. Any recalculation shall be based on project cost data beginning with the year that the recalculation is to become effective through 2035.

(h) **Agricultural Rate Management Trust Fund**

(1) **Establishment.** Through a trust agreement executed contemporaneously with this amendment, the State and the Agricultural Contractors that sign the Monterey Amendments shall

the percentage of the total of that contractor's statement of charges for that year, as redetermined by the State on or about May 15th of that year, for (a) the Delta Water Charge; (b) the capital cost and minimum operation, maintenance, power and replacement components of the Transportation Charge (including off-aqueduct power charges); and (c) the water system revenue bond surcharge, that is equal to the percentage of that contractor's annual entitlement for that year that was not allocated to it by the State by April 15th of that year.

(ii) In addition to the provisions of subdivision (h)(4)(i) of this article, if on April 15 of any year any of the irrigable land within the Tulare Lake Basin Water Storage District (Tulare) is flooded, and Tulare in writing requests the trustee to do so, the trustee shall, to the extent there are funds in Tulare's account, distribute to the State from such account for the benefit of Tulare an amount equal to the percentage of the total of Tulare's statement of charges for that year, as redetermined by the State on or about May 15th of that year, for (a) the Delta Water Charge; (b) the capital cost and minimum components of the Transportation Charge (including off-aqueduct power charges); and (c) the water system revenue bond surcharge, that is equal to the percentage of the irrigable land within Tulare that is flooded on April 15.

(iii) Each Agricultural Contractor shall remain obligated to make payments to the State as required by other articles in this contract. Any amount to be disbursed pursuant to subdivisions (h)(4)(i) and (h)(4)(ii) shall be paid by the trustee to the State on July 1 of the year involved and shall be credited by the State toward any amounts owed by such respective Agricultural subdivision (d) of this article so long as the amount in that contractor's account is less than its share of the Cap.

(7) **Distribution of Funds in Excess of the Cap.** Whenever accumulated funds (including interest) in an Agricultural Contractor's account in the trust fund exceed that contractor's share of the Cap, or the estimated remaining payments the contractor is required to make to the State prior to the end of the project repayment period, that contractor may direct the trustee to pay such excess to the contractor.

(8) **Termination of Trust Fund.** At the end of the project repayment period, the Agricultural Rate Management Trust Fund shall be terminated and any balances remaining in the accounts for each of the Agricultural Contractors shall be disbursed to the respective Agricultural Contractors.

(i) **Definitions.** For the purposes of this article, the following definitions will apply:

(1) "Agricultural Contractor" shall mean the following agencies as they now exist or in any reorganized form:

- (i) County of Kings,
- (ii) Dudley Ridge Water District,
- (iii) Empire West Side Irrigation District,
- (iv) Kern County Water Agency for 993,300 acre-feet of its entitlement,
- (v) Oak Flat Water District,
- (vi) Tulare Lake Basin Water Storage District.

(2) "Urban Contractor" shall mean every other agency having a long term water supply contract with the State as they exist as of the date of this amendment or in any reorganized form as well as

24. Article 53 is added to read:

53. PERMANENT TRANSFERS AND REDUCTIONS OF ENTITLEMENT

(a) Article 41 provides that no assignment or transfer of a contract or any part thereof, rights thereunder or interest therein by a contractor shall be valid unless and until it is approved by the State and made subject to such reasonable terms and conditions as the State may impose. In accordance with State policy to assist water transfers, the State and the County of Kings, Dudley Ridge Water District (DRWD), Empire West Side Irrigation District, Kern County Water Agency (KCWA), Oak Flat Water District and Tulare Lake Basin Water Storage District (for the purposes of this article the "Agricultural Contractors") shall, subject to the conditions set forth in this article, expeditiously execute any necessary documents and approve all contracts between willing buyers and willing sellers until permanent transfers totaling 130,000 acre-feet of annual entitlements of the Agricultural Contractors and, to the extent provided in such contracts, rights in project transportation facilities related to such annual entitlement have been made to other contractors (the "Urban Contractors") or noncontractors in accordance with the provisions of this article. Such approval requirement shall apply to all contracts executed prior to January 1, 2011. KCWA shall be responsible for approval of such transfers for any portion of the 130,000 acre-feet not previously made available under this article by the other Agricultural Contractors. A contract between a willing buyer and a willing seller shall mean a contract between (1) a buyer which is an Urban Contractor or, to the extent provided in subdivision (e) of this article, a noncontractor and (2) a seller which is an Agricultural Contractor entitlements as well as transportation rights in accordance with the following terms and procedure:

(1) The Agricultural Contractor shall provide the State a copy of a bona fide contract or Proposed Contract (the "Proposed Contract") and the State shall, within five working days of receipt, provide copies of such Proposed Contract to all Urban Contractors together with a Notice of Proposed Contract stating the date on or before which a Notice of Intent to Exercise a Right of First Refusal (NOI) must be delivered to both the State and the seller, which date shall be 90 days from the date the State mails the Notice of Proposed Contract.

(2) The Proposed Contract shall provide for the transfer of rights in project transportation facilities sufficient to deliver to the seller's service area in any one month eleven percent (11%) of the annual entitlement being transferred or such greater amount as the seller determines to sell; *Provided*, however, that sellers shall not be obligated to sell any transportation rights in the Coastal Aqueduct.

(3) To exercise the right of first refusal, an Urban Contractor shall deliver to the State and the seller its NOI within the time period stated in the Notice of Proposed Contract and shall proceed in good faith to try to complete the transfer to the Urban Contractor. If two or more Urban Contractors deliver NOI's to the State, the amount of annual entitlement and transportation rights being sold shall be allocated among those Urban Contractors that are prepared to perform the purchase by the Performance Date provided for herein in proportion to their maximum annual entitlements, or in another manner acceptable to the Urban Contractors delivering the

(5) If an Urban Contractor issuing a NOI fails to complete its exercise of the Right of First Refusal by the Performance Date, the seller shall be free to sell its entitlement in substantial conformance with the terms and conditions set forth in the Proposed Contract . An Urban Contractor issuing a NOI may assign its rights to exercise a right of first refusal to another Urban Contractor and the assignee shall have the same rights as the assignor to complete the purchase by the Performance Date.

(6) In exercising the Right of First Refusal, an Urban Contractor, at its option, may either agree to perform the Proposed Contract in its entirety, including all of its terms and conditions, or agree to pay the price offered under the Proposed Contract for the annual entitlement and transportation rights without condition and without being entitled to enforce or being subject to any other provisions of the Proposed Contract.

(e) As used in this article, "price" shall mean the dollar amount of consideration provided for in the Proposed Contract.

(f) Upon the effective date of any such transfer, the seller shall be relieved of and the buyer shall become liable to the State for all prospective Delta Water Charges, the related Transportation Charges and any other charges for the annual entitlements and associated transportation rights transferred unless the seller and buyer provide otherwise in the contract for the transfer and the State approves such other provisions. However, the contractor making the sale shall remain obligated to the State to make the payments if the buyer defaults on its payments to the State related to the water transferred and is not a party to a long term water supply contract of the type contained in Department of Water impaired. The capital cost and minimum operation, maintenance, power and replacement components of the Transportation Charges shall then be reallocated among the other entities participating in repayment of costs of that reach. For the purposes of this determination, all payments received by the State from the seller relating to the annual entitlement sold shall be deemed to have been received from the buying contractor. Any increased Transportation minimum operation, maintenance, power and replacement component charges allocated to the buying contractor pursuant to this subdivision (g) shall begin January 1 of the year following the effective date of the transfer.

(h) Individual contractors may transfer entitlements among themselves in amounts in addition to those otherwise provided for in this article. The State shall expeditiously execute any necessary documents and approve all contracts involving permanent sales of entitlements among contractors, including permanent sales among Urban Contractors. Such sales shall be subject to the provisions of subdivisions (b), (f) and (g) of this article; *Provided*, however, that for a buying contractor needing transportation capacity in excess of the capacity factors on which its charges are based in any reach, reallocation of the Transportation capital cost component charges for transfers other than (i) the 130,000 acre-feet provided for in this article and (ii) the approximate 33,000 acre-feet of transfers proposed from contractors located in Santa Barbara or San Luis Obispo counties, shall be determined both prospectively and retroactively.

(i) On January 1 following the year in which such Monterey Amendments take effect and continuing every year thereafter until

25. Article 54 is added to read:

54. Usage of Lakes Castaic and Perris

(a) The State shall permit the contractors participating in repayment of the capital costs of Castaic Lake (Reach 30) and Lake Perris (Reach 28J) to withdraw water from their respective service connections in amounts in excess of deliveries approved pursuant to other provisions of the state water contracts. Each such contractor shall be permitted to withdraw up to a Maximum Allocation from the reach in which it is participating. The contractors participating in repayment of Castaic Lake may withdraw a collective Maximum Allocation up to 160,000 acre-feet pursuant to this article, which shall be apportioned among them pursuant to the respective proportionate use factors from the Department of Water Resources' Bulletin 132-94, Table B-1 upon which capital cost repayment obligations are based, as follows:

Castaic Lake

Participating Contractor	**Proportionate Use Factor**	**Maximum Allocation (Acre Feet)**
The Metropolitan Water District of Southern California	0.96212388	153,940
Ventura County Flood Control and Water Conservation District	0.00860328	1,376
Castaic Lake Water Agency	0.02927284	4,684
Total	1.00000000	160,000

delivery schedule at any time, and the modified schedule shall be subject to review in the same manner. If necessary, the State may modify the schedule after consultation with the contractor and other contractors participating in repayment of that reach but may not change the total quantity of water to be withdrawn. As part of the consultation, the State shall advise a contractor if it determines a withdrawal will adversely impact the rate of delivery provided for the contractor in this contract. The State shall not be responsible for any such impacts.

(c) A contractor may withdraw all or a portion of its Maximum Allocation. It shall restore any withdrawn portion of such allocation by furnishing an equivalent amount of replacement water to the reservoir from which the water was withdrawn within five years from the year in which the withdrawal takes place. The unused portion of the allocation, in addition to any replacement water furnished to the reservoir, shall remain available for subsequent withdrawal. The State shall keep an accounting of the contractor's storage withdrawals and replacements. In any year, the State shall permit a contractor to withdraw an amount equivalent to the contractor's Maximum Allocation minus remaining replacement water requirements due to previous withdrawals. If the contractor fails to schedule and replace the withdrawn water within the five-year return period, the State shall provide the replacement water from water scheduled for delivery to the contractor in the sixth year or as soon as possible thereafter. The total amount of scheduled annual entitlement which a contractor can use in any one year for restoring its Maximum Allocation and storing water in surface storage facilities

A contractor may use any of this total amount for replacement water but cannot use any more than that provided for in Article 56 to add to storage in project surface conservation facilities and in nonproject surface storage facilities. There shall be no limit under this article on the amount of scheduled annual entitlement a contractor can use to restore its Maximum Allocation in a year when its percentage of annual water supply allocation is one-hundred percent (100%), nor shall there be any limit under this article on the amount of interruptible water, nonproject water or water obtained through an exchange which a contractor can use to restore its Maximum Allocation.

(d) For any replacement water furnished to reservoir storage pursuant to this article, the responsible contractor shall pay the State charges for the conservation, if any, and transportation of such replacement water as are associated with the type of replacement water that is furnished, as if such water were delivered to the turnout at the reservoir to which the replacement water is furnished. Adjustments from estimated to actual costs shall be subject to provisions applicable to the type of replacement water. The State shall not charge contractors for water withdrawn pursuant to this article.

(e) The State shall operate capacity in Castaic and Perris Reservoirs, not required for purposes of Maximum Allocation deliveries, in compliance with the requirement of Article 17(b) of The Metropolitan Water District of Southern California's water supply contract with the State to maintain an amount of water reasonably sufficient to meet emergency requirements of the contractors participating in repayment of that reach. A

26. Article 55 is added to read:

55. Transportation of Nonproject Water

(a) Subject to the delivery priorities in Article 12(f), contractors shall have the right to receive services from any of the project transportation facilities to transport water procured by them from nonproject sources for delivery to their service areas and to interim storage outside their service areas for later transport and delivery to their service areas: *Provided*, that except to the extent such limitation in Section 12931 of the Water Code be changed, a contractor shall not use the project transportation facilities under this option to transport water the right to which was secured by the contractor through eminent domain unless such use be approved by the Legislature by concurrent resolution with the majority of the members elected to each house voting in favor thereof.

(b) For any nonproject water delivered pursuant to this article, contractors shall pay the State the same (including adjustments) for power resources (including on-aqueduct, off-aqueduct, and any other power) incurred in the conservation and transportation of such water as if such nonproject water were entitlement water, as well as all incremental operation, maintenance, and replacement costs, and any other incremental costs, which may include an administrative or contract preparation charge, all as determined by the State. Incremental costs shall mean those nonpower costs which would not be incurred if nonproject water were not scheduled for or delivered to contractors. Only those contractors not participating in the repayment of a reach shall be required to pay a use of facilities limits and in accordance with the provisions provided for in this subdivision (c) and any applicable water right laws, by setting forth on the preliminary water delivery schedule submitted to the State on or before October 1 of each year pursuant to Article 12(a) the quantity of project water it wishes to store in the next succeeding year. There shall be no limit on the amount of project water a contractor can store outside its service area during any year in a then existing and operational groundwater storage program. The amount of project water a contractor can add to storage in project surface conservation facilities and in nonproject surface storage facilities located outside the contractor's service area each year shall be limited to the lesser of the percent of the contractor's Table A annual entitlement shown in column 2 or the acre-feet shown in column 3 of the following table, depending on the State's final water supply allocation percentage as shown in column 1. However, there shall be no limit to storage in nonproject facilities in a year in which the State's final water supply allocation percentage is one hundred percent. These limits shall not apply to water stored pursuant to Article 12(e).

(2) Storage capacity in project surface conservation facilities at any time in excess of that needed for project operations shall be made available to requesting contractors for storage of project and nonproject water. If such storage requests exceed the available storage capacity, the available capacity shall be allocated among contractors requesting storage in proportion to their annual entitlements designated in their Table A's for that year. A contractor may store water in excess of its allocated share of capacity as long as capacity is available for such storage.

(3) If the State determines that a reallocation of excess storage capacity is needed as a result of project operations or because of the exercise of a contractor's storage right, the available capacity shall be reallocated among contractors requesting storage in proportion to their annual entitlements designated in their Table A's for that year. If such reallocation results in the need to displace water from the storage balance for any contractor or noncontractor, the water to be displaced shall be displaced in the following order of priority:

First, water, if any, stored for noncontractors.

Second, water stored for a contractor that previously was in excess of that contractor's allocation of storage capacity.

Third, water stored for a contractor that previously was within that contractor's allocated storage capacity.

The State shall give as much notice as feasible of a potential displacement.

point of return to the aqueduct to the turn-out in the contractor's service area. In addition, the contractor shall pay all incremental operation, maintenance, and replacement costs, and any other incremental costs, as determined by the State, which shall not include any administrative or contract preparation charge. Incremental costs shall mean those nonpower costs which would not be incurred if such water were scheduled for or delivered to the contractor's service area instead of to interim storage outside the service area. Only those contractors not participating in the repayment of a reach shall be required to pay a use of facilities charge for use of a reach for the delivery of water to, or return of water from, interim storage.

(7) A contractor electing to store project water in a nonproject facility within the service area of another contractor shall execute a contract with that other contractor prior to storing such water which shall be in conformity with this article and will include at least provisions concerning the point of delivery and the time and method for transporting such water.

(d) **Sale of Project Water For Use Outside Service Area**

(1) If in any year a contractor has been allocated annual entitlement that it will not use within its service area, the contractor has not elected to store project water in accordance with the provisions of subdivision (c) of this article during that year, and the contractor has not elected to carry over entitlement water from the prior year pursuant to the provisions of Article 12(e), the contractor may sell such annual entitlement for use outside its service area in accordance with the following provisions.

(4) Each year the price per acre-foot to be paid by the State to contractors selling water remaining in the Pool or placed in the Pool after February 15, but on or before March 15 that is purchased by a contractor requesting such purchase by April 1 or by the State on April 1 shall be equal to twenty-five percent (25%) of the Delta water rate as of that date. The price per acre-foot to be paid to the State for the purchase of water from the Pool by a contractor placing a request for such purchase between March 2 and April 1 shall be equal to twenty-five percent (25%) of the Delta water rate as of the later date. Any water placed in the Pool on or before March 15 that is not purchased by a contractor or the State by April 1 may be withdrawn from the Pool by the selling contractor.

(5) If there are more requests from contractors to purchase water from the Pool than the amount in the Pool, the water in the Pool shall be allocated among those contractors requesting such water in proportion to their annual entitlements for that year up to the amount of their requests. If requests to purchase water from the Pool total less than the amount of water in the Pool, the sale of Pool water shall be allocated among the contractors selling such water in proportion to their respective amounts of water in the Pool.

(6) Any water remaining in the Pool after April 1 that is not withdrawn by the selling contractor shall be offered by the State to contractors and noncontractors and sold to the highest bidder: *Provided*, that if the highest bidder is a noncontractor, all contractors shall be allowed fifteen days to exercise a right of first refusal to purchase such water at the price offered by

Article 12(e) for carrying over water from the last three months of that year into the first three months of the succeeding year.

(f) **Bona Fide Exchanges Permitted**

Nothing in this article shall be deemed to prevent the Agency from entering into bona fide exchanges of project water for use outside the Agency's service area with other parties for project water or nonproject water if the State consents to the use of the project water outside the Agency's service area. Also, nothing in this article shall be deemed to prevent the Agency from continuing those exchange or sale arrangements entered into prior to September 1, 1995, which had previously received any required State approvals. A "bona fide exchange" shall mean an exchange of water involving a contractor and another party where the primary consideration for one party furnishing water to another is the return of a substantially similar amount of water, after giving due consideration to the timing or other nonfinancial conditions of the return. Reasonable payment for costs incurred in effectuating the exchange and reasonable deductions from water delivered, based on expected storage or transportation losses may be made. A "bona fide exchange" shall not include a transfer of water from one contractor to another party involving a significant payment unrelated to costs incurred in effectuating the exchange. The State, in consultation with the contractors, shall have authority to determine whether transfers of water constitute "bona fide exchanges" within the meaning of this paragraph and not disguised sales.

October 1, 1996 date and the January 1, 2000 date may be extended by unanimous agreement of the State, Kern County Water Agency and The Metropolitan Water District of Southern California.

(b) The State shall administer the water supply contracts of any contractors that do not execute the Monterey Amendment so that such contractors are not affected adversely or to the extent feasible beneficially by the Monterey Amendments of other contractors' water supply contracts.

(c) If a court of competent jurisdiction issues a final judgment or order determining that any part of a contractor's Monterey Amendment is invalid or unenforceable, all provisions of that amendment shall be of no force or effect as to such contractor, except as provided in subdivisions (e) and (f) of this paragraph.

(d) If any part of the Monterey Amendment of the Kern County Water Agency's or The Metropolitan Water District of Southern California's contracts or if the conveyance of the Kern Fan Element of the Kern Water Bank to the Kern County Water Agency provided for in Article 52 is determined by a court of competent jurisdiction in a final judgment or order to be invalid or unenforceable, the Monterey Amendments of all contractors and the Kern Water Bank Contract shall be of no force and effect except as provided in subdivisions (e) and (f) of this paragraph.

(e) Notwithstanding subdivisions (c), (d) and (f) of this paragraph, if any part of the Monterey Amendment of the Kern County Water Agency's or The Metropolitan Water District of Southern California's contract is determined by a court of competent jurisdiction in a final judgment or order to be invalid

District of Southern California. In cases arising under subdivision (c) or (d), the affected contractor whose Monterey Amendment has been determined to be partially invalid or unenforceable must first request the waiver.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment on the date first above written.

Approved as to legal form
and sufficiency

Susan N. Weber
Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER
RESOURCES

Director

ATTEST:

Robert H. Clark
ASSISTANT SECRETARY

CASTAIC LAKE WATER AGENCY

GENERAL MANAGER

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 18 TO THE WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY

THIS AMENDMENT to the Water Supply Contract is made this 31st day of March, 1999, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, herein referred to as the "State," and Castaic Lake Water Agency, herein referred to as the "Agency."

RECITALS:

A. The State and the Agency have entered into and subsequently amended a Water Supply Contract (the "Water Supply Contract") providing that the State will supply certain quantities of water to the Agency, and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payment.

B. The contractors and the State have amended the Water Supply Contracts to implement provisions of the Monterey Agreement (the "Monterey Amendment").

C. Among other things, Article 53 of the Water Supply Contract provides for the permanent transfer of up to 130,000 acre-feet of agricultural entitlement water to urban agencies.

D. The Agency and the Wheeler Ridge-Maricopa Water Storage District have entered into an Agreement to Purchase Wheeler Ridge-Maricopa Water Storage District State Water Project Entitlement to Water executed as of this date to provide for the sale by Kern County Water Agency, herein referred to as "KCWA", on behalf of Wheeler Ridge-Maricopa to the Agency of 41,000 acre-feet per year of KCWA's annual entitlement that has been allocated to Wheeler Ridge-Maricopa by KCWA under the contract between Wheeler Ridge-Maricopa and KCWA dated January 8, 1970 and all amendments thereto.

E. The State and Agency wish to set forth their agreement as to such matters as (i) the 41,000 acre-feet per year increase in the Agency's annual entitlement, (ii) the transfer of related transportation repayment obligations, and (iii) the revision of proportionate use of facilities factors set forth in the Water Supply Contract.

F. The State and KCWA are simultaneously with the execution and delivery of this Amendment, entering into Amendment No. 28 to KCWA's Water Supply Contract between KCWA and the State in order to reflect (i) the transfer of Table A Entitlement described herein, (ii) the transfer of related transportation repayment obligations, and (iii) the revision of proportionate use of facilities factors.

G. This Amendment is permitted by the terms of the Water Supply Contract, and except as amended herein, the provisions of the Water Supply Contract will remain in full force and effect.

NOW, THEREFORE, it is mutually agreed that the following changes are hereby made to the Agency's Water Supply Contract:

1. Article 53(j) is added to read:

(j) In accordance with Article 53(a) the Agency is increasing its Table A annual entitlements by 41,000 acre-feet beginning in year 2000 and each succeeding year thereafter for the term of the contract through a sale from Kern County Water Agency of 41,000 acre-feet of the 130,000 acre-feet made available to Urban Contractors. As a result of this sale, Table A as designated in Article 6(b) is amended as follows:

TABLE A

ANNUAL ENTITLEMENTS
CASTAIC LAKE WATER AGENCY
(Acre-feet)

Year		
1	(1968)	3,700
2	(1969)	5,000
3	(1970)	5,700
4	(1971)	6,700
5	(1972)	8,936
6	(1973)	12,400
7	(1974)	15,400
8	(1975)	18,200
9	(1976)	21,200
10	(1977)	24,100
11	(1978)	24,762
12	(1979)	28,000
13	(1980)	30,400
14	(1981)	32,800
15	(1982)	34,800
16	(1983)	37,300
17	(1984)	39,600
18	(1985)	41,800
19	(1986)	43,600
20	(1987)	45,600
21	(1988)	48,000
22	(1989)	50,100
23	(1990)	52,000
24	(1991)	54,200
25	(1992)	54,200
26	(1993)	54,200
27	(1994)	54,200
28	(1995)	54,200
29	(1996)	54,200
30	(1997)	54,200
31	(1998)	54,200
32	(1999)	54,200
~~33~~	~~(2000)~~	~~54,200~~
33	(2000)	95,200
And each succeeding year thereafter, for the term of this contract as an annual entitlement:		~~54,200~~ 95,200

The following apply to this sale:

(1) Increases in the Agency's Delta Water and Transportation Charges and Water System Revenue Bond Surcharge resulting from the increase in the Agency's annual entitlements for 2000 and each year thereafter shall commence January 1, 2000, and be identified by the State and included in its annual Statement of Charges to the Agency.

(2) All future adjustments in charges and credits of past costs associated with the 41,000 acre-feet of annual entitlement (or applicable portion thereof) and the related transportation capacity in Reaches 1 through 16A of the California Aqueduct shall be attributable to the Agency as if the Agency's annual entitlement and the related transportation capacity had been increased by the 41,000 acre-feet of annual entitlement purchased from the KCWA in years prior to January 1, 2000.

(3) For cost allocation and repayment purposes, Exhibit A attached hereto shows entitlement and capacity amounts for each aqueduct reach in which the Agency participates. These redetermined values shall be used to derive the proportionate use of facilities factors as set forth in Table B as designated in Article 24(b). The capacity amounts shown in Exhibit A are estimated values. Actual values will be used by the State in implementing the terms of this Amendment and in redetermination of Table B of this Water Supply Contract under Article 28.

Article 12(c)(1) which defines the limits on the instantaneous rate of flow to the Agency from Castaic Lake based on peaking factors, is modified to delete "ninety-nine (99)" and replace it with "one hundred fifty (150)."

3. This Amendment is contingent upon the effectiveness of Water Supply Contract Amendment No. 28, between the State and the KCWA. If either amendment ceases to be effective, the State may identify the date on which the contract amendments shall be deemed inoperative, for the purpose of assuring timely repayment of contract obligations and orderly administration of the long-term water supply contracts.

4. The Agency agrees to indemnify, defend, and hold harmless the State and any of its officers, agents, or employees from any liability, expenses, defense costs, attorney fees, claims, actions, liens and lawsuits of any kind arising from or related to any and all actions implementing this Amendment and associated agreements.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment on the date first above written.

Approved as to legal form
and sufficiency:

for Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Stephen J. Kashiwada
for Director

CASTAIC LAKE WATER AGENCY

ATTEST:

Robert H. Clark
Signature

Ass't Secretary
Title

Signature

President, Board of Directors
Title

AMENDMENT NO. 18
EXHIBIT A

CASTAIC LAKE WATER AGENCY
ANNUAL ENTITLEMENT AND CAPACITY VALUES FOR EACH REACH FOR COST ALLOCATION AND REPAYMENT ONLY

The values related to this transfer are estimated to be as follows:

California Aqueduct[1]	Before Transfer		Entitlement Transferred from KCWA (AF) (3)	Capacity Transferred from KCWA (cfs) (4)	Additional Capacity Required (cfs) (5)	After Transfer	
	Annual Entitlement (AF) (1)	Capacity (cfs) (2)				Total Annual Entitlement (AF) (6)	Total Capacity (2)+(4)+(5) (cfs) (7)
Reach 1	54,200	95	41,000	122	0	95,200	217
Reach 2A	54,200	95	41,000	122	0	95,200	217
Reach 2B	54,200	95	41,000	122	0	95,200	217
Reach 3	54,200	95	41,000	122	0	95,200	217
Reach 4	54,200	95	41,000	122	0	95,200	217
Reach 5	54,200	95	41,000	122	0	95,200	217
Reach 6	54,200	95	41,000	122	0	95,200	217
Reach 7	54,200	95	41,000	122	0	95,200	217
Reach 8C	54,200	95	41,000	122	0	95,200	217
Reach 8D	54,200	95	41,000	122	0	95,200	217
Reach 9	54,200	75	41,000	122	0	95,200	197
Reach 10A	54,200	75	41,000	122	0	95,200	197
Reach 11B	54,200	75	41,000	122	0	95,200	197
Reach 12D	54,200	75	41,000	122	0	95,200	197
Reach 12E	54,200	75	41,000	122	0	95,200	197
Reach 13B	54,200	75	41,000	122	0	95,200	197
Reach 14A	54,200	75	41,000	120	0	95,200	195
Reach 14B	54,200	75	41,000	77	0	95,200	152
Reach 14C	54,200	75	41,000	46	11	95,200	132
Reach 15A	54,200	75	41,000	39	18	95,200	132
Reach 16A	54,200	75	41,000	25	32	95,200	132
Reach 17E	54,200	75	41,000	0	57	95,200	132
Reach 17F	54,200	75	41,000	0	57	95,200	132
West Branch							
Reach 29A	54,200	75	41,000	0	57	95,200	132
Reach 29F	54,200	75	41,000	0	57	95,200	132
Reach 29G	54,200	75	41,000	0	57	95,200	132
Reach 29H /2/	54,200	--	41,000	0	--	95,200	--
Reach 29J	54,200	75	41,000	0	57	95,200	132
Reach 30 /2/	54,200	--	41,000	0	--	95,200	--

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[1] These numbers apply to the reaches as set forth in Bulletin 132, Figure B-4, "Repayment Reaches and Descriptions."

[2] Aqueduct capacity in cfs is not applicable to Pyramid Lake (Reach 29H) and Castaic Lake (Reach 30). The maximum instantaneous flow rate for deliveries to the Agency from Castaic Lake is 150 cfs.

Valencia Water Company Water Management Program
Approved November 29, 2001,
and Related CPUC Decisions

VALENCIA WATER COMPANY

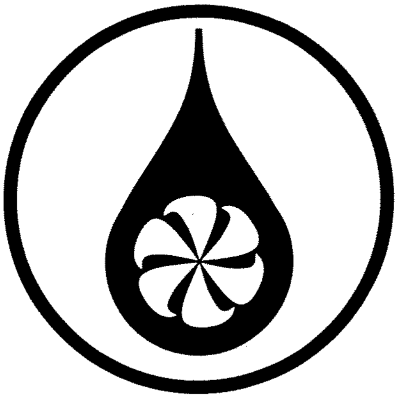
WATER MANAGEMENT PROGRAM

DECEMBER 16, 1999

Revised April 10, 2000
Further Revised May 14, 2001

Approved by Commission Nov. 29, 2001
(D.01-11-048)

Valencia Water Company



VALENCIA WATER COMPANY

WATER MANAGEMENT PROGRAM

DECEMBER 16, 1999

Revised April 10, 2000
Further Revised May 14, 2001

Approved by Commission Nov. 29, 2001
(D.01-11-048)

VALENCIA WATER COMPANY
WATER MANAGEMENT PROGRAM

At the direction of the Public Utilities Commission, Valencia Water Company filed Application 99-12-025 for Commission approval of an updated Water Management Program on December 14, 1999. The Water Management Program submitted on that date, which was later admitted into evidence in Application 99-12-025 as Exhibit 3, is provided under Tab A.

On April 10, 2000, Valencia Water Company served its prepared direct testimony in Application 99-12-025. The prepared direct testimony of Robert J. DiPrimio, President of Valencia, which was later admitted into evidence in Application 99-12-025 as Exhibit 1, included a review of recent water supply and demand information and revised Table III-1 and Figure III-2 of the Water Management Program to reflect the latest information as of that date. The updated Table III-1 and Figure III-2, as attached to Mr. DiPrimio's prepared direct testimony, are provided under Tab B.

On May 14, 2001, at the direction of the presiding Administrative Law Judge in Application 99-12-025, Valencia Water Company updated its Water Management Program through testimony and by submitting a further revision of Figure III-2. The revision of Figure III-2 was later admitted into evidence in Application 99-12-025 as Exhibit 51. This most recent update of Figure III-2 is provided under Tab C.

VALENCIA WATER COMPANY

WATER MANAGEMENT PROGRAM

DECEMBER 16, 1999

VALENCIA WATER COMPANY

WATER MANAGEMENT PROGRAM

DECEMBER 16, 1999

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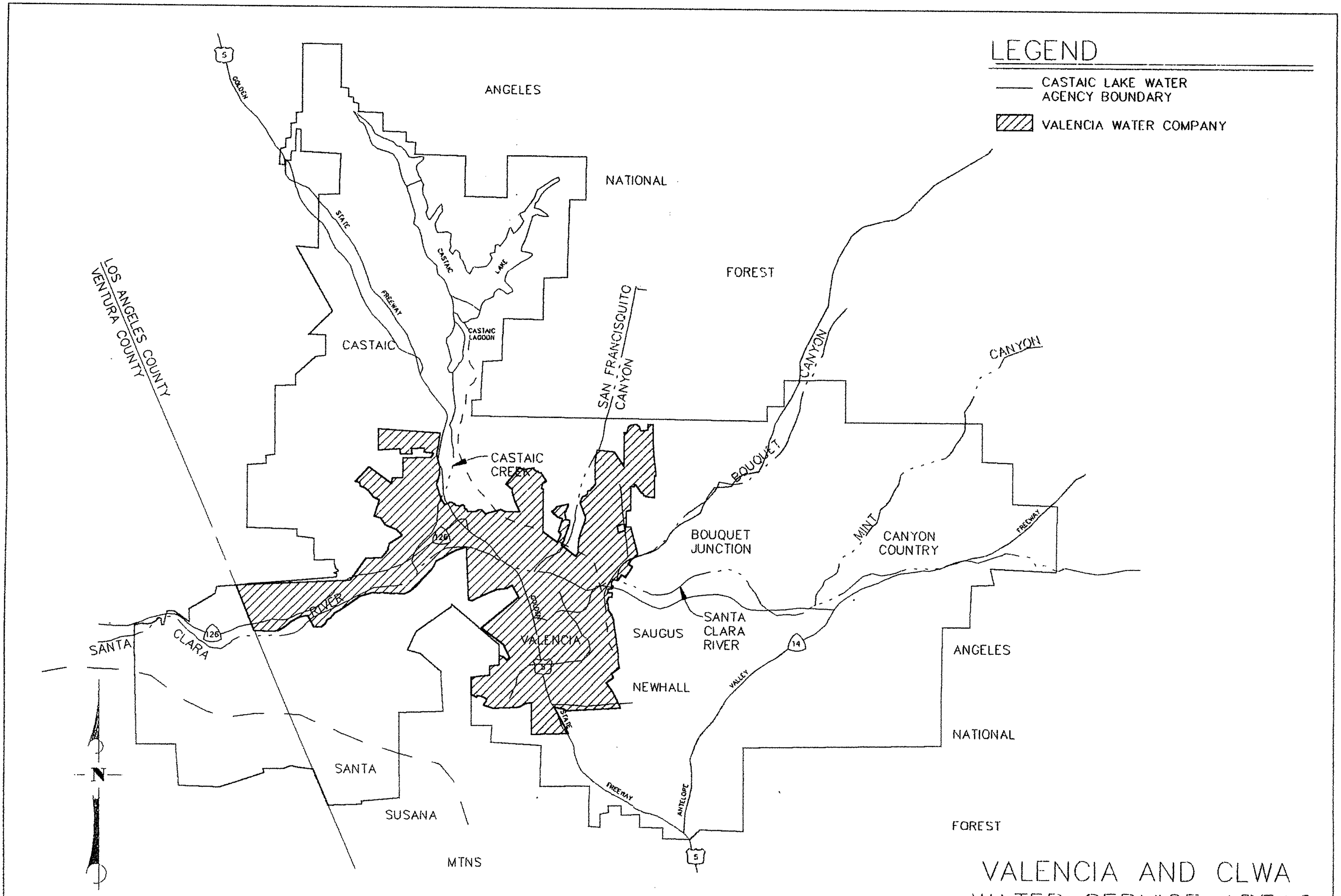
NARRATIVE DESCRIPTION OF UTILITY AND SERVICE AREA

I.a) GEOGRAPHICAL LOCATION

Valencia Water Company is located in the Santa Clarita Valley (Valley) which is in the northern portion of Los Angeles County. For most residents of the Valley, domestic water service is provided by four retail water purveyors. They are Los Angeles County Waterworks District 36, Newhall County Water District, Santa Clarita Water Company and Valencia Water Company (Valencia). The Castaic Lake Water Agency (CLWA) is a wholesaler that obtains water from California's State Water Project. CLWA also provides retail water service as a result of its recent acquisition of the Santa Clarita Water Company in September, 1999. The service areas of Valencia and CLWA are shown on Figure I-1.

The Valley is an irregular shaped area of approximately 500 square miles and lies approximately 35 miles northwest of downtown Los Angeles. Rolling hills, mountains, and alluvial valleys constitute the major physical features of the Valley. The largest of the alluvial valley areas is along the main stem of the Santa Clara River which traverses the region in an east-west direction. Additional significant valley areas are the South Fork of the Santa Clara River in the Newhall-Saugus-Valencia area, the Castaic Valley, San Francisquito Canyon, and Bouquet Canyon. Smaller alluvial valleys occur along several other canyons. Elevations range from approximately 800 feet above sea level at the downstream (westerly) end of the region to a maximum of approximately 3,100 feet above sea level.



SCALE: 1"=16,500'

VALENCIA AND CLWA WATER SERVICE AREAS

FIGURE I–1

I.b) CUSTOMER DESCRIPTION

The service area of Valencia is developed to include a mix of residential and commercial land uses, mostly comprised of single family homes, apartments, condominiums and a number of local shopping centers and neighborhood commercial developments. The City of Santa Clarita and Los Angeles County are the largest overall water users for irrigation purposes. Magic Mountain Amusement Park is the largest individual commercial user. The service area also includes two golf courses, the Valencia Industrial Center and the Valencia Commerce Center. Heavy industry is non-existent and light industry can be classified as service oriented with light manufacturing/assembly endeavors. All services are metered, with the exception of fire services.

I.c) PLANNED SYSTEM IMPROVEMENTS WHICH WILL AFFECT SUPPLY

Valencia plans improvements to its water system incrementally as demand for water service increases. Improvements are made based upon reliably meeting customer water demands, compliance with applicable PUC rules and regulations governing service, providing operational flexibility during periods of drought and peak summer usage, and meeting Los Angeles County fire flow requirements.

The principal system improvements for imported water and recycled water are planned and constructed by CLWA. CLWA has in place a Capital Improvement Program that will permit it to provide additional facilities as they become necessary. This program is funded primarily by new connection fees and is, therefore, not a burden on existing customers. CLWA's capital program is discussed in more detail in Section III.a). Additionally, CLWA has developed its *draft Integrated Water Resources Plan Water Demand and Supply Evaluation (IWRP)* (1998). This document presents the results of an evaluation of future water supply needs in the service area of CLWA and serves as a principal planning document for its Capital Improvement Program.

In 1993, CLWA prepared a draft *Reclaimed Water System Master Plan* that outlined a multi-phase program to deliver recycled water in the Valley. CLWA has completed environmental review and is constructing phase I of the project which will deliver approximately 1,700 acre-feet of recycled water. Overall, the program is expected to reclaim up to 10,000 acre-feet of highly treated (tertiary) wastewater suitable for reuse on golf courses, landscaping and other non-potable uses. Valencia encourages the use of recycled water as an important program to maximize current supplies in meeting overall water needs for the Valley.

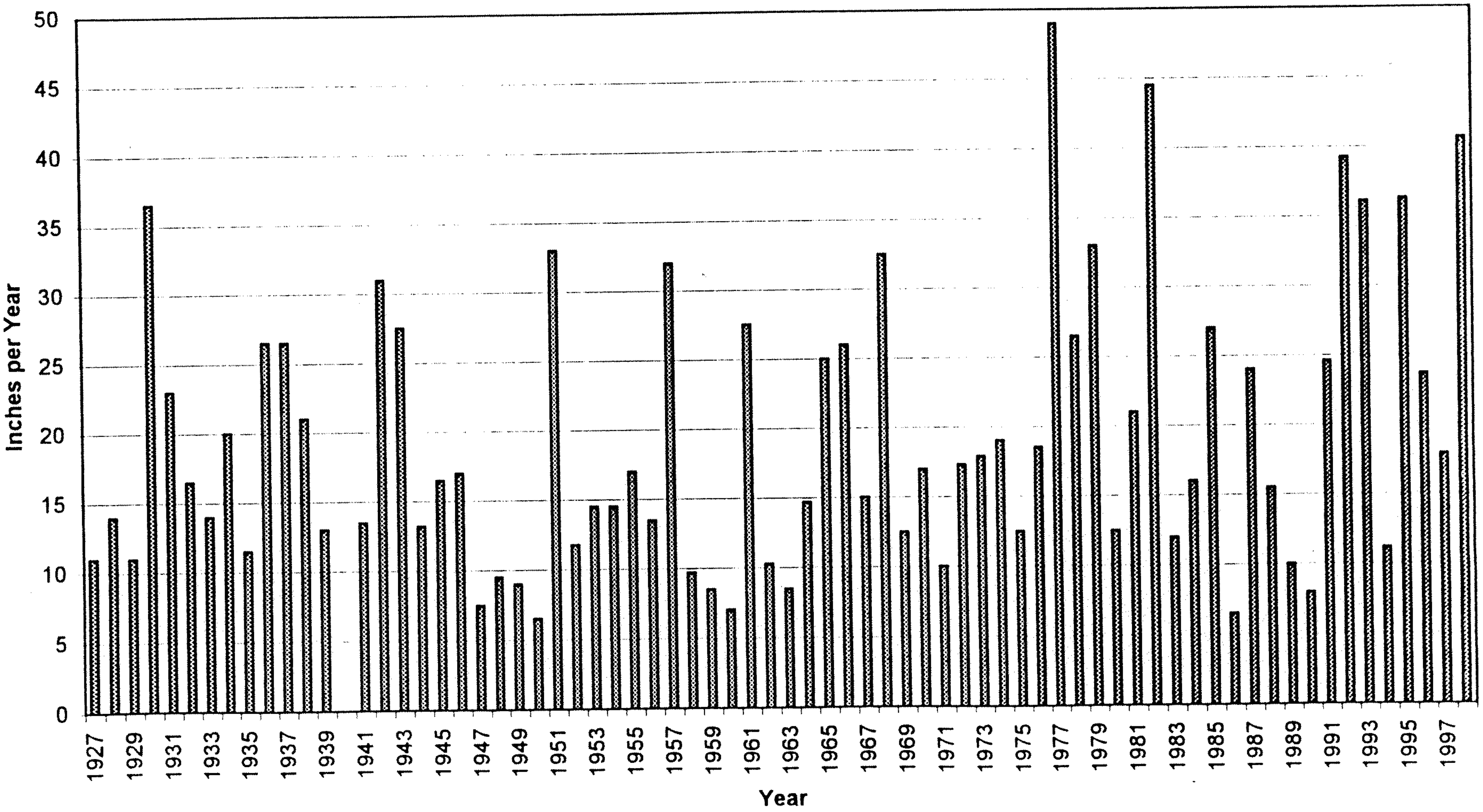
I.d) EFFECTS OF DROUGHT ON SYSTEM

Droughts have occurred locally in 1947-50, 1958-60 and 1990-91. Recent statewide droughts have occurred in 1976-77 and 1987-91. The rainfall data in Figure I-2 graphically illustrates the time periods with low rainfall. Since the area's water supplies are dependent upon rainfall conditions both locally and statewide, it is important to note that wet and dry year conditions do not always occur at the same time in Northern and Southern California. As a result, Valencia and the other Valley water purveyors can adjust the mix of available water resources on a year-to-year basis in response to local and statewide hydrologic conditions.

Prior to the 1990-1991 drought, there was minimal impact on the Santa Clarita Valley other than requiring additional well production to compensate for the lack of spring rainfall for crops, lawns and gardens. It was not until 1990-1991 that the state-wide drought impacted the water supply in the Santa Clarita Valley. The drought caused cutbacks in imported water supply. Water production declined in some alluvial wells operating in the shallow, outlying reaches of the aquifer. However, because Valencia's alluvial wells are located in the major water bearing reaches of the aquifer, none of Valencia's alluvial wells experienced loss of production during this time.

In addition to its alluvial groundwater supply, Valencia pumped water from the Saugus Formation, and along with requesting customers to voluntarily conserve 10 percent,

Santa Clarita Valley
Annual Rainfall
Figure I-2



customer water demands were met for the duration of the drought. CLWA elected not to participate in the state's Drought Water Bank because alternate local supplies were available to meet Valley water demands. Members of the Upper Santa Clara Valley Water Committee (which includes Valencia, CLWA, Los Angeles County Waterworks District 36, Newhall County Water District, and Santa Clarita Water Company) signed a Drought Emergency Water Sharing Agreement, agreeing to share water from all sources and to facilitate beneficial water transfers, exchanges and wheeling arrangements. Also, the Committee worked with the City of Santa Clarita and the County of Los Angeles to implement water use ordinances for Valley residences, review water consumption and supply data, and recommend measures to encourage conservation.

Since the 1990-91 drought, Valencia, CLWA and the other water purveyors have continued to work cooperatively to ensure customer demands are met under varying hydrologic conditions and with overall increasing demands from planned growth. These efforts have included water resource planning activities, acquisition of new water supplies and construction of transmission and treatment facilities. These activities are reported in Section III of this report.

I.e) VALENCIA WATER COMPANY SERVICE AREA

Figure I-1 shows the existing boundaries of Valencia's service area, as well as the service area of CLWA.

I.f) VALLEY PRECIPITATION

The Valley is characterized as having a Mediterranean climate. Winter temperatures are slightly lower and summer temperatures slightly higher than in coastal areas. Temperatures range from maximums near 110°F during the summer months to minimums near 20°F during the winter. Typically, dry years are followed by wet years in a cyclical pattern. The ten-year average annual precipitation (1988-1998) for the valley is 24 inches. Figure I-2 shows the annual historical rainfall in the Valley. As this graph shows, there have been 12 years with precipitation above 30 inches, and ten years when precipitation has fallen below 10 inches.

SECTION II

PREVIOUS WATER MANAGEMENT PROGRAM

II.a) ACCOMPLISHMENTS OF PREVIOUS CONSERVATION PROGRAMS

CLWA, working in cooperation with the retail water purveyors, has implemented most of the conservation efforts in the Valley over the last five years. Valencia supports these conservation efforts indirectly through the water rates paid to CLWA for purchased water.

Customer Bills

Valencia provides all metered customers with historical usage on their monthly billing statements. This allows customers to compare their water usage with the same period of the prior year, and to monitor their water usage over time. Additionally, each monthly bill includes brief messages promoting conservation, such as "Use Water Wisely". This program has been very effective because it reaches such a large percentage of Valencia's customers, and because of the fact that customers are reminded on a monthly basis about their usage and about the importance of conservation.

Conservation Water Kit Program

This program targets older homes in the Valley which were constructed prior to enactment of ordinances requiring low-flow toilets and showers. The kits are available in Valencia's lobby for customers to take, and are distributed through the mail upon request from customers. The kits contain toilet displacement bags, shower flow restrictors and leak detection tablets. The program has resulted in water savings as well as a heightened awareness of conservation activities.

Education of Residential Customers

The goal of this program is to instill a water conservation ethic in students. The education program is sponsored by CLWA, and has been extremely successful during the last five years. The program includes distribution of education packets and giveaways featuring conservation messages to students. This program is ongoing and is described in more detail in Section IV.a) CLWA Conservation Programs. This program reaches approximately 6,000 students, grades kindergarten through sixth, every year.

Landscape Brochure Distribution

The goal of this program has been to educate the public about landscapes which are best adapted to the Mediterranean climate of the Valley. The original program discussed in the previous Water Management Program has been expanded to include multiple brochures on landscape education. The landscape brochure distribution program now works in conjunction with the Landscape Education Program which is described in more detail in Section IV.a) CLWA Conservation Programs.

Information to Residential Customers

Public information to customers involves promoting water conservation through public information programs which include newspaper articles, radio, direct mail, brochures, newsletters, web sites, and public events. CLWA has used all of these means to successfully promote conservation during the last five years, and continues to do so. These measures are described in more detail in Section IV.a) CLWA Conservation Programs.

II.b) 1995 WATER MANAGEMENT PLAN

The 1995 WMP reports regional water supply information, which shows the minimum and maximum water supply available in the Valley of 102,260 acre-feet and 110,800 acre-feet, respectively. This represents the area's water supply over a range of operational and hydrologic conditions.

The 1995 WMP reports the on-going planning efforts of Valencia, CLWA and the other local retail water purveyors which to date, have yielded significant improvements to the Valley's water supply capacity and Valencia's ability to deliver from multiple sources of water within its service area. The sources of water identified in the report are 1) Santa Clara Alluvial Aquifer, 2) Saugus Formation, 3) imported water from the State Water Project, and 4) recycled water.

Valencia's 1995 WMP concluded that sufficient supply was available to meet projected water demands for the foreseeable future. Water demand projections were normalized from actual Valencia customer data using the PUC's approved statistical method and reasonable assumptions for customer growth. As illustrated in Table II-1, the water demand forecasted in the 1995 WMP has closely matched actual recorded water demands over the last five years. Accordingly, Valencia believes its planning assumptions and methods used to forecast water demands are reasonable and appropriate for use in calculating projected water demands in the updated WMP.

TABLE II-1
1995 Water Management Program
Projected vs. Actual Demands
(Acre-Feet)

	1995	2000
Projected in 1995 WMP	18,000	22,065
Actual 1995	17,641	-
Latest Projection for 2000	-	23,088

It is important to note that the 1995 WMP recognized that imported water from the State Water Project is subject to reduction during droughts. Several water supply programs were identified to overcome temporary water supply shortfalls in the future, should a reduction occur. The programs identified were acquisition of additional State Water Project supply, short and long term water transfers, water conservation and public information, regional and local conjunctive use of groundwater and imported water supplies and water reclamation.

SECTION III

WATER SOURCES AND SUPPLY OUTLOOK

III.a) INTRODUCTION

This section describes the water supplies available to Valencia and illustrates how they are used when meeting existing and projected water demands. Historically, local groundwater pumped from the Alluvial Aquifer and Saugus Formation were the primary sources of water in the Santa Clarita Valley. In 1980, CLWA began delivering imported water from the State Water Project to the four retail water purveyors in the Valley. CLWA and these four entities meet regularly as the Upper Santa Clara Valley Water Committee (Committee) to coordinate the beneficial use of water in the Valley.

Since being formed in 1967, the Committee has hired consultants to conduct technical studies and coordinate water management activities that have formed the basis of the knowledge and understanding of the Valley's water resources. Ultimately, these efforts have resulted in delivery of reliable and high quality water service for Valley customers while developing coordinated resource protection strategies for its continued use.

It should be noted that the groundwater basin in the Valley is unadjudicated. Therefore, neither Valencia nor the other purveyors have "water rights", as would be the case in an adjudicated basin, that dictate their water supply. The total supply available to all purveyors in the basin and the ability of Valencia to access those supplies determines the amount available to Valencia to meet its long-term supply needs. The imported water supply is allocated to water service areas established by CLWA allowing water to be delivered to these service areas when needed. It is based upon the collection of connection fees paid by new development and allocated to water service areas to fund CLWA's capital program. Generally, however, the imported water supply is delivered on a first come, first serve basis.

Therefore, in order to assess Valencia's capacity to deliver water to existing customers as well as meet planned future developments, this WMP will present information about the **total supply** available not only to Valencia, but to the other three retail purveyors as well. This **regional** perspective is appropriate and consistent with the previous WMPs submitted by Valencia to the PUC. It also reflects Valencia's opinion that its water supplies are dependent upon the **total supply** available **and** Valencia's capacity to access and deliver those supplies to its customers.

Reference Documents

The following reference documents were used by Valencia to complete and update its WMP:

1) *1995 Water Management Program* prepared by Valencia Water Company. This report was approved by the PUC during Valencia's last general rate case (Decision No. 94-12-020).

2) *1998 Santa Clarita Valley Water Report* prepared by the Upper Santa Clara Valley Water Committee, dated February, 1999. This report was requested by the Los Angeles County Board of Supervisors and provides factual information about the current water resources within the Santa Clarita Valley. Updated annually, this report is intended to provide timely and accurate information about both water supply and demand conditions within the Santa Clarita Valley.

3) *Castaic Lake Water Agency Draft Integrated Water Resources Plan Water Demand and Supply Evaluation (IWRP)* (1998). This document presents the results of an evaluation of future water supply needs in the service area of Castaic Lake Water Agency.

Description of Water Resources

The WMP identifies six basic water resources available to Valencia. They are: groundwater, imported water supplied by CLWA, recycled water, firming water (i.e.: State's Drought Water Bank, acquiring additional SWP entitlement, and local supply augmentation), conjunctive use programs, and conservation. The WMP emphasizes developing water supplies that increase the diversity of supply available to Valencia.

Diversity of supply is considered a key element of reliability, giving Valencia the ability to draw upon multiple sources of supply during future dry years.

1) Alluvial Aquifer: The Alluvial Aquifer has historically been the main source of water within the region prior to importation of water from the State Water Project. In 1998, the local purveyors operated 35 wells and produced approximately 24,000 acre-feet of water from this aquifer for domestic consumption. Based on information from the *1998 Water Report* and *IWRP*, the aquifer has an adopted perennial yield of 32,500 acre-feet per year. Current operating results indicate the aquifer is in good operating condition. An excerpt from the *1998 Water Report (page 6)* describes how the aquifer is managed:

> *The current management practice of the Committee is to maximize use of the Alluvial Aquifer because of the aquifer's ability to store and produce good quality water on an annual basis. During times of average and wet precipitation, the amount of water pumped from the Alluvial Aquifer can exceed the perennial yield without consequence. However, during prolonged dry periods, exceeding the perennial yield may stress the aquifer by temporarily lowering water levels. Historical groundwater data collected from the Alluvial Aquifer over many hydrologic cycles provides assurance that groundwater elevations return to normal in average to wet years following periods of abnormally low rainfall.*

The *1998 Water Report* and *IWRP* indicate that during wet periods, production from the Alluvial Aquifer can be as much as 40,000 acre-feet per year (CLWA draft *IWRP* page 5-2). The *IWRP* suggests that sound basin management considers additional pumping when the aquifer is full (i.e., groundwater elevations are high) to create storage space so that capture of local runoff is increased.

Valencia currently operates 18 wells in the Alluvial Aquifer and has an operational production capacity of approximately 19,700 gallons per minute to meet average day and maximum day demands.

2) Saugus Formation: The second source of groundwater production in the Valley is the Saugus Formation. The areal extent of the Saugus Formation is approximately 85 square miles. It is a very important source of supply because it underlies the Alluvial Aquifer and is estimated to contain approximately 1.4 million acre-feet of water in storage, which is about seven times more than the amount found in the Alluvial Aquifer. This quantity of water in storage provides Valley purveyors with a large underground reservoir capable of providing the local purveyors with a reliable annual supply as well as a dry year supply when needed.

   The Saugus Formation has not been fully developed but available information reported in the *1998 Water Report* and CLWA's *IWRP* indicates that recharge ranges between 11,000-13,000 acre-feet in dry years and 20,000-22,000 acre-feet in wet years. It is believed that the Saugus Formation could produce up to 40,000 acre-feet or more of groundwater per year. This increased level is assumed to be limited to dry years (short term) when importation of water is reduced. The Saugus Formation is currently full and maintaining the substantial volume of water in storage is an important strategy to help "drought proof" water supplies in the Valley.

   At the present time, there are 12 Saugus wells operated by the purveyors with a current operational production capacity of approximately 23,000 acre-feet per year. This basin capacity excludes three existing wells that are temporarily out of service due to the detection of ammonium perchlorate. The detection of this contaminant is localized to those three wells and the on-going remedial activities of the Committee are further discussed on page 12 of the *1998 Water Report*.

Valencia currently operates 5 wells in the Saugus Formation and has an operational production capacity of approximately 10,000 gallons per minute to meet average day and maximum day demands.

3) Imported Water: The State Water Project (SWP) began in the early 1960s when public agencies (SWP Contractors) throughout the State of California each executed an individual water supply contract with the Department of Water Resources (DWR) that became the ways and means for the construction and operation of SWP facilities designed to deliver water to the Contractors. Each such contract sets forth a maximum annual entitlement called the "Table A Entitlement." A SWP Contractor may annually request that DWR deliver water in the following year in any amount up to the Contractor's Table A Entitlement. The SWP contracts provide that in a year when DWR is unable to deliver the full amount of contractor requests, deliveries will be allocated according to the Table A entitlements of each contractor. Some Contractors (including CLWA) have never requested delivery of their full annual entitlement because lower growth, other water supplies, and water conservation efforts have held their demand for SWP water below these projections. Other Contractors order their full Table A entitlements nearly every year.

   CLWA is the SWP contractor or wholesaler of imported water in the Valley. CLWA operates two water treatment plants capable of producing 55 million gallons of water per day. Both plants are designed to be expanded as water demands increase. From the plants, treated water is delivered by gravity to each of the four purveyors through a distribution network of pipelines and turnouts.

   CLWA has an SWP Table A entitlement of 95,200 acre-feet per year. The SWP is not complete and supplies are subject to reduction when state-wide droughts occur. As a result, CLWA and the local retail purveyors have worked together to plan and develop operational strategies to augment the Valley's water supply when imported water is reduced. A discussion of alternate or "firming water" supplies is described later in this section of the report. An expanded discussion of alternative water supplies available to Valencia and the other water companies is presented in Section 4 of CLWA's *IWRP*.

It is important to note that CLWA funds a $500 million capital improvement program by collecting connection fees from new developments, which are set by the CLWA Board of Directors and periodically adjusted for changes in the program and estimated costs. The program is designed to fund a wide array of projects deemed necessary by CLWA to meet the water needs for planned developments identified in the general plans of the City of Santa Clarita and the Counties of Los Angeles and Ventura. The program includes construction of facilities for the treatment, storage, and transmission of water as well as acquisition of additional water supplies.

CLWA's Capital Improvement Program has been developed to fulfill its stated mission, which is to provide reliable, quality water at a reasonable cost. Several of the projects are designed to provide, when needed, additional facilities and/or water supplies increasing the dependability of SWP supply. The program's implementation has firmed-up SWP supply in the form of additional water supplies in the earlier years, followed by development of water banking, storage, and conjunctive use in later years. Facilities and water supplies are added on an incremental basis and at least 3 to 5 years ahead of need to ensure infrastructure keeps pace with planned development.

Valencia currently operates 6 connections (Turnouts) with CLWA and has an operational production capacity of approximately 31,500 gallons per minute to meet average day and maximum day demands.

4) Recycled Water: CLWA has developed a master plan for delivering highly treated recycled water in the Valley. Recycled water is available from two existing water reclamation plants operated by the County Sanitation Districts of Los Angeles County. CLWA is constructing phase I of the project which will

deliver up to 1,700 acre-feet of water for non-potable use. Valencia encourages the use of recycled water as an important program to maximize current supplies in meeting overall water needs for the Valley.

5) Firming Water: Firming water supplies are defined as alternate short term supplies (1 to 3 years) made available to the local purveyors to be used when imported water is reduced during drought conditions. For purposes of Valencia's WMP, three firming supply options are included in this report. They are: 1) acquiring additional SWP entitlement, 2) the Drought Water Bank, operated by the State of California, and 3) local supply augmentation.

   In 1999, CLWA acquired 41,000 acre-feet of SWP Table A Entitlement (via a permanent transfer) from Kern County Water Agency and its member unit the Wheeler Ridge-Maricopa Water Storage District. This transfer was completed under the terms of the Monterey Agreement, in which agricultural SWP Contractors agreed, on a willing seller willing buyer basis, to make available 130,000 acre-feet of entitlement for permanent transfer to urban SWP Contractors. By this permanent transfer, CLWA SWP Table A Entitlement is 95,200 acre-feet per year. In CLWA's *IWRP*, additional imported water was identified as one component of an overall plan to increase the reliability and availability of water within its service area. For the foreseeable future, this transfer increases their total supply while providing a significant "drought buffer" even in times of shortage.

   The State Drought Water Bank is implemented as needed by an executive order of the Governor or a finding by DWR's Director that water deliveries will be curtailed. The purpose of the Bank is to help California's urban, agricultural and environmental interests meet their water supply needs during water short years. This procedure was used successfully in 1991, 1992 and 1994 when DWR purchased water from willing sellers and sold the water to willing buyers under a set of allocation guidelines. Although CLWA's allocation of imported water was reduced in 1991, it did not participate in the Drought Water Bank program because other alternate supplies were available to meet Valley water demands. For purposes of planning, CLWA's *IWRP* identified short-term deliveries of 20,000 acre-feet or more of water purchased from the state's Drought Water Bank in dry years if needed, to augment the Valley's water supplies.

It is important to note that there are several other state programs in place that CLWA can utilize to "firm up" SWP supplies when they are reduced. A partial listing of programs includes the Supplemental Water Purchase Program, the Interruptible Water Service Program and the SWP Turn-back Pool. These programs are discussed in detail in Section 3, page 3-16 of CLWA's *IWRP*. In summary, these programs provide substantial opportunity for CLWA to increase its water supply and effectively implement water management activities to enhance supply reliability.

Local supply augmentation includes demand management programs (voluntary and mandatory rationing programs) and conjunctive use of stored local groundwater. For planning purposes, the WMP assumes that Valencia customers could voluntarily conserve 10 percent from their normal usage. This is reasonable since Valencia customers, during the last drought in 1991, voluntarily conserved over 20 percent.

As discussed in item 2 above, the Saugus Formation could produce up to 40,000 acre-feet of water per year. This assumes approximately 30,000 acre-feet of water could be withdrawn on a short term basis from the Saugus Formation in addition to the dry year recharge rate of 11,000 acre-feet. In order to achieve this level of production, existing agricultural wells could be converted for domestic use and/or new wells could be constructed.

At the present time, the Valley's primary supplies of groundwater, imported water and recycled water are adequate to meet existing and projected demands for the foreseeable future. As water demands increase, Valencia, CLWA and the other purveyors will analyze and determine the most beneficial mix of supply options available on a short term basis to meet customer demands. In summary, Valencia's WMP has identified approximately 50,000 acre-feet of firming water supplies (excluding 10 percent voluntary conservation) that is available to Valencia and the other purveyors to be used if and when SWP supplies are reduced.

6) Future Water Sources: Water supply and facilities for the Valley have increased incrementally over the years in order to keep pace with customer demands. It is not reasonable for service providers to build all that is necessary and acquire water rights to accommodate projected water demands twenty to thirty years in the future. CLWA and the local purveyors plan for new supplies and facilities a minimum of 3 to 5 years ahead of need. In its *IWRP*, CLWA addressed opportunities to increase the sources of both local and imported water supplies over time. These programs include:

Acquisition of Additional SWP Entitlements. CLWA has recently purchased under the Monterey Agreement an additional entitlement of 41,000 acre-feet. In the near term, this additional supply of water will provide added reliability to CLWA's base water supplies. At the present time, additional SWP entitlement is available and CLWA is evaluating the benefits of acquiring additional entitlement along with other programs such as water banking and other storage opportunities needed for planned growth within the Valley.

Devils Den Ranch Groundwater. CLWA is studying the potential to develop groundwater supplies from property it owns on the west side of the San Joaquin Valley near the Kings-Kern County line. Known as the Devil's Den Ranch, water from this groundwater basin could be pumped into the California Aqueduct and delivered to CLWA.

Water Conservation. CLWA will continue to develop and implement its comprehensive water conservation program in cooperation with the four retail agencies. The major emphasis will be on landscape water conservation activities. Based on empirical data on the impact of conservation measures in other cases, which range from 10 to 20 percent, a minimum 10 percent reduction in water demand through conservation is expected.

Water Transfers and Banking. CLWA will continue to pursue transfer and banking activities with other agencies. Particular emphasis will be placed on acquiring additional SWP entitlement under the Monterey Agreement. CLWA will also investigate the opportunities to bank its existing and future surplus SWP entitlement with agencies in Kern County and other neighboring agencies.

Expanded Lake Storage. CLWA will investigate with the MWD and Department of Water Resources the possibility of expanded storage in Castaic Lake beyond its current allocation. Also, flood flows into Castaic Lake will be evaluated to determine if there are opportunities to capture and store local storm water flows.

Recycled Water. CLWA plans to fully implement a cost-effective water recycling program with the four retail purveyors and the Los Angeles County Sanitation Districts, and seek loans from the State and others for a portion of the capital costs.

Groundwater Management. The Committee plans to construct additional wells in the Saugus Aquifer for use during droughts. A phased program to develop these wells would provide valuable additional water supply reliability.

Artificial Groundwater Recharge. CLWA will be evaluating the feasibility of artificial groundwater recharge of the Alluvial and Saugus Aquifers. The Alluvium can best be recharged using off-stream or in-stream spreading facilities. The Saugus can best be recharged by direct injection of imported treated water.

Groundwater Quality Protection Strategy. The Committee plans to expand its coordinated groundwater quality program to reduce the risk of contamination of the drinking water supply.

Conjunctive Use. The Committee plans to assess potential conjunctive use programs. Conjunctive use is the coordinated operation of local and imported water supplies to achieve improved overall water supply management.

In summary, various water supply augmentation programs are being pursued to ensure that new supplies are planned and ultimately added over time. The Valley's water supply is not limited by the current available supply. These long-term planning activities by Valencia, CLWA and the other Committee members are reasonable and appropriate to ensure that new supplies are brought on-line when needed to meet customer demands.

III.b) SUMMARY OF AVAILABLE WATER SUPPLY

The total available water supply for Valencia and the other retail water purveyors is illustrated in Figure III-1. As stated earlier, the Valley is subject to a wide range of hydrologic conditions and water supply variability. In some years, a wet year supply exists and in other years, it is reduced. Figure III-1 shows the supply options available to Valencia and the other purveyors from a wet year to a dry year condition. In summary, the supply ranges from 156,900 acre-feet to 142,800 acre-feet.

Valencia's WMP considers that drought periods may affect available water supplies in any single year and for a duration not longer than three consecutive years. According to DWR, long droughts in excess of three years are rare in Northern California. Except for the period of 1929-1934, there is no evidence of previous droughts exceeding three years in length from historical records dating back to the early 1870s.[1] It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local supplies in Southern California. Conversely, dry conditions in Southern California may not impact water deliveries from Northern California. For this reason, Valencia, CLWA and the other Committee members have emphasized developing water supplies that add diversity to the Valley's water resources. Diversity of supply is considered a key element of reliability, giving Valencia the option of drawing on multiple sources of supply during future dry year conditions and thereby making the Valley water purveyors less dependent upon the SWP.

Figure III-1 also illustrates how Valencia and the other Committee members can implement strategies (i.e., banking, transfers) utilizing existing available surplus supplies for use during dry years. This approach strives to balance the available water resources between wet years and dry years resulting in an overall long term increase in water supply yield, especially during dry years, and ultimately defers or eliminates the need to acquire additional new sources of water. It is not reasonable to develop long term water

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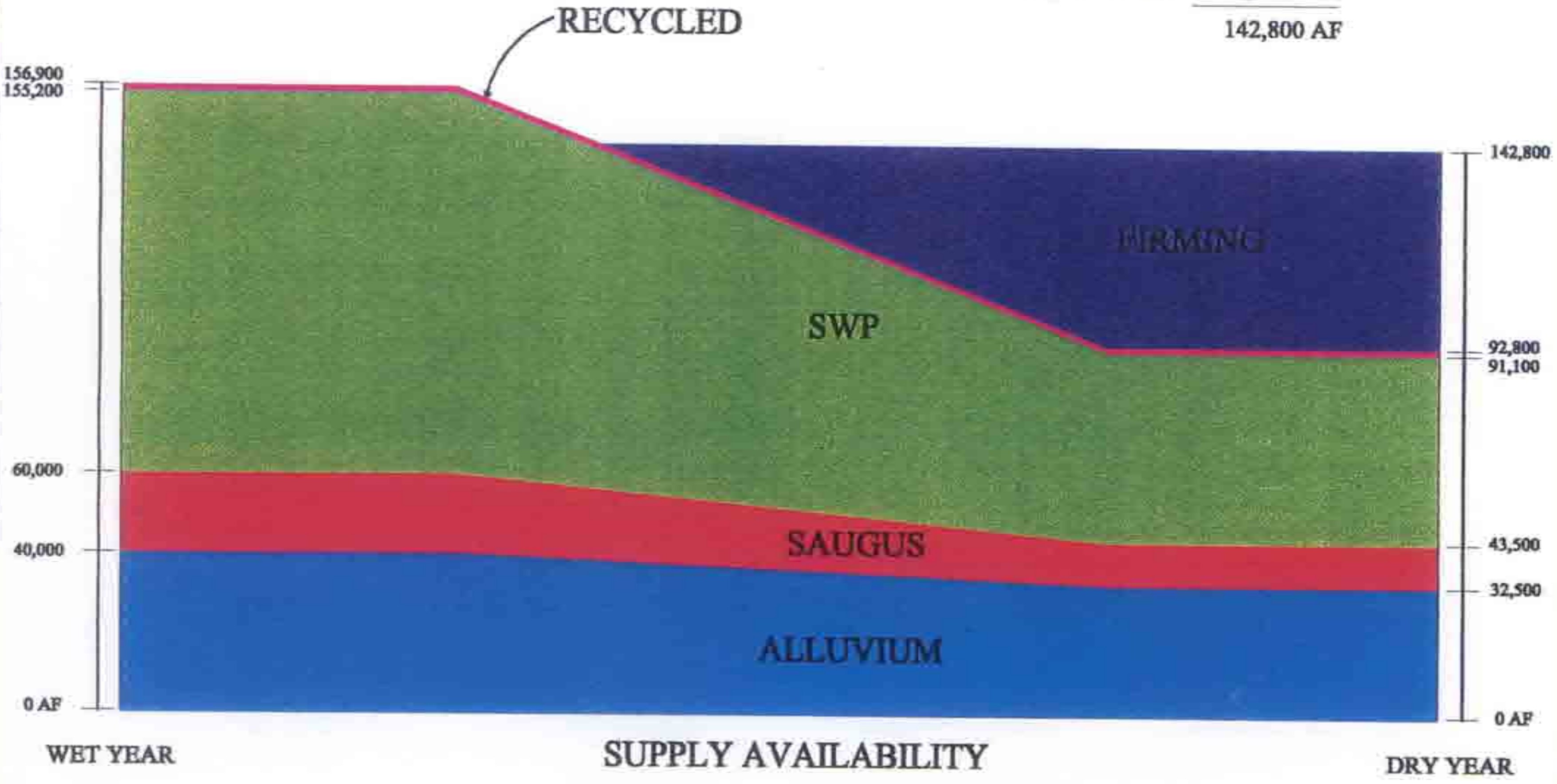
[1] *The Hydrology of the 1987-1992 California Drought*, Department of Water Resources, Maurice Roos, Chief Hydrologist (October 1992)

SANTA CLARITA VALLEY WATER SUPPLIES

FIGURE III-1

	FULL SUPPLY
ALLUVIUM	40,000
SAUGUS	20,000
SWP	95,200
RECYCLED	1,700
	156,900 AF

	DRY YEAR
ALLUVIUM	32,500
SAUGUS	11,000
SWP	47,600
RECYCLED	1,700
	92,800 AF
FIRMING SUPPLIES	50,000
	142,800 AF



supplies to meet future water demands based solely upon dry year estimates. To do so would result in an over-subscription in water supplies causing an undue cost burden for customers. Valencia, CLWA and the other Committee members add water supply and facilities on an incremental basis and in advance of need.

III.c) WATER DEMANDS

Water Demands-Valley Wide

In its *IWRP*, CLWA evaluated the long-term water demands resulting from applicable county and/or city plans within its service area. The *IWRP* calculated a range of water demands based upon existing urban land use plans and estimated water demand factors for those uses. The *IWRP* estimated Valley build-out water demands of 149,000 to 201,000 acre-feet per year. Valencia believes this information is useful for water planners to assess ultimate build-out water demands for the Valley, but is not appropriate for use in Valencia's WMP. The WMP is required to project water demands over a 20-year timeframe. The *IWRP* water demand projections are not based on any specific timeframe. It simply provides a build-out or ultimate estimate of water demands for the Valley based on existing land use approvals and the City and County General Plans.

The approach used in Valencia's WMP utilizes Los Angeles County's Development Monitoring System (DMS) to forecast future water demands. The County's Regional Planning Department maintains DMS and calculates the water demands of all subdivision and parcel map projects occurring within the unincorporated lands of Los Angeles County and the City of Santa Clarita. The County DMS reports existing water demands and projected water demands from all pending, approved and recorded projects in each of the retail purveyors' service areas.[2] Table III-1 shows a DMS build-out water demand of 79,394 acre-feet for the Valley.[3]

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[2] Pending projects are those for which the developer has submitted a tract map to the County for approval, and the project is under review by the County. Approved projects are those which the County has approved the tract map, and the developer may begin construction of the project. Recorded projects are those which have met all requirements according to the General Plan, and the County has accepted the project as complete.

TABLE III-1
Santa Clarita Valley
DMS Build-Out Water Demands
(Acre-Feet)

	Existing Total Demand	Pending Demand	Approved Demand	Recorded Demand	TOTAL
Newhall County	8,087	2,640	1,177	564	12,468
Santa Clarita	20,319	2,272	3,515	790	26,896
LA County Dist. #36	578	477	207	90	1,352
Valencia	19,874	1,540	2,408	1,245	25,067
TOTAL PURVEYOR DEMAND	**48,858**	**6,929**	**7,307**	**2,689**	**65,783**
Other	13,611	0	0	0	13,611
TOTAL DEMAND	**62,469**	**6,929**	**7,307**	**2,689**	**79,394**

The "Other" demand listed above is reported in the *1998 Water Report* as groundwater primarily used for agricultural purposes and domestic use for Los Angeles County's Peter J. Pitchess Detention Center. It is assumed that agricultural demands will decline over time and will be offset to a lesser extent by increasing urban water use as development occurs. For purposes of planning, Valencia's WMP conservatively includes the existing agricultural demands in its analyses of future urban water demand projections.

In summary, the County's DMS report provides Valencia and the PUC with the most accurate and up-to-date summary of all building activity and corresponding water demands likely to receive water service from Valencia and the other retail purveyors in the foreseeable future. Some of these projects reported in DMS would require Valencia to file an advice letter with the PUC requesting an extension of service. When Valencia files an advice letter to extend service, the County's DMS report would be available to the PUC for review as a method to ensure itself that Valencia had sufficient supply and would not be overextending its ability to serve new customers. The DMS report is updated on a regular basis by Los Angeles County and provides a Valley-wide

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[3] DMS water demands obtained from Mr. Bill Miller at Los Angeles County Regional Planning Department, report dated July 28, 1999.

perspective regarding the current availability of supply to meet existing and projected water demands.

Water Demands- Valencia

Table III-2 shows total water demand for Valencia from 1990 and projected through 2020. The projected demand is based on estimates of customer growth and usage per customer for each class of customers. The annual usage factors for each class of customers were derived from a multiple regression analysis study which statistically analyzed historical usage, rainfall, and temperature data to project future usage under normal conditions. The annual usage factor for the single family residential class of customers, which represents more than half of Valencia's total demand, is .60 acre-feet per year per customer. The average of Valencia's actual historical usage per residential customer since 1988 is .57 acre-feet, which provides additional support for the reasonableness of the .60 acre-feet used for these demand projections.

Using the CPUC approved regression analysis model and assuming 800 new customers per year (based on a long-term historical average), Valencia's service area demand, projected to year 2020, is approximately 41,000 AF. It should be noted that per capita water usage by Valencia's customers is declining over time. Residential customer demand was calculated to be approximately .62 acre-feet per year in Valencia's 1995 general rate case. Using the same CPUC approved regression analysis model used in the 1995 general rate case, updated to reflect current data, residential customer demand is now approximately .60 acre-feet per year. This decrease reflects the ongoing conservation efforts in the community.

TABLE III-2
Valencia Water Company
Water Demand
(Acre-Feet)

Water Use Sectors	1990	1995	2000	2005	2010	2015	2020
	Actual		Projected				
Single family residential	9,351	9,544	12,067	14,646	16,991	19,336	21,681
Multi-family residential	857	954	1,093	1,314	1,525	1,736	1,947
Commercial	2,753	2,750	4,754	5,683	6,488	7,292	8,097
Industrial	1,669	1,332	1,564	1,866	2,163	2,460	2,758
Institutional / governmental	1,556	2,725	3,270	3,931	4,559	5,187	5,815
Golf Course Irrigation	386	336	340	680	680	680	680
Total	**16,572**	**17,641**	**23,088**	**28,120**	**32,406**	**36,691**	**40,978**

III.d) WATER SUPPLY OUTLOOK

Valencia uses the following water reliability goal for its water supply: Water demands are met 95 percent of the time or 19 out of 20 years. In the remaining 5 percent of the time, it is assumed that the maximum allowable supply shortage will be 10 percent of demands. Valencia, as well as the other local purveyors chose this level even though during the last drought of the early 1990's, a 10 percent reduction was targeted, and 20 percent was actually achieved on a voluntary basis.

Valencia's WMP describes many water management options available to meet future water supply needs. It is recognized that the various water supplies available to Valencia and the other water purveyors have different reliability characteristics. As such, Valencia has met this challenge by planning and developing its own water system ensuring that it is flexible in its operation and capable of accessing and delivering a diverse mix of water at any given time. In this way, Valencia has addressed reliability in that its customers are not limited to receiving only one source of supply.

The recent drought of the early 1990's provided an illustration of the benefits of having a diverse supply. Valencia was not subject to any water shortages except for one year because three primary sources of water were available: the SWP, Alluvial Aquifer and the Saugus Formation. Those areas of the state that were solely dependent on the SWP or local surface waters, such as Santa Barbara and Ventura Counties, were affected immediately and suffered severe cutbacks during the initial years of the drought. This was not the case for Santa Clarita Valley residents because alternate supplies were only needed in the fifth year (1991) of the drought after the SWP experienced temporary reductions in supply. Since 1991, on-going water development activities by the Committee have increased water supply to the region, enhancing water reliability.

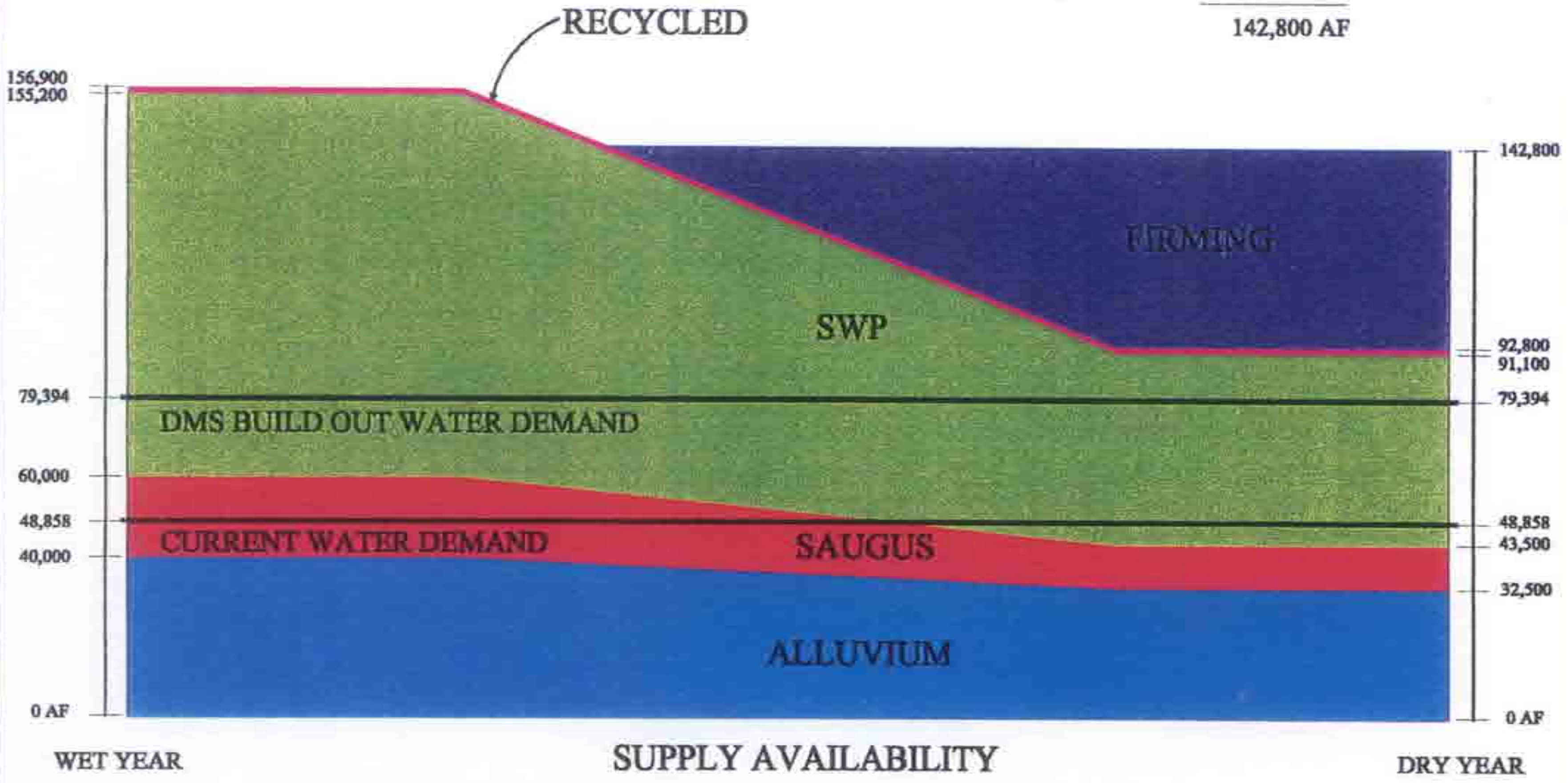
Figure III-2 compares the current available water supply under varying conditions with total demand (existing and projected) reported in DMS. Because the Valley's water supplies are diverse and Valencia has existing facilities to access those supplies, no supply deficiencies are forecasted in this WMP. CLWA's existing SWP Entitlement provides sufficient reliability for the foreseeable future to meet projected demands. In the event of an extended dry period (up to three years), Valencia along with the other water companies have access to alternate supplies to ensure dependable service to customers.

SANTA CLARITA VALLEY WATER SUPPLIES

FIGURE III-2

	FULL SUPPLY
ALLUVIUM	40,000
SAUGUS	20,000
SWP	95,200
RECYCLED	1,700
	156,900 AF

	DRY YEAR
ALLUVIUM	32,500
SAUGUS	11,000
SWP	47,600
RECYCLED	1,700
	92,800 AF
FIRMING SUPPLIES	50,000
	142,800 AF



*Current water demand of 48,858 acre-feet as reported in Table III-5 of the 1998 Water Report.

SECTION IV

WATER CONSERVATION PROGRAMS TO BE IMPLEMENTED

The majority of water conservation programs implemented by Valencia have little or no cost associated with them, usually requiring little more than the dissemination of literature, public information, and inexpensive kits for home conservation. Most of the conservation efforts in the Valley are managed by CLWA in cooperation with the retail water purveyors. Valencia's direct investment in these programs is minimal but funds them indirectly through water rates paid to CLWA for purchased water. For this reason, there was no need to conduct elaborate economic tests to justify Valencia's participation in these water conservation programs.

IV.a) CLWA CONSERVATION PROGRAMS

CLWA's various water conservation programs are geared toward eliminating wasteful water use practices, developing public information on current and potential conservation practices and implementing worthwhile programs on a timely basis. Public education and conservation programs are important elements toward meeting future water demands.

Youth Elementary Education Program

Approximately 6,000 students per year participate in CLWA's Elementary Education Program, provided as a community service to students grades K-6. Conducted in partnership with the Valley elementary schools, children in the program learned different aspects about water and its importance to life. The California State accredited program offered by CLWA also includes a pilot program on water for grades K-3.

Thousands of education packets and materials featuring water conservation messages were distributed through the Elementary Education Program and to children attending public events. Examples of youth education item giveaways are water conservation rulers (which graphically shows that only 1/3 of 1% of Earth's water is available for consumption) and water bottles (which display a penguin and the slogan "It's cool to be water-wise").

Water Conservatory Garden and Learning Center

Approximately 100 people per week visit CLWA's conservatory Garden and Learning Center to learn more about water-wise landscaping. The seven-acre garden in the heart of the Valley features educational signs and hundreds of varieties of roses and plants that are best suited for the extreme climates of the Valley. A comprehensive Conservatory Garden Guide is available at the offices of CLWA. The guide lists important planting details about hundreds of plant species.

Conservatory Garden Docent Program

The Conservatory Garden Docent Program provides an opportunity for community volunteers to become involved in the maintenance and public presentation of the garden. Docents are in the garden every weekend and during most special events. In 1998, local residents and community groups contributed a total of 2,655 volunteer docent hours.

Adult Landscape Education Program

A total of 600 adults participated in the 1997-98 Landscape Education Program, which offered 11 monthly workshops on different aspects of water-wise landscaping. The workshops are held each year from January through October at the Conservatory Garden and Learning Center. Topics include Irrigation Basics, Selecting Fall Plants, Soils and Landscape Design. To promote the program, brochures showing the schedule of workshops are distributed through point of purchase displays at local nurseries. The most current schedule of landscape education workshops is included in Appendix A. Additionally, Appendix B includes CWLA's newsletter, *Water Currents*, which provides information to the public about the landscape education program.

Speaker's Bureau

As another public service to the community, CLWA directors and staff serve as speakers at local events and civic organization meetings. Since the program inception in November 1997, over 300 people have attended Speaker Bureau presentations on topics including: the Conservatory Garden and Learning Center, the History of Water in California and in the Valley, the State Water Project and CLWA Facilities, Water Quality, and the Elementary Education Program. Each presentation begins and ends with a discussion of the value of water in our State and in Southern California.

Public Information – Print and Broadcast Media, Direct Mail and Web Site

CLWA disseminates water conservation information in many of its public materials and notifications, as described below.

Newspapers/Magazines/Directories:

Press releases and advertisements promoting water conservation and CLWA programs (as described above) are submitted and appear throughout the year in: The Signal, The Daily News, The Magazine of Santa Clarita, and the Valley Chamber Business Directory.

Radio:

A series of five public service announcements along with 21 advertisements air monthly on a year-round basis on the local radio station, KBET-AM. The 60-second paid spots alternately present information on water-wise landscaping and residential water conservation. The three-minute public service announcements are abbreviated versions of the CLWA Speakers Bureau speeches.

Direct Mail: Approximately 50,000 1998 Water Quality Reports were mailed to businesses and residences in accordance with State and Federal law. CLWA and the retail purveyors used the eight-page report to feature a series of main headline statements on water conservation and preservation. One page of the report was devoted to water conservation tips and information. On the back cover of the report was a popular multiple-choice "Water IQ" test.

CLWA Newsletter *Water Currents*

The CLWA newsletter, *Water Currents*, was mailed in the same envelope with the Annual Water Quality Report. The message on the front of the envelope was: "Use Water Wisely. Every Drop Counts." A subsequent envelope was printed with the message, "Summer is Here. Use Water Wisely."

Each quarterly CLWA newsletter features water conservation tips and includes a return post card which people can use to request more information on landscape education workshops, elementary school education programs, CLWA Speakers Bureau and other water conservation issues. A new feature of *Water Currents* is a column called "Talking Purely About Water" which provides information on how people can preserve water resources. A copy of the Summer 1999 issue of *Water Currents* is attached as Appendix B.

Theater On-Screen Advertising

A theater on-screen advertising campaign by CLWA is currently underway on 24 movie screens in two theaters in the Valley. The Disney Productions feature movie, "Mighty Joe Young", was filmed at the CLWA Conservatory Garden. While this hit movie was appearing in the local theaters, water conservation messages presented by CLWA appeared prior to all the theater's movies. Due to the success of the program and the large number of people this type of advertising reaches, CLWA has continued the on-screen advertising which promotes conservation and invites the public to visit the Conservatory Garden.

Throughout the year, CLWA distributes a series of brochures entitled, "The Value of Water," "Castaic Lake Water Agency," "The Conservatory Garden and Learning Center," and the "CLWA Speakers Bureau." "The Value of Water" brochure shows tables and graphs of how much water is used for agriculture, business, the environment, and residential purposes. The other full color brochures in the series stress the importance of wise-water use.

CLWA Web Site

The CLWA web site, http://www.clwa.org/ presents extensive up-to-date information on many aspects of CLWA, its activities, and its facilities. The web site features a variety of high resolution, color photos for browsers to select to view. During 1998, the CLWA web site received 4,000 hits.

Public Tours of Rio Vista Water Treatment Plant

To help people better understand and appreciate the treatment and transmission of imported State Water Project water, public tours of Rio Vista Water Treatment Plant are provided every Thursday and on the third Saturday of each month at 1 p.m. A total of 1,600 people toured the plant in 1998.

Public Events and Activities

To help people better understand and appreciate the water resources of the State of California, CLWA conducted two State Water Project tours, a Water Issues Committee, a Los Angeles County Public Library Program, and a California Water Awareness Month Open House. CLWA participated as an exhibitor in the Valley Chamber of Commerce Business Mixer, and in the City of Santa Clarita's River Rally. CLWA also participated in the October 1998 Business Expo which was attended by approximately 13,000 – 15,000 people. CLWA participated in the City of Santa Clarita Emergency Preparedness Expo which is a city sponsored event featuring local businesses providing services and information related to emergency preparedness. Thousands of individuals participated in other CLWA and community public events.

California State Water Awareness Campaign

About 700 guests attended the CLWA annual Open House, which celebrates California Water Awareness Month. At the Open House, participants were asked to provide a water saving tip to share with others. The tips are printed in CLWA newsletters. Also, each May, children's suggestions on how to save water are aired every morning on the local radio station, KBET-AM.

As part of the Water Awareness Campaign, CLWA annually invites a group of active community members to tour the State Water Project. The inspection trip, which began at the Rio Vista Water Treatment Plant, allowed participants to see where the imported water supply used locally originates and the path it travels to reach the Valley. The State Water Project tour is conducted by CLWA to help better educate local residents and business representatives about the importance of water to the Valley.

Civic / Private Special Events

In 1998, the public facilities of CLWA were used by dozens of community clubs and organizations for meetings and receptions. The CLWA administrative building and its adjacent Conservatory Garden also were used for a variety of private celebrations throughout the year.

The objective of CLWA in opening its doors for public use was to provide wide-spread exposure to the practice of water-wise landscaping and the basic practices of water treatment and transmission. A total of 4,200 guests attended civic and private special events held at CLWA. It is considered that the vast majority of these individuals would not have visited the water treatment plant and conservation garden otherwise.

Many of the special events raised money for non-profit service organizations in the community.

Water Conservation Giveaway Items

Thousands of water conservation items were distributed at the public events and activities described above. Some of the items included:

- Notepads printed with the headline "Water is Precious. Use Water Wisely."
- Toothbrushes imprinted with the headline "Save Water. Turn Off Your Tap."
- Magnets imprinted with public hours for the Garden and the Rio Vista tours
- Water Bottles imprinted with "It's Cool to be Water-Wise"
- Totebags imprinted with "Help Conserve and Preserve All Natural Resources."

- Poppy seeds with text on planting this drought-resistant California State Flower
- Rio Vista Water Bottles: CLWA distributed thousands of bottles of water treated at Rio Vista in an attempt to help local residents understand that their tap water is safe to drink.

Water Conservation Awards

In 1998 and 1999, CLWA was awarded first place in The Association of California Water Agencies (ACWA) Theodore Roosevelt Environmental Award. CLWA was one of three finalists in the Clair A. Hill Award for Excellence, and received three of nine first place awards in the Water Management Awareness Program. During 1998 and 1999, CLWA received certification in the ACWA Water Management Program and was honored for their achievements at the ACWA Fall Conference.

Connection Fees

Connection fees are paid by developers to CLWA based on water demand. Developers therefore have a strong incentive to take measures to conserve water within their developments, such as irrigation drip systems and drought tolerant plants.

IV.b) VALENCIA WATER CONSERVATION PROGRAMS

In addition to the programs administered by CLWA as described above, Valencia has several of its own water conservation programs. It should be noted that per capita water usage by Valencia's customers continues to decline over time. Residential customer demand was calculated as approximately .62 acre-feet per year in Valencia's 1995 general rate case. Using the same CPUC approved regression analysis model used in the 1995 general rate case, updated to reflect current data, residential customer demand is now approximately .60 acre-feet per year. This decrease reflects the ongoing conservation efforts in the community.

Customer Bills

This program has been reaching all metered customers on a monthly basis, which represents more than 95% of Valencia's customers. All metered customers are provided with historical usage on their monthly billing statements. This allows customers to compare their water usage with the same period of the prior year, and to monitor their water usage over time. Additionally, each monthly bill includes brief messages promoting conservation, such as "Use Water Wisely". This program has been very effective because it reaches such a large percentage of Valencia's customers, and because of the fact that customers are reminded on a monthly basis about their usage and about the importance on conservation.

Adopt-a-School

Valencia has participated in the local Adopt-a-School program for the last two years. In this program, a Valencia representative visits local elementary schools and teaches the students about water conservation and water saving techniques. Water education materials are also distributed.

Stevenson Ranch Family Festival

Valencia has participated in the Stevenson Ranch Family Festival for the last two years. Stevenson Ranch is one of the communities within Valencia's service area. At the festival, Valencia has a booth where Valencia representatives answer questions from the public and distribute information on conservation and water saving techniques.

City of Santa Clarita Emergency Preparedness Expo

Valencia participates in the City of Santa Clarita Emergency Preparedness Expo which is a city sponsored event featuring local businesses providing services and information related to emergency preparedness. At this event, Valencia has a booth where Valencia representatives answer questions from the public and distribute information on conservation and water saving techniques.

Water Conservation Kits

Water Conservation Kits are available in the lobby of Valencia's offices, and kits are also distributed through the mail upon customer request. The kits include a water saver for shower heads, a toilet displacement bag, a dye tablet for leak detection, as well as information on water saving techniques.

IV.c) VALENCIA WATER LOSS REDUCTION TECHNIQUES

Valencia has many standard procedures which help to minimize water losses. Valencia consistently tracks unaccounted for or slippage water to ensure slippage remains at a reasonable level based on industry averages. All Valencia employees are trained to continually watch for leaks and any leaks noted are repaired immediately. Employees are instructed to watch for and put a stop to any unauthorized hydrant use throughout the service area to discourage this practice.

All services within Valencia's system are metered, with the exception of fire services. Customer water meters are changed out on a regular rotation to help ensure their accuracy. Meters for main line facilities are checked and calibrated on routine schedules which vary with the type of meter and the local service conditions.

Valencia has a regular schedule for exercising valves to insure proper operation to facilitate blocking or rerouting flows during emergencies which include major main breaks.

Valencia has very little corrosion because most pipelines are either plastic, ductile iron, or asbestos cement. The ground and surface waters are not considered to be corrosive, the soils are not considered to induce corrosion, and the groundwater table is below pipeline construction zones.

APPENDIX A

CLWA LANDSCAPE EDUCATION PROGRAM

Castaic Lake Water Agency

LANDSCAPE EDUCATION WORKSHOPS

All Workshops are from 9:00 a.m. to 12:00 noon and include question and answer periods
We repeat these classes each year, and generally meet the third Saturday each month.

Soils and Fertilizers Prepare your soil for improved plant health (Healthy plants use less water)	November 20, 1999
Pruning Methods to prune most any plant Hands-on pruning for roses and fruit trees	January 15, 2000
Propagation Grow new plants from seeds, cuttings, grafting, division, and more.	February 19, 2000
Plant Selection: Trees and Shrubs	March 18, 2000
Irrigation Basics Sprinkler and Drip Irrigation Design and Installation	April 15, 2000
Water Management/Audit Techniques for managing water in and around your home (Easy ways to save water and money)	May 20, 2000
Turf Selection/Maintenance Selecting and maintaining a healthy lawn	June 17, 2000
Landscape Design Principles New home or old... Learn the basics of good landscape design	July 15, 2000
Pest Diagnosis: Weeds Identify and control weeds	August 19, 2000
Pest Diagnosis: Diseases & Insects Identify and control plant diseases and Insects	September 16, 2000
Fall Plant Selection: Annuals and Perennials	October 21, 2000

APPENDIX B

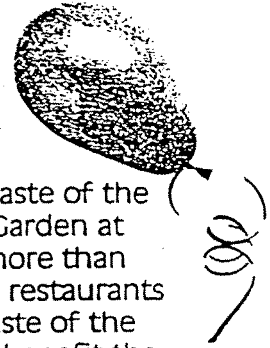
WATER CURRENTS – SUMMER 1999

ASTAIC
AKE
ATER
GENCY

SUMMER 1999

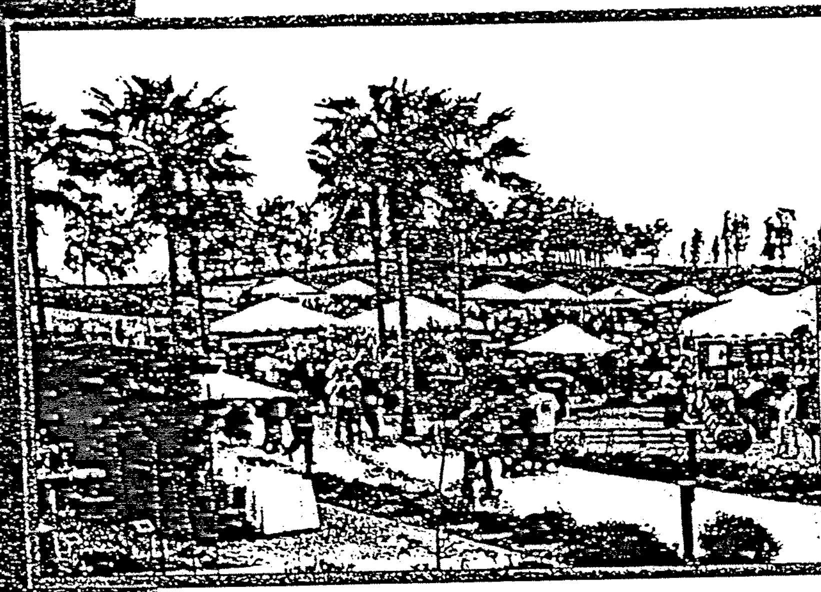
Water Currents

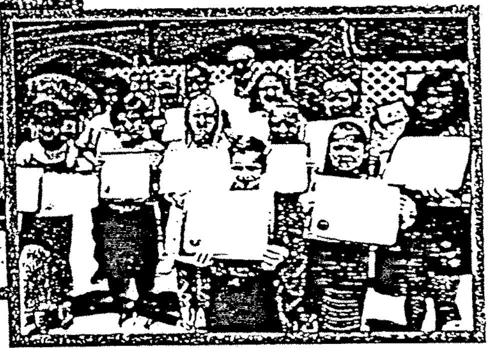
Locals Celebrate Water Awareness, Support Worthy Causes at Castaic Lake Water Agency



On Sunday, May 2, over 1,000 people attended the annual "Taste of the Town" fundraiser, held in the beautiful seven-acre Conservatory Garden at Castaic Lake Water Agency. The event showcased the talents of more than two dozen local restaurants and caterers. Taste of the Town proceeds benefit the Santa Clarita Valley Child and Family Development Center.

About 1,300 people attended CLWA's Open House on Saturday, May 15. The popular annual event featured guided tours of CLWA's state-of-the-art Rio Vista Treatment Plant, as well as Landscape Education Workshops and self-guided tours of the Conservatory Garden.





On display was the work of hundreds of aspiring young artists who entered the CLWA-sponsored Water Awareness Coloring Contest. Winners received certificates in a special awards ceremony. (See page 6.)

At a game booth, guests were invited to test their water knowledge (and win prizes) by answering questions concerning water-related issues and trivia. As in years past, local nurseries, area agencies and community businesses were on hand to promote the products and services they provide.

CLWA holds its annual Open House each May in celebration of California Water Awareness Month

In this issue . . .

- State Water Project Trip
- Water Conservation Tips
- Composting Classes Offered
- Landscape Education Program
- . . . and more!

Community Leaders Embark Upon a Comprehensive Three-Day Inspection Trip of the State Water Project

As part of the state-wide California Water wareness Campaign, Castaic Lake Water Agency nvited a group of active community members to our the State Water Project. The inspection trip, hich began at the Rio Vista Water Treatment Plant in anta Clarita, allowed participants to see where the mported water supply used locally originates and the path it travels to reach the Santa Clarita Valley.

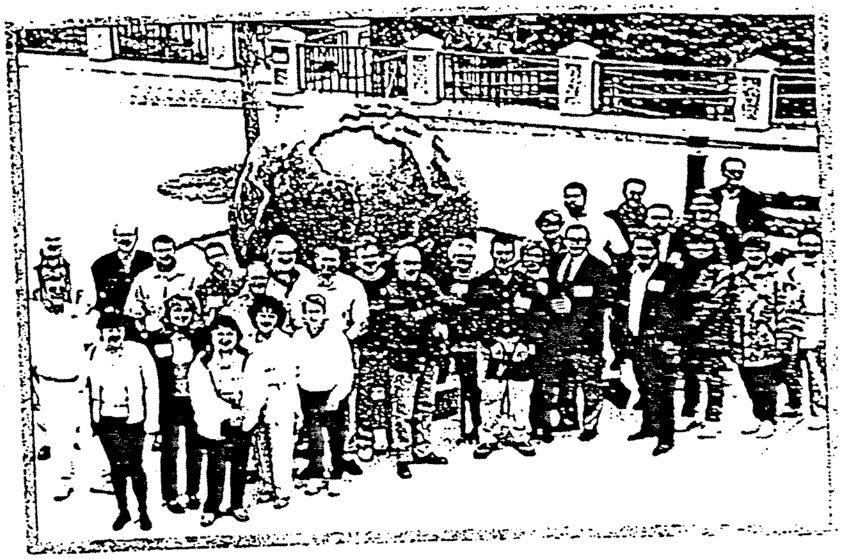
After touring the Rio Vista Plant, participants traveled to Castaic Lake to visit the Earl Schmidt Filtration Plant. From there, participants visited the Edmonston Pumping Plant and the Vista del Lago Visitor Center at Pyramid Lake.

On the second day of the tour, those attending had the opportunity to visit Oroville Lake and Dam, the Edward G. Hyatt Power Plant, and the Feather River Fish Hatchery.

The third and final day of the outing included a tour of the Sacramento/San Joaquin Delta and the Harvey O. Banks Pumping Plant.

Community leaders involved represented local businesses, school districts, non-profit organizations, sports groups, water providers, landholders, government divisions, environmental groups, and the press.

The State Water Project Inspection Trip is conducted annually by CLWA, to help better educate local residents and business representatives about the importance of water to the Santa Clarita Valley.



Inspection trip participants seen here at the CLWA Rio Vista Water Treatment Plant and Conservatory Garden.

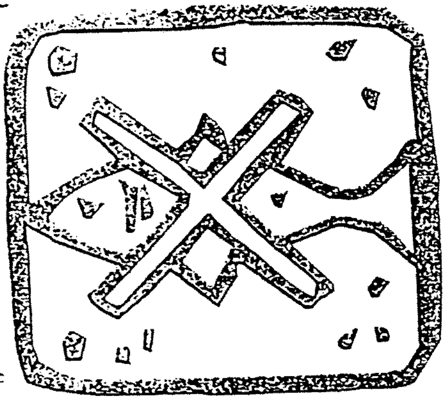
City staff member, Jenn. Santizo, and AYSO soccer player Tyler Roth pictured above at the Harvey O [illegible]

At Edmonston Pumping Plant (at the base of the Grapevine), State Water Project Inspection Trip gues learned how water is pumped up 2,000 fee [illegible]

alking "Purely About" Vater . . .

NO DUMPING. THIS DRAINS TO OCEAN.

You have probably seen these familiar words enciled on storm drains throughout the Santa arita Valley. Since the Pacific Ocean seems a long ays away, sometimes it's easy to forget that water oured into local storm drains eventually winds up iere. If run-off water has been contaminated with xic substances, these ollutants pour into e ocean as well.



When water is ested for toxins in a boratory, it is common for substances o be measured in *arts per billion.* only takes a small uantity of certain ubstances to foul an normous amount of vater.

For instance, one quart of motor oil can form an il slick covering thousands of square feet and can ontaminate 250,000 gallons of water. One cup of CBs (a dry cleaning industry byproduct) can contaminate the water supply of four families for a year.

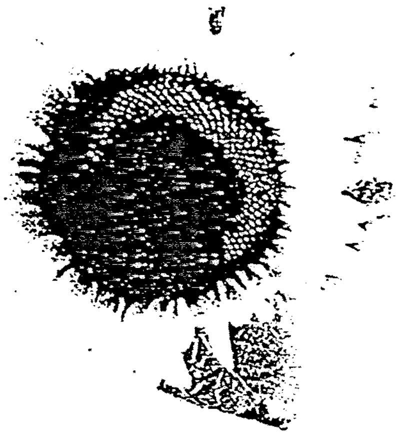
Take a quick look around your home and identify substances that are toxic to the environment. Pay particular attention to batteries, petroleum products, paints and solvents. They will often carry messages such as "do not dispose of in a landfill," or "do not discharge into public sewer system." You can help to protect our environment by heeding these warnings.

On July 1, 1999, the City of Santa Clarita Department of Environmental Services introduced a door-to-door hazardous waste pilot program. Residents of Santa Clarita can call 1-800-499-7587 to schedule an appointment for free hazardous waste pick-ups at their homes.

Materials collected between now and September 30, 1999, include: antifreeze, auto batteries, used motor oil, latex paint, oil-based paint, pesticides, herbicides, household cleaners and other toxic substances.

"You never want to put household hazardous materials in the storm drains or in the trash," said City Recycling Coordinator, David Peterson. "The City's new program will contribute to the sustainability of our quality of life in Santa Clarita."

Castaic Lake Water Agency offers information about hazardous materials. For a copy of a hazardous materials handout, fill out the postcard in this newsletter and mail it to the Agency. Please help out by doing



Castaic Lake Water Agency Landscape Education Program

All workshops are 9 a.m. - noon at the Conservatory Garden at Rio Vista Treatment Plant

Pest Diagnosis: Weeds

August 21

Pest Diagnosis:

Diseases & Insects

September 18

Plant Selection:

Annuals & Perennials

October 16

Call 297-1600 to Register

A Community GROWS Where Water FLOWS

All living things depend on water.

A supply of clean, pure water is essential for life. Do your part to protect and conserve this precious natural resource. Please use only your fair share.

Use Water Wisely.

It's A Way of Life!

If you would like to be added to our mailing list or receive more informatio about local water resources, please fill out this card and drop it in the mail.

Name ______________________________

Address ______________________________

City ____________________ State ________ Zip __________

CASTAIC LAKE WATER AGENCY

Please send me information regarding the following:

- ☐ Landscape Education Workshops
- ☐ Elementary School Education Program
- ☐ CLWA Speakers Bureau
- ☐ Emergency Preparedness Information on Water
- ☐ 1999 Water Quality Report
- ☐ Water Conservation/Water Preservation

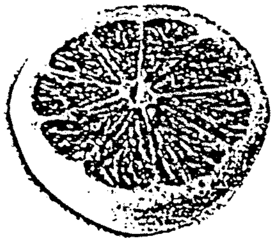
WATER CONSERVATORY
GARDEN & LEARNING CENTER

A COMMUNITY PROJECT SPONSORED BY
CASTAIC LAKE WATER AGENCY

Open: Tuesday through Friday
8 a.m. – 5 p.m.
Saturdays 9 a.m. – 3 p.m.
Closed: Sundays, Mondays and Holidays

CASTAIC LAKE WATER AGENCY

LOCATED AT
27234 BOUQUET CANYON ROAD
IN SANTA CLARITA



It takes a lot of water to produce food.

It takes 14 gallons of water to grow an orange, and 48 gallons to produce a cup of milk. An 8-ounce steak requires 1,232 gallons! And it takes lots more water to manufacture the packaging.

Use Water Wisely.

It's A Way of Life!

Postage
Required
Post Office wi
not deliver
without prope
postage.

CASTAIC LAKE WATER AGENCY
27234 BOUGUET CANYON RD
SANTA CLARITA CA 91350-2102

tudent Artists Honored at LWA Open House

Award-winning student artists in grades K-6 were nored at the Castaic Lake Water Agency Open House, - their entries in the Water Awareness Month loring Contest. The following elementary school stunts received certificates, ribbons and prizes for their lorful drawings:

and Prize Winner anpreet Kaur, darcreek School, t place (K-2) - anpreet Kaur, darcreek School, d Place (K-2) - thy Simonet, netree School, d Place (K-2) - vin Hancock, netree School, onorable ention (K-2) - eston Kilbride, netree School, t place (3-4) - ura Jane hiteside, edarcreek School, 2nd Place (3-4) - Julie Ann Traurig, anta Clarita Elementary, 3rd Place (3-4) - Adam Lewis, anta Clarita Elementary, Honorable Mention (3-4) - ennifer Arango, Santa Clarita Elementary School, st place (5-6) - Merlinda Salas, Canyon Springs School, nd Place (5-6) -Omar Vargas, Canyon Springs School, rd Place (5-6) - Paulina Franco, Canyon Springs School, onorable Mention (3-4) - Brooke Bergiadis, Highlands lementary School.

The theme of the 1999 CLWA Coloring Contest as, "Where does my drinking water come from?" undreds of entries were received by the CLWA ducation Department from elementary schools hroughout the Santa Clarita Valley. (Winners are ictured on the cover of this newsletter.)

Mark Your Calendar to Attend Yard Waste Classes

You are invited to join in Los Angeles County Yard aste Workshops, being held at the Conservatory arden at Rio Vista Water Treatment Plant. Upcoming cal classes are being held at 1 p.m. on Saturday, eptember 18 and November 20, 1999. Gardening loves, water bottles, and AMC Theater and Starbucks iscount coupons are distributed to participants. For [illegible] (1-888-253-2652)

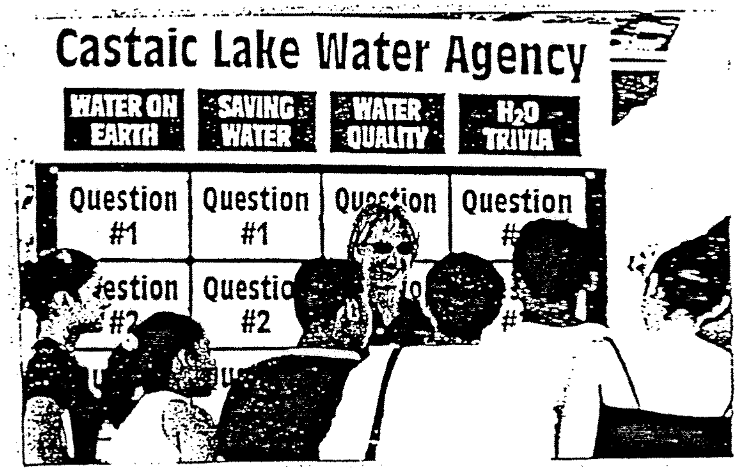
School Program Chalks Up Record-Breaking Year

Almost 6,000 students in grades K-6 were involved in the Castaic Lake Water Agency Elementary School Education Program this past school year. This participation represents an increase of 82% over the previous school year. Highlighting the 1998/1999 program was the introduction of a new grade 4 program, which focuses on microscopic testing and treatment of water samples at the CLWA Earl Schmidt Filtration Plant Laboratory.

Surf to CLWA on the Web

Computer users can find up-to-date information on educational programs, meeting dates and agendas, water-saving hints, and water trivia on the internet. To learn more about CLWA, check out the Agency's web site at:

www.clwa.org



As a public service, CLWA participated as an exhibitor at the 1999 Santa Clarita Valley Country Fair. Guests were invited to play the "Water Game," answering questions about water-related topics. The Country Fair was held July 3 and 4 at Newhall Park. The annual event benefits the Theatre Arts for Children organization.

Water Currents
is a publication of
Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350
For newsletter information ca
Kiza Stratton at (661) 297-160

APPENDIX C

NEWSPAPER ARTICLE ON RECYCLED WATER

The Signal, November 1999

McKeon pours support into CLWA bill

■ Legislation to fund $76.5 million water reclamation project.

By Chris Dickerson
Signal Staff Writer

U.S. Rep. Howard P. "Buck" McKeon, R-Santa Clarita, announced Tuesday that he has introduced a bill that would provide federal funding for a $76.5 million water reclamation project proposed by the Castaic Lake Water Agency.

House Resolution 3322 will authorize the secretary of the Interior, in cooperation with CLWA, to "participate in the design, planning, and construction of a project to reclaim and reuse wastewater within and outside of the service area of the Castaic Lake Water Agency."

The bill stipulates that the federal government shall provide up to 25 percent of the project's costs.

"I am happy to seek this assistance for the CLWA as it embarks on this important project," McKeon said in a written statement. "Making use of reclaimed water will free up more drinking water for the citizens of the Santa Clarita Valley. It's great that the CLWA is planning now to take the steps necessary to provide water for the valley far into the future."

Under the plan, CLWA, the Santa Clarita Valley's water wholesaler, will provide approximately 9,000 acre feet per year of water to existing customers — 3,700 acre feet for golf courses, 1,300 acre feet for parks, 1,100 acre feet for residential landscaping, 1,000 acre feet for schools, 700 acre feet for a co-generation plant, 500 acre feet for commercial/industrial and 500 acre feet for Six Flags Magic Mountain.

About 7,300 acre feet per year of the recycled water will also go for future users, including planned residential developments, industrial development and golf courses.

The recycled water comes from effluent that is treated at existing facilities owned and operated by the Los Angeles County Sanitation

See CLWA, page A3

CLWA

Continued from page A1

Districts.

The components of CLWA's recycled water project include a reuse pump station located at each water reclamation plant to provide recycled water to the distribution system; about 429,000 linear feet of distribution pipe ranging in size from 6 to 38 inches in diameter; 10 booster pump stations with varying capacities located throughout the distribution system; and 12 above-ground reservoirs providing a total storage capacity of 24.5 million gallons.

CLWA is embarking on the reclamation project to make more efficient use of its available water.

The Water Use Efficiency component of the CALFED Bay-Delta Program is expected to bypass more than 3 million acre feet of water demand annually by the year 2020 through locally implemented conservation efforts like water recycling. CALFED, the U.S. Bureau of Reclamation and the state Department of Water Resources are encouraging regional water recycling opportunities that maximize reuse at minimal cost.

"Because the Santa Clarita Valley is growing rapidly, new developments can be planned to include the infrastructure necessary to provide recycled water to new communities," McKeon said. "Construction of these facilities at the onset of development is much more cost-effective than retrofitting existing facilities. Being able to use recycled water for industrial and similar uses frees up drinking water for households."

TABLE III-1 (Revised)
Santa Clarita Valley
DMS Build-Out Water Demands
(Acre-Feet)

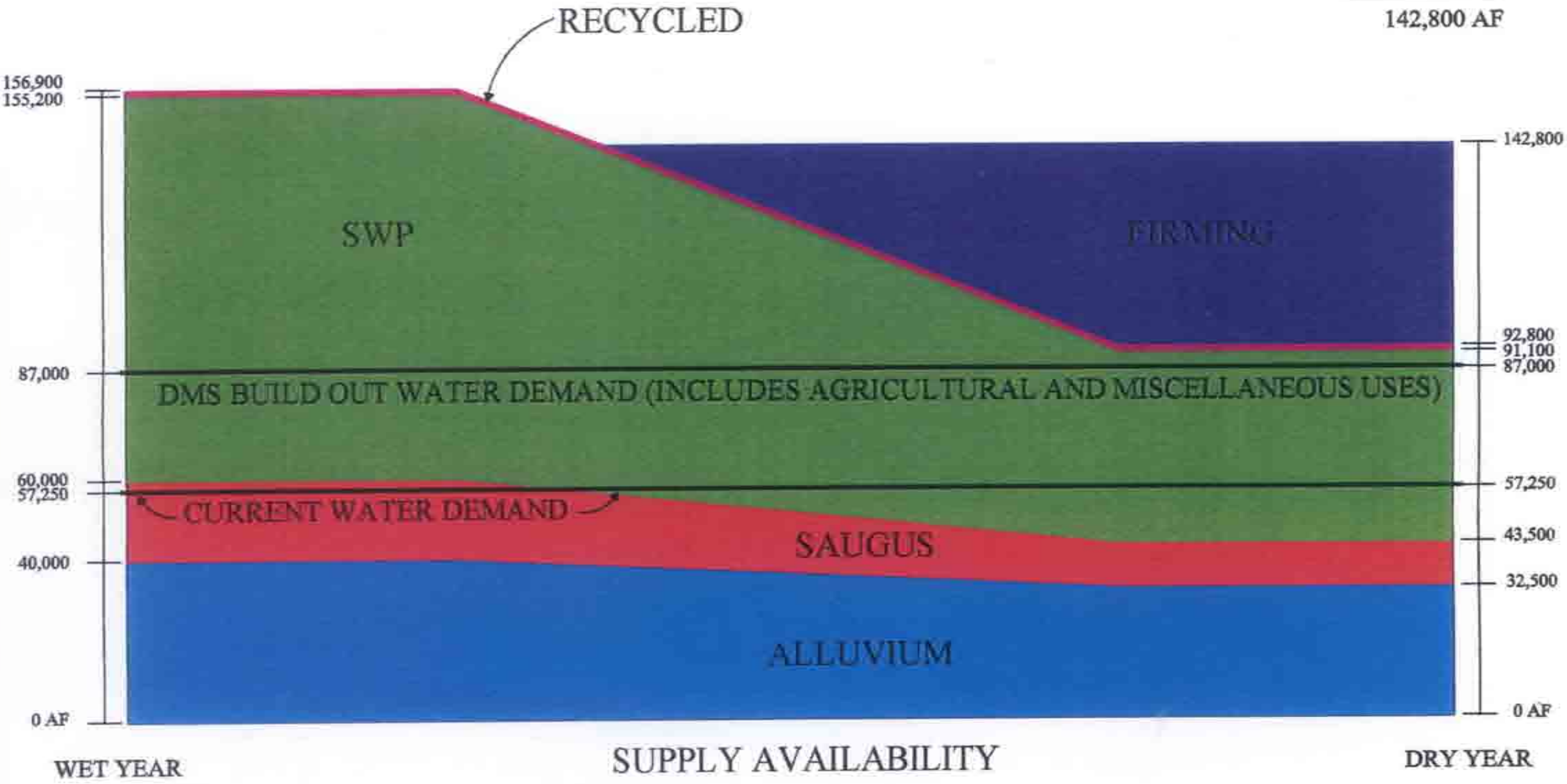
	Existing Total Demand	Pending Demand	Approved Demand	Recorded Demand	TOTAL
Newhall County	9,348	3,790	1,260	1,264	15,662
Santa Clarita	24,513	2,294	3,646	967	31,420
LA County Dist. #36	654	617	114	204	1,589
Valencia	22,735	2,647	4,602	1,255	31,239
TOTAL PURVEYOR DEMAND	**57,250**	**9,348**	**9,622**	**3,690**	**79,910**
Other (Note 1)	17,174	0	0	0	7,100
TOTAL DEMAND	**74,424**	**9,348**	**9,622**	**3,690**	**87,010**

Note 1: Long term agricultural demand and other miscellaneous uses are estimated to decrease from 17,174 acre-feet per year to 7,100 acre-feet per year over time.

SANTA CLARITA VALLEY WATER SUPPLIES
FIGURE III-2
(REVISED)

WET YEAR	
ALLUVIUM	40,000
SAUGUS	20,000
SWP	95,200
RECYCLED	1,700
	156,900 AF

DRY YEAR	
ALLUVIUM	32,500
SAUGUS	11,000
SWP	47,600
RECYCLED	1,700
	92,800 AF
FIRMING SUPPLIES	50,000
	142,800 AF



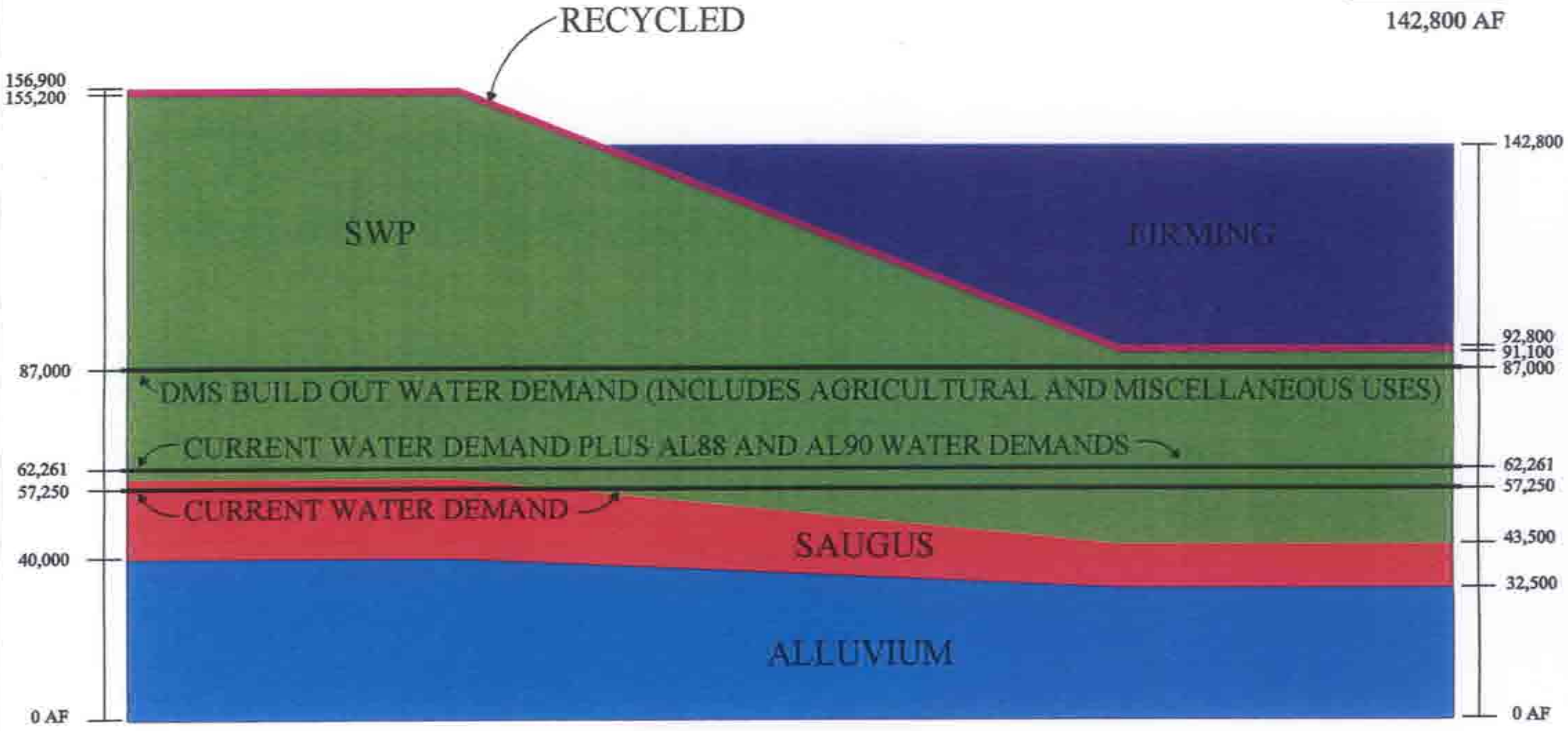
*Current water demand of 57,250 acre-feet as reported in Table IV-1 of the 1999 Water Report.

SANTA CLARITA VALLEY WATER SUPPLIES
FIGURE III-2

(REVISED - TO SHOW DEMANDS FOR AL88 AND AL 90)

	WET YEAR
ALLUVIUM	40,000
SAUGUS	20,000
SWP	95,200
RECYCLED	1,700
	156,900 AF

	DRY YEAR
ALLUVIUM	32,500
SAUGUS	11,000
SWP	47,600
RECYCLED	1,700
	92,800 AF
FIRMING SUPPLIES	50,000
	142,800 AF



WET YEAR SUPPLY AVAILABILITY DRY YEAR

*Current water demand of 57,250 acre-feet as reported in Table IV-1 of the 1999 Water Report.
**Water demands for AL88 and AL90 are included in DMS build out water demand.

2002 Point of Delivery Agreement
(Semitropic Groundwater Banking Program)
February 13, 2004

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

2002 POINT OF DELIVERY AGREEMENT AMONG THE DEPARTMENT OF WATER RESOURCES OF THE STATE OF CALIFORNIA CASTAIC LAKE WATER AGENCY AND KERN COUNTY WATER AGENCY

SWPAO #02015

SWPAO #02015

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

2002 POINT OF DELIVERY AGREEMENT AMONG THE DEPARTMENT OF WATER RESOURCES OF THE STATE OF CALIFORNIA CASTAIC LAKE WATER AGENCY AND KERN COUNTY WATER AGENCY

THIS AGREEMENT is made this 19th day of December, 2002, pursuant to the provisions of the California Water Resources Development Bond Act and other applicable laws of the State of California, among the State of California, acting by and through its Department of Water Resources, herein referred to as the "DEPARTMENT," the Kern County Water Agency, herein referred to as the "AGENCY," a political subdivision of the State of California created by an Act of the California State Legislature (Statutes 1961, Chapter 1003 or as amended), and the Castaic Lake Water Agency, herein referred to as "CASTAIC LAKE," a political subdivision of the State of California created by an Act of the California State Legislature (Statues 1962, Chapter 103 or as amended).

RECITALS

A. CASTAIC LAKE and Semitropic Water Storage District, herein referred to as "Semitropic," a Member Unit of the AGENCY, entered into an agreement dated October 9, 2002, herein referred to as "CASTAIC LAKE/Semitropic Program Agreement," which provides for the storage and recovery rights on an interim basis in the Semitropic Water Banking and Exchange Program, which is owned, operated, and maintained by Semitropic.

B. The DEPARTMENT, AGENCY, and Semitropic have entered into an agreement entitled "Agreement Among Department of Water Resources, State of California, Kern County Water Agency and Semitropic Water Storage District for Introduction of Local Water into the California Aqueduct," executed on May 2, 1995 and subsequently amended. Such agreement, hereafter referred to as the "Semitropic Turn-in Agreement," contains terms and conditions governing the introduction of Local Water into the California Aqueduct. Under certain circumstances, water stored on behalf of CASTAIC LAKE could be recovered by Semitropic and introduced into the California Aqueduct under the terms of such turn-in agreement.

C. Pursuant to Article 15(a) of CASTAIC LAKE'S long-term Water Supply Contract with the DEPARTMENT, the DEPARTMENT hereby finds that the delivery and temporary storage of water outside CASTAIC LAKE'S service area under this Agreement and the CASTAIC LAKE/Semitropic Program Agreement will not materially impair CASTAIC LAKE'S capacity to make payments to the DEPARTMENT.

D. This Agreement applies to CASTAIC LAKE'S 2002 approved Table A water.

E. CASTAIC LAKE has not elected to sell SWP water during the year 2002 pursuant to CASTAIC LAKE'S Water Supply Contract with the DEPARTMENT.

F. The purpose of this Agreement is to set forth provisions governing the delivery of up to 24,000 acre-feet of CASTAIC LAKE'S 2002 approved Table A water for storage in the Semitropic Water Banking and Exchange Program, and for the future return of such water by exchange of a like amount of the AGENCY'S Table A water, or recovery by direct pumpback of CASTAIC LAKE'S stored water into the California Aqueduct from the Semitropic Water Banking and Exchange Program.

G. Consistent with the California Environmental Quality Act, CASTAIC LAKE prepared and on August 6, 2002 filed with the Office of Planning and Research, a draft, *Initial Study and Proposed Negative Declaration for the CASTAIC LAKE Water Agency 2002 Groundwater Banking Project* (SCH# 2002081032). CASTAIC LAKE'S Board adopted findings and a Negative Declaration at their October 3, 2002 Board meeting, concluding that implementation of the project will not have a significant effect and impact on the environment. The Department of Water Resources, acting as a responsible agency, has considered the negative declaration prepared by CASTAIC LAKE in deciding to enter into this agreement and will file a Notice of Determination with the Office of Planning and Research.

AGREEMENT

The DEPARTMENT approves delivery of up to 24,000 acre-feet of CASTAIC LAKE'S 2002 approved Table A water for storage in the Semitropic Water Banking and Exchange Program within the AGENCY'S service area, and for the future return of such water by exchange of a like amount of the AGENCY'S approved Table A water or recovery by direct pumpback under the following terms and conditions:

1. TERM

Upon execution by all parties, this Agreement shall be effective as of January 1, 2002, and shall provide for the delivery of up to 24,000 acre-feet of CASTAIC LAKE'S 2002 approved Table A water to the Semitropic Water Banking and Exchange Program at reach 10A of the California Aqueduct from January 1, 2002 through December 31, 2002. This Agreement shall terminate with the delivery of all return water to CASTAIC LAKE under this Agreement or December 31, 2012, whichever comes first, unless the CASTAIC LAKE/Semitropic Program Agreement is fully terminated. In that event, this Agreement will be terminated on the same date as the termination of the CASTAIC LAKE/Semitropic Program Agreement.

2. USE OF STORED WATER

a. SWP water delivered by the DEPARTMENT to AGENCY on behalf of CASTAIC LAKE under this Agreement will not be sold to or by the AGENCY but will be temporarily stored for CASTAIC LAKE and later recovered by direct pumpback or exchanged for a like amount of the AGENCY'S approved Table A water or other water, to be used in CASTAIC LAKE'S service area. All water stored pursuant to this agreement shall be returned to CASTAIC LAKE by December 31, 2012. The specific provisions for storage and return of CASTAIC LAKE'S water in the Semitropic Water Banking and Exchange Program are governed by the CASTAIC LAKE/Semitropic Program Agreement. As provided in said agreement, 90 percent of CASTAIC LAKE'S water delivered to Semitropic will be returned to CASTAIC LAKE for use in CASTAIC LAKE'S service area in future years, unless CASTAIC LAKE and the AGENCY agree that the actual losses are different than the assumed 10 percent as therein provided.

b. In the event return water is delivered to CASTAIC LAKE by exchange, the parties acknowledge that the AGENCY shall be entitled to an equivalent amount of CASTAIC LAKE'S water previously stored in the Semitropic Water Banking and Exchange Program.

3. USE OF CALIFORNIA AQUEDUCT CAPACITY FOR STORED AND RETURN WATER

Conveyance of the storage and return water in the California Aqueduct shall be in accordance with a schedule approved by the DEPARTMENT. CASTAIC LAKE'S water supply contract with the DEPARTMENT shall govern priority of delivery for return water. CASTAIC LAKE shall be responsible for any demonstrable adverse impacts that may result from deliveries under this Agreement as determined by the DEPARTMENT. To the extent CASTAIC LAKE increases its requests for Table A water as a result of this Agreement, such increases shall not be considered an adverse impact.

4. DELIVERY SCHEDULES FOR STORED/RETURN WATER

a. <u>State Approval of Delivery Schedules</u>: In coordination with and upon approval of the AGENCY, CASTAIC LAKE shall be responsible for scheduling delivery of CASTAIC LAKE'S water with the DEPARTMENT. All water delivery schedules and revisions shall be in accordance with

Article 12 of CASTAIC LAKE'S Water Supply Contract with the DEPARTMENT. The DEPARTMENT'S approval of the schedules is dependent upon the times and amounts of the scheduled water and the overall delivery capability of the SWP. Water delivered to CASTAIC LAKE or AGENCY shall be scheduled when the sum of deliveries scheduled to CASTAIC LAKE or AGENCY under this agreement, plus the scheduled approved annual Table A deliveries, plus deliveries pursuant to any other agreements do not exceed the quantities on which the Proportionate Use-of-Facilities factors are based pursuant to CASTAIC LAKE'S and AGENCY'S Water Supply Contracts with the DEPARTMENT, unless the DEPARTMENT determines that the deliveries will not adversely impact Table A deliveries to SWP contractors or adversely impact SWP operations or facilities. The DEPARTMENT shall not be obligated to convey water for storage or return water at times when such delivery would adversely impact SWP operations or facilities, other SWP contractors' water deliveries or costs, or delivery of Table A water or other water supplies to the AGENCY.

a. <u>Delivery Schedules for Stored Water</u>: As part of coordinating delivery schedules with the AGENCY, CASTAIC LAKE shall submit a delivery schedule for delivery of CASTAIC LAKE'S water into storage, which shall include but not necessarily be limited to amounts, times, rates of delivery, and points of delivery, to the AGENCY for review and approval. The AGENCY shall review the proposed schedule with CASTAIC LAKE and as promptly as possible shall inform CASTAIC LAKE of its decision to either approve, propose modifications, or withhold approval. The AGENCY agrees that it shall not arbitrarily withhold approval or propose unreasonable modifications. The AGENCY may deny approval of, or propose modification to, CASTAIC LAKE'S delivery schedule under this Agreement, if on the basis of a with and without analysis, the AGENCY determines that such deliveries would adversely impact the AGENCY'S water management activities, finances, water supply or operations, and CASTAIC LAKE does not agree to mitigate for such impacts. The base case (without analysis) shall be those conditions estimated to occur in the absence of the CASTAIC LAKE/Semitropic Program Agreement. Upon receipt of the AGENCY'S approval, CASTAIC LAKE shall submit the delivery schedule to the DEPARTMENT for approval. The DEPARTMENT shall not approve any CASTAIC LAKE schedule that has not been approved by the AGENCY.

c. <u>Delivery Schedules for Return Water</u>: CASTAIC LAKE shall, as soon as possible, submit a schedule to the AGENCY specifying the quantity of CASTAIC LAKE'S previously stored water to be returned by recovery and direct pumpback or by exchange of a portion of the AGENCY'S approved Table A water or other water. If delivered by exchange, the parties shall provide copies of all necessary agreements. Said schedules shall specify the amount, month, and year when said return water was previously stored. The AGENCY may propose modifications to the proposed schedule for the return of CASTAIC LAKE'S previously stored water if, on the basis of a with and without analysis, the AGENCY determines that such scheduled deliveries will adversely impact the AGENCY'S finances, water supply or operations, and CASTAIC LAKE does not agree to mitigate for such impacts. The AGENCY agrees that it shall not propose unreasonable modifications. The base case (without analysis) shall be those conditions estimated to occur in the absence of the CASTAIC LAKE/ Semitropic Program Agreement.

5. APPROVED TABLE A WATER

Water returned to CASTAIC LAKE under this Point of Delivery Agreement shall not be considered by the DEPARTMENT in the determination of approved Table A water under Article 18 or allocation of other SWP water to CASTAIC LAKE under CASTAIC LAKE'S Water Supply Contract with the DEPARTMENT.

6. RETURN WATER DELIVERED INTO AQUEDUCT

Water returned by recovery and direct pumpback to the California Aqueduct from the Semitropic Water Banking and Exchange Program on behalf of CASTAIC LAKE shall meet the terms of the Semitropic Turn-in Agreement.

7. STORED/RETURN WATER RECORDS

CASTAIC LAKE shall certify to the DEPARTMENT'S State Water Project Analysis Office by January 31, of each year, the following information for the previous calendar year:

a. The quantity of water delivered and stored under this Agreement.

b. The quantity of water stored under this Agreement that will be available for return to CASTAIC LAKE.

c. The actual losses of stored water, if CASTAIC LAKE and the AGENCY agree that actual losses are different than the 10 percent assumed in the CASTAIC LAKE/Semitropic Program Agreement.

d. The quantity of water returned to CASTAIC LAKE pursuant to this agreement.

The DEPARTMENT will maintain monthly records accounting for the delivery of CASTAIC LAKE'S SWP water supplies delivered pursuant to this Agreement for storage in the Semitropic Water Banking and Exchange Program and future return water delivered from the AGENCY to CASTAIC LAKE.

8. CHARGES

a. Water Delivered to Storage:

CASTAIC LAKE shall pay the DEPARTMENT the 2002 Variable Operation, Maintenance, Power and Replacement Component of the Transportation Charge and Off-Aqueduct Power Facility Costs for power resources incurred in the transportation of such water to Semitropic turnouts in Reach 10A of the California Aqueduct.

b. Return Water Delivered:

(1) When the AGENCY returns stored water by recovery and direct pumpback to Reach 10A of the California Aqueduct for delivery to CASTAIC LAKE'S service area, CASTAIC LAKE shall pay the DEPARTMENT the Variable Operation, Maintenance, Power and

Replacement Component of the Transportation Charge and Off-Aqueduct Power Facility Costs for power resources incurred in the delivery of such water from Reach 10A of the California Aqueduct to CASTAIC LAKE'S turnouts in Reach 30A of the California Aqueduct.

(2) When the AGENCY returns stored water by an exchange of its allocated Table A water, the AGENCY shall be entitled to a like amount of CASTAIC LAKE'S previously stored water and the AGENCY will release a like amount of the AGENCY'S Table A water on behalf of Semitropic at Reach 10A. The AGENCY shall pay the Variable Operation, Maintenance, Power and Replacement Component of the Transportation Charge and Off-Aqueduct Power Facility Costs for power resources incurred as if such water were conveyed to the AGENCY from the Delta to Reach 10A of the California Aqueduct. CASTAIC LAKE shall pay the Variable Operation, Maintenance, Power and Replacement Component of the Transportation Charge and Off-Aqueduct Power Facility Costs for power resources incurred from Reach 10A to CASTAIC LAKE'S turnout structures in Reach 30A.

b. In addition to the charges identified above, CASTAIC LAKE agrees to pay to the DEPARTMENT any additional identified non-power costs that would otherwise be borne by the SWP contractors not signatory to this

Agreement or by the DEPARTMENT as a result of the DEPARTMENT providing service under this Agreement.

d. Payment terms shall be in accordance with the AGENCY'S and CASTAIC LAKE'S Water Supply Contracts with the DEPARTMENT.

9. APPROVALS

The delivery of water under this Agreement shall be contingent on and subject to any necessary approvals and shall be governed by the terms and conditions of such approvals and any other applicable legal requirements. CASTAIC LAKE shall be responsible for securing any required approvals, permits or orders. CASTAIC LAKE shall furnish to the DEPARTMENT copies of all approvals acquired for the delivery and storage of water under this Agreement.

10. LIABILITY

a. The DEPARTMENT is only providing water delivery service through the SWP and assumes no liability for the AGENCY'S or CASTAIC LAKE'S water under this Agreement beyond the designated points of delivery.

b. In the event of a claim of liability against the DEPARTMENT or the AGENCY or their officers or their employees, individually or severally, that arises as a result of this Agreement or other related agreements, CASTAIC LAKE shall defend, indemnify, and hold the AGENCY, the DEPARTMENT, and any of their officers or employees harmless from any such claim, except to the extent that such claim arises from the sole negligence or willful misconduct of the AGENCY and/or the DEPARTMENT.

11. NO MODIFICATION OF WATER SUPPLY CONTRACTS

This Agreement shall not be interpreted to modify the terms or conditions of either the Water Supply Contract between the DEPARTMENT and the AGENCY dated November 15, 1963, or the Water Supply Contract between the DEPARTMENT and CASTAIC LAKE dated April 30,1963, as both are amended up to and including the date of this Agreement.

12. CLAIMS DISPUTE

In the event of dispute regarding interpretation or implementation of this Agreement, the Director of the Department of Water Resources and general managers of CASTAIC LAKE and the AGENCY shall endeavor to resolve the dispute by meeting within 30 days after the request of a Party. If the dispute is unresolved, the Parties shall use the services of a mutually acceptable consultant in an effort to resolve the dispute. Parties involved in the dispute shall share the fees and expenses of the consultant equally. If a consultant cannot be agreed upon, or if the consultant's recommendations are not acceptable to the Parties, and unless the Parties otherwise agree, the matter may be resolved by litigation and any Party may at its option pursue any available legal remedy including, but not limited to, injunctive and other equitable relief.

13. ASSIGNMENT OF AGREEMENT

This Agreement shall not be assignable by the AGENCY or CASTAIC LAKE in whole or in part without the written consent of the DEPARTMENT, AGENCY and CASTAIC LAKE.

14. MODIFICATION OF AGREEMENT

No modification of the terms of this Agreement shall be valid unless made in writing and signed by the Parties to this Agreement.

15. SIGNATURE CLAUSE

The signatories represent that they have been appropriately authorized to enter into this Agreement on behalf of the Party for whom they sign.

IN WITNESS WHEREOF, the Parties hereto have entered into this Agreement.

Approved as to legal form
and Sufficiency

Chief Counsel
DEPARTMENT OF WATER RESOURCES

STATE OF CALIFORNIA
DEPARTMENT OF WATER
RESOURCES

Director

KERN COUNTY WATER AGENCY

Name

General Manager
Title

DEcember 10, 2002
Date

CASTAIC LAKE WATER AGENCY

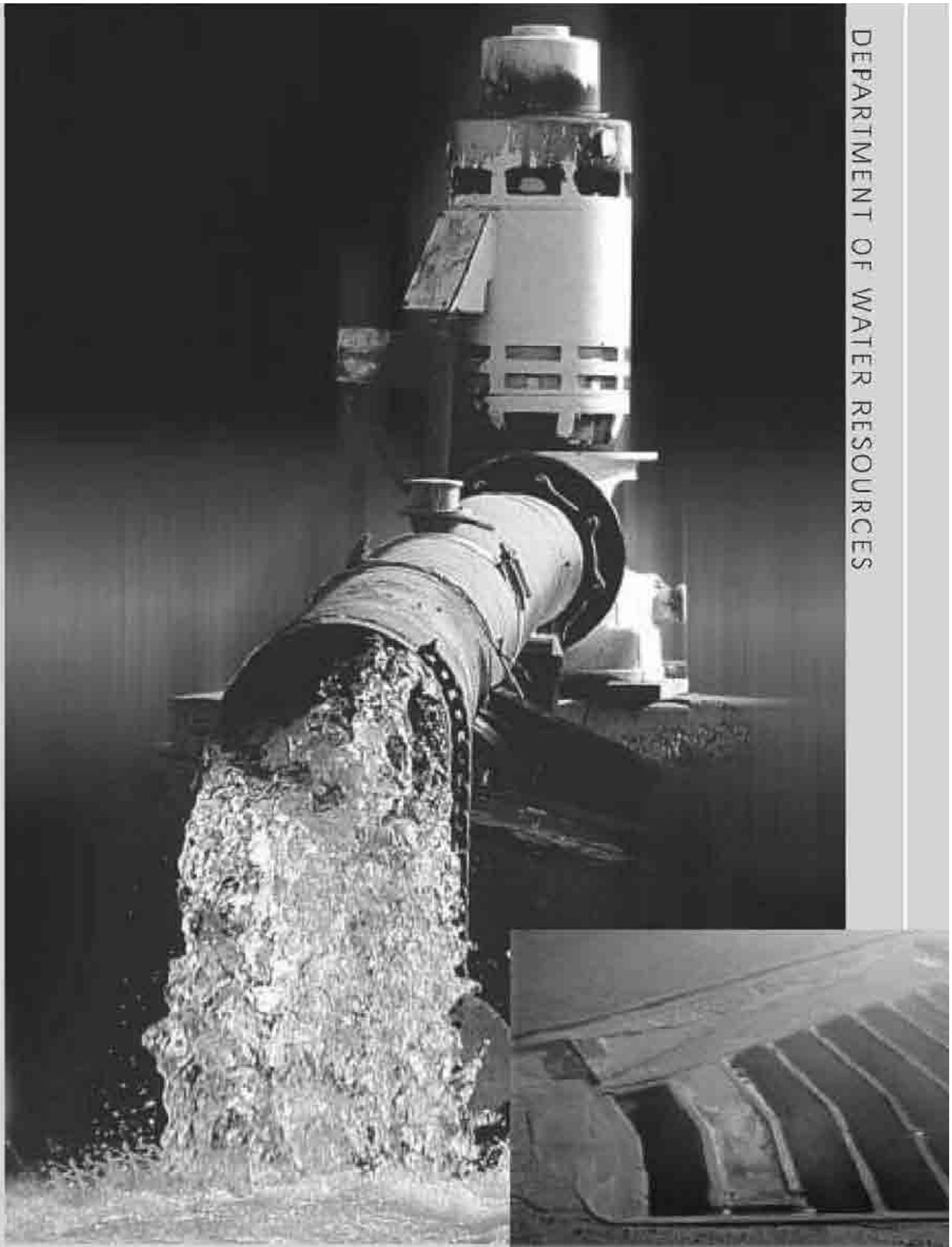
Name

GENERAL MANAGER
Title

12/6/02
Date

AGlasgow:DJohnson
N:\SWPContracts\2002\pod\02015.clwa.kcwa.pod.doc
SPELL CHECKED: November 19, 2002
FINALIZED:

DEPARTMENT OF WATER RESOURCES



BULLETIN 118 · UPDATE 2003

CALIFORNIA'S GROUNDWATER

Cover photograph:
A typical agricultural well with the water discharge pipe and the electric motor that drives the pump.

Inset photograph:
Groundwater recharge ponds in the Upper Coachella Valley near the Whitewater River that use local and imported water. Recharge ponds are also called spreading basins or recharge basins.

State of California
The Resources Agency
Department of Water Resources

CALIFORNIA'S
GROUNDWATER

BULLETIN 118 *Update 2003*

October 2003

GRAY DAVIS
Governor
State of California

MARY D. NICHOLS
Secretary of Resources
The Resources Agency

MICHAEL J. SPEAR
Interim Director
Department of Water Resources

Foreword

Groundwater is one of California's greatest natural resources. In an average year, groundwater meets about 30 percent of California's urban and agricultural water demands. In drought years, this percentage increases to more than 40 percent. In 1995, an estimated 13 million Californians, nearly 43 percent of the State's population, were served by groundwater. The demand on groundwater will increase significantly as California's population grows to a projected 46 million by the year 2020. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality impacts, or limited by a lack of data, management, and coordination between agencies.

Over the last few years, California voters and the Legislature have provided significant funding to local agencies for conjunctive use projects, groundwater recharge facilities, groundwater monitoring, and groundwater basin management activities under Proposition 13 and the Local Groundwater Management Assistance Act of 2000. Most recently, the 2002 passage of Proposition 50 will result in additional resources to continue recent progress toward sustaining our groundwater resources through local agency efforts. We are beginning to see significant benefits from these investments.

The State Legislature recognizes the need for groundwater data in making sound local management decisions. In 1999, the Legislature approved funding and directed the Department of Water Resources (DWR) to update the inventory of groundwater basins contained in Bulletin 118 (1975), *California's Ground Water* and Bulletin 118-80 (1980), *Ground Water Basins in California.* In 2001, the Legislature passed AB 599, requiring the State Water Resources Control Board to establish a comprehensive monitoring program to assess groundwater quality in each groundwater basin in the State and to increase coordination among agencies that collect groundwater contamination information. In 2002, the Legislature passed SB 1938, which contains new requirements for local agency groundwater management plans to be eligible for public funds for groundwater projects.

Effective management of groundwater basins is essential because groundwater will play a key role in meeting California's water needs. DWR is committed to assisting local agencies statewide in developing and implementing effective, locally planned and controlled groundwater management programs. DWR is also committed to federal and State interagency efforts and to partnerships with local agencies to coordinate and expand data monitoring activities that will provide necessary information for more effective groundwater management. Coordinated data collection at all levels of government and local planning and management will help to ensure that groundwater continues to serve the needs of Californians.

Michael J Spear

Michael J. Spear
Interim Director

State of California
Gray Davis, *Governor*

The Resources Agency
Mary D. Nichols, *Secretary for Resources*

Department of Water Resources
Michael J. Spear, *Interim Director*

L. Lucinda Chipponeri
Deputy Director

Peggy Bernardy
Chief Counsel

Stephen Verigin
Acting Chief Deputy Director

Jonas Minton *Deputy Director*	**Peter Garris** *Deputy Director*	**Vernon T. Glover** *Deputy Director*

Division of Planning and Local Assistance
Mark Cowin, Chief

Statewide Water Planning Branch
Kamyar Guivetchi, Chief

Conjunctive Water Management Branch
John Woodling, Chief

This Bulletin was prepared under direction of
Doug Osugi
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with assistance from
Tom Hawkins **Derick Louie**
Tom Lutterman **Darby Vickery** **Ilene Wellman-Barbree** **Judy Colvin**

Data collection, regional information, and basin descriptions provided by Department district offices

Northern District

Dwight Russell, *District Chief*
William Mendenhall, *Chief, Resources Assessment Branch*
Toccoy Dudley, *Chief, Groundwater Section*
Mike Ward, *Engineer WR, technical lead*
Todd Hillaire **Noel Eaves** **Dan McManus** **Bill Ehorn** **Debbie Spangler**
Kelley Staton **Doti Watkins** **Charlene Sundermann** **Bruce Ross**

Central District

Karl Winkler, *District Chief*
Emil Calzascia, *Chief, Water Management*
Bob Niblack, *Chief, Geology and Groundwater Section*
Chris Bonds, *Engineering Geologist, technical lead*
Sandra Maxwell **Mark Souverville** **Tanya Meeth** **Bill Waggoner** **Solomon Mesghina**
Bill Brewster **Anne Roth**

San Joaquin District

Paula J. Landis, *District Chief*
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Editorial, design, and production services were provided by
Brenda Main, *Supervisor of Technical Publications*
Linda Sinnwell, *Art Director*
Marilee Talley **Alice Dyer** **Xiaojun Li** **Gretchen Goettl** **Joanne Pierce**

Acknowledgments

Successful completion of this update and continued implementation of this program would not be possible without the dedicated efforts of the Central, Northern, San Joaquin, and Southern District Offices of the California Department of Water Resources. The information in this report is the result of contributions from many local, state, and federal agencies outside DWR. We would like to acknowledge the contributions of the following agencies.

California Department of Pesticide Regulation
California Department of Toxic Substances Control
California Department of Health Services
California State Water Resources Control Board
California Regional Water Quality Control Boards
United States Geological Survey
United States Bureau of Reclamation

We also wish to thank numerous reviewers who provided valuable comments on the April 2003 public review draft of this bulletin.

Acronyms and abbreviations

AB Assembly Bill
BMO Basin management objective
CAS California Aquifer Susceptibility
CVP Central Valley Project
DBCP Dibromochloropropane
DCE Dichloroethylene
DHS California Department of Health Services
DPR California Department of Pesticide Regulation
DTSC California Department of Toxic Substances Control
DWR California Department of Water Resources
DWSAP Drinking Water Source Assessment Program
EDB Ethylene dibromide
EC Electrical conductivity
EMWD Eastern Municipal Water District
EWMP Efficient water management
EPA U.S. Environmental Protection Agency
ESA Federal Endangered Species Act
ET Evapotranspiration
ETAW Evapotranspiration of applied water
EWA Environmental Water Account
GAMA Groundwater Ambient Monitoring and Assessment
GIS Geographic information system
GMA Groundwater Management Agency
gpm Gallons per minute
GRID Groundwater Resources Information Database
GRIST Groundwater Resources Information Sharing Team
H & S Health and Safety Code
HR Hydrologic region
ISI Integrated Storage Investigations
ITF Interagency Task Force
JPA Joint powers agreement
maf Million acre-feet
MCL Maximum contaminant level
mg/L Milligrams per liter
MOU Memorandum of understanding
MTBE Methyl tertiary-butyl ether
OCWD Orange County Water District
PAC Public Advisory Committee
PCE Tetrachloroethylene
PCA Possible contaminating activity
PPIC Public Policy Institute of California
ROD Record of Decision
RWQCB Regional Water Quality Control Board
SB Senate Bill
SGA Sacramento Groundwater Authority
SVOC Semi-volatile organic compound
SVWD Scotts Valley Water District
SWRCB State Water Resources Control Board

taf Thousand acre-feet
TCE Trichloroethylene
TDS Total dissolved solids
UWMP Urban water management plan
USACE U.S. Army Corps of Engineers
USBR U.S. Bureau of Reclamation
USC United States Code
USGS U.S. Geological Survey
VOC Volatile organic compound
WQCP Water Quality Control Plan

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Major Findings

1. **Groundwater provides about 30% of the State's water supply in an average year, yet in many basins the amount of groundwater extracted annually is not accurately known.**
    - In some regions, groundwater provides 60% or more of the supply during dry years.
    - Many small- to moderate-sized towns and cities are entirely dependent on groundwater for drinking water supplies.
    - 40% to 50% of Californians rely on groundwater for part of their water supply.
    - In many basins, groundwater use is indirectly estimated by assuming crop evapotranspiration demands and surveying the acreage of each crop type.

2. **Opportunities for local agencies to manage their groundwater resources have increased significantly since the passage of Assembly Bill 3030 in 1992. (Water Code § 10750 et seq.). In the past several years more agencies have developed management programs to facilitate conjunctive use, determine the extent of the resource, and protect water quality.**
    - The act provides the authority for many local agencies to manage groundwater.
    - The act has resulted in more than 200 local agencies adopting groundwater management plans to date.
    - The act encourages regional cooperation in basins and allows private water purveyors to participate in groundwater management through memoranda of understanding with public agencies.
    - Many local agencies are recognizing their responsibility and authority to better manage groundwater resources.

3. **Agencies in some areas have not yet developed groundwater management plans.**
    - Concerns about cooperative management, governance, and potential liabilities have kept some agencies from developing management plans.
    - Development of management programs to maintain a sustainable groundwater supply for local use has not been accomplished throughout the State.

4. **A comprehensive assessment of overdraft in the State's groundwater basins has not been conducted since Bulletin 118-80, but it is estimated that overdraft is between 1 million and 2 million acre-feet annually.**
    - Historical overdraft in many basins is evident in hydrographs that show a steady decline in groundwater levels for a number of years.
    - Other basins may be subject to overdraft in the future if current water management practices are continued.
    - Overdraft can result in increased water production costs, land subsidence, water quality impairment, and environmental degradation.
    - Few basins have detailed water budgets by which to estimate overdraft.
    - While the most extensively developed basins tend to have information, many basins have insufficient data for effective management or the data have not been evaluated.
    - The extent and impacts of overdraft must be fully evaluated to determine whether groundwater will provide a sustainable water supply.
    - Modern computer hardware and software enable rapid manipulation of data to determine basin conditions such as groundwater storage changes or groundwater extraction, but a lack of essential data limits the ability to make such calculations.
    - Adequate statewide land use data for making groundwater extraction estimates are not available in electronic format.

5. **Surface water and groundwater are connected and can be effectively managed as integrated resources.**
    - Groundwater originates as surface water.
    - Groundwater extraction can affect flow in streams.
    - Changes in surface water flow can affect groundwater levels.
    - Legal systems for surface water and groundwater rights can make coordinated management complex.

6. **Groundwater quality and groundwater quantity are interdependent and are increasingly being considered in an integrated manner.**
    - Groundwater quantity and groundwater quality are inseparable.
    - Groundwater in some aquifers may not be usable because of contamination with chemicals, either from natural or human sources.
    - Unmanaged groundwater extraction may cause migration of poor quality water.
    - Monitoring and evaluating groundwater quality provides managers with the necessary data to make sound decisions regarding storage of water in the groundwater basin.
    - State agencies conduct several legislatively mandated programs to monitor different aspects of groundwater quality.
    - California Department of Water Resources (DWR) monitors general groundwater quality in many basins throughout the State for regional evaluation.

7. **Land use decisions affecting recharge areas can reduce the amount of groundwater in storage and degrade the quality of that groundwater.**
    - In many basins, little is known about the location of recharge areas and their effectiveness.
    - Protection and preservation of recharge areas are seldom considered in land use decisions.
    - If recharge areas are altered by paving, channel lining, or other land use changes, available groundwater will be reduced.
    - Potentially contaminating activities can degrade the quality of groundwater and require wellhead treatment or aquifer remediation before use.
    - There is no coordinated effort to inform the public that recharge areas should be protected against contamination and preserved so that they function effectively.

Additional Important Findings

8. **Funding to assist local groundwater management has recently been available in unprecedented amounts.**
    - Proposition 13 (Water Code, § 79000 et seq.) authorized $230 million in loans and grants for local groundwater programs and projects, almost all of which has been allocated.
    - The Local Groundwater Management Assistance Act of 2000 (Water Code, § 10795) has resulted in more than $15 million in grants to local agencies in fiscal years 2001, 2002, and 2003.
    - Proposition 50 (Water Code, § 79500 et seq) will provide funding for many aspects of water management, including groundwater management and groundwater recharge projects.
    - Funding for the California Bay-Delta program has provided technical and facilitation assistance to numerous local groundwater planning efforts.

9. **Local governments are increasingly involved in groundwater management.**
    - Twenty-four of the 27 existing county groundwater management ordinances have been adopted since 1990.
    - Most ordinances require the proponents of groundwater export to demonstrate that a proposed project will not cause subsidence, degrade groundwater quality, or deplete the water supply before the county will issue an export permit.
    - While the ordinances generally require a permit for export of groundwater, most do not require a comprehensive groundwater management plan designed to ensure a sustainable water resource for local use.
    - Some local governments are coordinating closely with local water agencies that have adopted groundwater management plans.
    - Many local governments are monitoring and conducting studies in an effort to better understand groundwater resources.

10. **Despite the increased groundwater management opportunities and activities, the extent of local efforts is not well known.**
    - There is no general requirement that groundwater management plans be submitted to DWR, so the number of adopted plans and status of groundwater management throughout the State are not currently known.
    - There are no requirements for evaluating the effectiveness of adopted plans, other than during grant proposal review.
    - No agency is responsible for tracking implementation of adopted plans.
    - Unlike urban water management plans, groundwater management plans are not required to be submitted to DWR, making the information unavailable for preparing the California Water Plan.

11. **Despite the fact that several agencies often overlie each groundwater basin, there are few mechanisms in place to support and encourage agencies to manage the basin cooperatively.**
    - Some local agencies have recognized the benefits of initiating basinwide and regional planning for groundwater management and have recorded many successes.
    - Regional cooperation and coordination depends on the ability of local agencies to fund such efforts.
    - There is no specific State or federal program to fund and support coordination efforts that would benefit all water users in a region and statewide.

12. **The State Legislature has recognized the need to consider water supplies as part of the local land use planning process.**
    - Three bills—Senate Bill 221[1], SB 610[2], and AB 901[3]—were enacted in 2001 to improve the assessment of water supplies. The new laws require the verification of sufficient water supply as a condition for approving certain developments and compel urban water suppliers to provide more information on the reliability of groundwater as an element of supply.
    - The Government Code does not specifically require local governments to include a water resources element in their general plans.

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[1] Business and Professions Code Section 11010, Government Code Sections 65867.5, 66455.3, and 66473.7.

[2] Public Resources Code Section 21151.9, Water Code Sections 10631, 10656, 10657, 10910-10912, 10915.

[3] Water Code Sections 10610.2, 10631, 10634.

13. **The need to monitor groundwater quality and contamination of groundwater continues to grow.**
    - As opportunities for developing additional surface water supplies become more limited, subsequent growth will increasingly rely on groundwater.
    - Human activities are likely the cause of more than half the exceedances of maximum contaminant levels in public water supply wells.
    - New contaminants are being regulated and standards are becoming more stringent for others, requiring increased monitoring and better management of water quality.

14. **Monitoring networks for groundwater levels and groundwater quality have not been evaluated in all basins to ensure that the data accurately represent conditions in the aquifer(s).**
    - Groundwater levels are monitored in about 10,000 active wells including those basins where most of the groundwater is used.
    - Groundwater levels are not monitored in approximately 200 basins, where population is sparse and groundwater use is generally low.
    - Groundwater quality monitoring networks are most dense near population centers and may not be representative of the basin as a whole.
    - Many of the wells being monitored are not ideally constructed to provide water level or water quality information that is representative of a specific aquifer.
    - Many wells are too deep to monitor changes in the unconfined (water table) portion of basins.

15. **The coordination of groundwater data collection and evaluation by local, State, and federal agencies is improving.**
    - The State Water Resources Control Board (SWRCB) recently formed the Groundwater Resources Information Sharing Team (GRIST) consisting of several State and federal agencies with groundwater-related programs.
    - DWR established a website in 1996 that has provided water-level data and hydrographs for more than 35,000 active and inactive wells monitored by DWR and cooperating agencies.
    - DWR collects and maintains water level data in part through partnerships with local agency cooperators.
    - DWR staff collaborated with many local, State, and federal agencies in developing this update of Bulletin 118.
    - SWRCB recently formed an interagency task force to develop a comprehensive groundwater quality monitoring program for assessing every groundwater basin in the State as required by the Groundwater Quality Monitoring Act of 2001 (AB 599; Water Code, § 10780 et seq.).
    - Water purveyors have concerns about balancing public access to data with water supply security.

16. **Boundaries of groundwater basins have been determined using the best available geologic and hydrologic information. These boundaries are important in determining the availability of local water supplies.**
    - Basin boundaries were derived primarily by identifying alluvial sediments on geologic maps using the best available information, but are subject to change when new information becomes available.
    - The Water Code requires the use of basin boundaries defined in Bulletin 118 in groundwater management plans and urban water management plans.
    - The location of basin boundaries will become more critical as the demand for water continues to increase.
    - Subbasin boundaries may be delineated for management convenience rather than based on hydrogeologic conditions.

17. **Little is known about the stream-aquifer interaction in many groundwater basins.**
    - Groundwater and surface water are closely linked in the hydrologic cycle.
    - The relationship between streamflow and extraction of groundwater is not fully understood in most basins and is generally not monitored.
    - Groundwater extraction in many basins may affect streamflow.
    - Interaction of groundwater flow and surface water may affect environmental resources in the hyporheic zone.
    - An understanding of stream-aquifer interaction will be essential to evaluating water transfers in many areas of the State.

18. **Although many new wells are built in fractured rock areas, insufficient hydrogeologic information is available to ensure the reliability of groundwater supplies.**
    - Population is increasing rapidly in foothill and mountain areas in which groundwater occurs in fractured rock.
    - The cumulative effect of groundwater development may reduce the yield of individual wells, lower the flow of mountain streams, and impact local habitat.
    - Characterization of groundwater resources in fractured rock areas can be very expensive and complex.
    - Many groundwater users in these areas have no other water supply alternatives.
    - Recent dry years have seen many wells go dry in fractured rock areas throughout the State.
    - Groundwater management in these areas is beginning, but there is insufficient data to support quantitative conclusions about the long-term sustainable yield.

19. **When new wells are built, drillers are required to file a Well Completion Report with DWR. That report contains a lithologic log, the usability of which varies considerably from driller to driller.**
    - The Well Completion Reports are confidential and not available to the public, as stipulated by the Water Code, unless the owner's permission is obtained.
    - The usefulness of the information in Well Completion Reports varies but is not fully realized.
    - Public access to Well Completion Reports would increase understanding of groundwater conditions and issues.
    - There is no provision in the Water Code that requires submission of geophysical logs, which would provide an accurate log of the geologic materials within the aquifer.
    - Geophysical logs would provide a greatly improved database for characterization of aquifers.

Recommendations

Major Recommendations

1. **Local or regional agencies should develop groundwater management plans if groundwater constitutes part of their water supply. Management objectives should be developed to maintain a sustainable long-term supply for multiple beneficial uses. Management should integrate water quantity and quality, groundwater and surface water, and recharge area protection.**
   - Groundwater management in California is a local agency responsibility.
   - In basins where there is more than one management agency, those agencies should coordinate their management objectives and program activities.
   - A water budget should be completed that includes recharge, extraction and change in storage in the aquifer(s).
   - Changes in groundwater quality should be monitored and evaluated.
   - Stakeholders should be identified and included in development of groundwater management plans.

2. **The State of California should continue programs to provide technical and financial assistance to local agencies to develop monitoring programs, management plans, and groundwater storage projects to more efficiently use groundwater resources and provide a sustainable supply for multiple beneficial uses. DWR should:**
   - Post information about projects that have successfully obtained funding through various grant and loan programs.
   - Provide additional technical assistance to local agencies in the preparation of grant and loan applications.
   - Continue outreach efforts to inform the public and water managers of grant and loan opportunities.
   - Participate, when requested, in local efforts to develop and implement groundwater management plans.
   - Continue to assess, develop, and modify its groundwater programs to provide the greatest benefit to local agencies.
   - Develop grant criteria to ensure funding supports local benefits as well as Statewide priorities, such as development of the California Water Plan and meeting Bay-Delta objectives.

3. **DWR should continue to work with local agencies to more accurately define historical overdraft and to more accurately predict future water shortages that could result in overdraft.**
   - A water budget should be developed for each basin.
   - The annual change in storage should be determined for each basin.
   - The amount of annual recharge and discharge, including pumping, should be determined.
   - Changes in groundwater quality that make groundwater unusable or could allow additional groundwater to be used should be included in any evaluation of overdraft.

4. **Groundwater management agencies should work with land use agencies to inform them of the potential impacts various land use decisions may have on groundwater, and to identify, prioritize, and protect recharge areas.**
   - Local planners should consider recharge areas when making land use decisions that could reduce recharge or pose a risk to groundwater quality.
   - Recharge areas should be identified and protected from land uses that limit recharge rates, such as paving or lining of channels.

- Both local water agencies and local governments should pursue education and outreach to inform the public of the location and importance of recharge areas.
- DWR should inform local agencies of the availability of grant funding and technical assistance that could support these efforts.

5. **DWR should publish a report by December 31, 2004 that identifies those groundwater basins or subbasins that are being managed by local or regional agencies and those that are not, and should identify how local agencies are using groundwater resources and protecting groundwater quality.**
   - Such information will be necessary to confirm whether agencies are meeting the requirements of SB 1938 (Water Code Section 10753.7).
   - Collection and summary of existing groundwater management plans will provide a better understanding of the distribution and coordination of groundwater management programs throughout the State.
   - Successful strategies employed by specific local agencies should be highlighted to assist others in groundwater management efforts.
   - Similarly, the impact of groundwater management ordinances throughout the State should be evaluated to provide a better understanding of the effect of ordinances on groundwater management.

6. **Water managers should include an evaluation of water quality in a groundwater management plan, recognizing that water quantity and water quality are inseparable.**
   - Local water managers should obtain groundwater quality data from federal, state, and local agencies that have collected such data in their basin.
   - Local agencies should evaluate long-term trends in groundwater quality.
   - Local agencies should work closely with the SWRCB and DWR in evaluating their groundwater basins.
   - Local agencies should establish management objectives and monitoring programs that will maintain a sustainable supply of good quality groundwater.

7. **Water transfers that involve groundwater (or surface water that will be replaced with groundwater) should be consistent with groundwater management in the source area that will assure the long term sustainability of the groundwater resource.**

8. **Continue to support coordinated management of groundwater and surface water supplies and integrated management of groundwater quality and groundwater quantity.**
   - Future bond funding should be provided for conjunctive use facilities to improve water supply reliability.
   - Funding for feasibility and pilot studies, in addition to construction of projects will help maximize the potential for conjunctive use.
   - DWR should continue and expand its efforts to form partnerships with local agencies to investigate and develop locally controlled conjunctive use programs.

9. **Local, State, and federal agencies should improve data collection and analysis to better estimate groundwater basin conditions used in Statewide and local water supply reliability planning. DWR should:**
   - Assist local agencies in the implementation of SB 221, SB 610, and AB 901 to help determine water supply reliability during the local land use planning process.
   - Provide and continue to update information on groundwater basins, including basin boundaries, groundwater levels, monitoring data, aquifer yield, and other aquifer characteristics.

- Identify areas of rapid development that are heavily reliant on groundwater and prioritize monitoring activities in these areas to identify potential impacts on these basins.
- Evaluate the existing network of wells monitored for groundwater elevations, eliminate wells of questionable value from the network, and add wells where data are needed.
- Work cooperatively with local groundwater managers to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts, beginning with the most heavily used basins.
- Expand DWR and local agency monitoring programs to provide a better understanding of the interaction between groundwater and surface water.
- Work with SWRCB to investigate temporal trends in water quality to identify areas of water quality degradation that should receive additional attention.
- Estimate groundwater extraction using a land use based method for over 200 basins with little or no groundwater budget information.
- Integrate groundwater budgets into the California Water Plan Update process.

10. **Increase coordination and sharing of groundwater data among local, State, and federal agencies and improve data dissemination to the public. DWR should:**
    - Use the established website to continually update new groundwater basin data collected after the publication of California's Groundwater (Bulletin 118-Update 2003).
    - Publish a summary update of Bulletin 118 every five years coincident with the California Water Plan (Bulletin 160).
    - Publish, in cooperation with SWRCB, a biennial groundwater report that addresses current groundwater quantity and quality conditions.
    - Coordinate the collection and storage of its groundwater quality monitoring data with programs of SWRCB and other agencies to ensure maximum coverage statewide and reduce duplication of effort.
    - Make groundwater basin information more compatible with other Geographic Information System-based resource data to improve local integrated resources planning efforts.
    - Compile data collected by projects funded under grant and loan programs and make data available to the public on the DWR website.
    - Encourage local agency cooperators to submit data to the DWR database.
    - Maximize the accuracy and usefulness of data and develop guidelines for quality assurance and quality control, consistency, and format compatibility.
    - Expand accessibility of groundwater data by the public after considering appropriate security measures.
    - State, federal and local agencies should expand accessibility of groundwater data by the public after considering appropriate security measures.
    - Local agencies should submit copies of adopted groundwater management plans to DWR.

Additional Important Recommendations

11. **Local water agencies and local governments should be encouraged to develop cooperative working relationships at basinwide or regional levels to effectively manage groundwater. DWR should:**
    - Provide technical and financial assistance to local agencies in the development of basinwide groundwater management plans.
    - Provide a preference in grant funding for groundwater projects for agencies that are part of a regional or basinwide planning effort.
    - Provide Proposition 50 funding preferences for projects that are part of an integrated regional water management plan.

12. **Groundwater basin boundaries identified in Bulletin 118 should be updated as new information becomes available and the basin becomes better defined. DWR should:**
    - Identify basin boundaries that are based on limited data.
    - List the kind of information that is necessary to better define basin boundaries.
    - Develop a systematic procedure to obtain and evaluate stakeholder input on groundwater basin boundaries.

13. **Improve the understanding of groundwater resources in fractured rock areas of the State.**
    - DWR, in cooperation with local and federal agencies, should conduct studies to determine the amount of groundwater that is available in fractured rock areas, including water quality assessment, identification of recharge areas and amounts, and a water budget when feasible.
    - Local agencies and local governments should conduct studies in their areas to quantify the local demands on groundwater and project future demands.
    - The Legislature should consider expanding the groundwater management authority in the Water Code to include areas outside of alluvial groundwater basins
    - DWR should include information on the most significant fractured rock groundwater sources in future updates of Bulletin 118.

14. **Develop a program to obtain geophysical logs in areas where additional data are needed.**
    - DWR should encourage submission of geophysical logs, when they are conducted, as a part of the Well Completion Report.
    - The geophysical logs would be available for use by public agencies to better understand the aquifer, but would be confidential as stipulated by the Water Code.
    - DWR should seek funding to work with agencies and property owners to obtain geophysical logs of new wells in areas where additional data are needed.
    - Geophysical logs would be used to better characterize the aquifers within each groundwater basin.

15. **Educate the public on the significance of groundwater resources and on methods of groundwater management.**
    - DWR should continue to educate the public on statewide groundwater issues and assist local agencies in their public education efforts.
    - Local agencies should expand their outreach efforts during development of groundwater management plans under AB 3030 and other authority.
    - DWR should develop educational materials to explain how they quantify groundwater throughout the State, as well as the utility and limitations of the information.
    - DWR should continue its efforts to educate individual well owners and small water systems that are entirely dependent on groundwater.

Introduction

Introduction

Groundwater is one of California's greatest natural resources. In an average water supply year, groundwater meets about 30 percent of California's urban and agricultural demand. In drought years, this percentage increases to 40 percent or even higher (DWR 1998). Some cities, such as Fresno, Davis, and Lodi, rely solely on groundwater for their drinking water supply. In 1995, an estimated 13 million Californians (nearly 43 percent of the State's population) used groundwater for at least a portion of their public supply needs (Solley and others 1998). With a projected population of nearly 46 million by the year 2020, California's demand on groundwater will increase significantly. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality, or limited by a lack of data, lack of management, and coordination between agencies.

In the last few years, California has provided substantial funds to local agencies for groundwater management. For example, the nearly $2 billion Water Bond 2000 (Proposition 13) approved by California voters in March 2000 specifically authorizes funds for two groundwater programs: $200 million for grants for feasibility studies, project design, and the construction of conjunctive use facilities; and $30 million for loans for local agency acquisition and construction of groundwater recharge facilities and grants for feasibility studies for recharge projects. Additionally, the Local Groundwater Management Assistance Act of 2000 (AB 303) resulted in $15 million in fiscal years 2001, 2002, and 2003 for groundwater studies and data collection intended to improve basin and subbasin groundwater management. These projects focus on improving groundwater monitoring, coordinating groundwater basin management, and conducting groundwater studies.

The State Legislature has increasingly recognized the importance of groundwater and the need for monitoring in making sound groundwater management decisions. Significant legislation was passed in 2000, 2001 and 2002. AB 303 authorizes grants to help local agencies develop better groundwater management strategies. AB 599 (2001) requires, for the first time, that the State Water Resources Control Board (SWRCB), in cooperation with other agencies, develop a comprehensive monitoring program capable of assessing groundwater quality in every basin in the State with the intent of maintaining a safe groundwater supply. SB 610 (2001) and SB 901 (2001) together require urban water suppliers, in their urban water management plans, to determine the adequacy of current and future supplies to meet demands. Detailed groundwater information is required for those suppliers that use groundwater. SB 221 (2001) prohibits approval of certain developments without verification of an available water supply. These bills are significant with respect to groundwater because much of California's new development will rely on groundwater for its supply.

Finally, SB 1938 (2002) was enacted to provide incentives to local agencies for improved groundwater management. The legislation modified the Water Code to require that specific elements be included in a groundwater management plan for an agency to be eligible for certain State funding administered by the Department of Water Resources for groundwater projects. AB 303 is exempt from that requirement.

History of Bulletin 118

DWR has long recognized the need for collection, summary, and evaluation of groundwater data as tools in planning optimal use of the groundwater resource. An example of this is DWR's Bulletin 118 series. Bulletin 118 presents the results of groundwater basin evaluations in California. The Bulletin 118 series was preceded by Water Quality Investigations Report No. 3, *Ground Water Basins in California* (referred to in this bulletin as Report No. 3), published in 1952 by the Department of Public Works, Division of Water Resources (the predecessor of DWR). The purpose of Report No. 3 was to create a base index map of the "more important ground water basins" for carrying out DWR's mandate in Section 229 of the Water Code. Section 229 directed Public Works to:

> …investigate conditions of the quality of all waters within the State, including saline waters, coastal and inland, as related to all sources of pollution of whatever nature and shall report thereon to the Legislature and to the appropriate regional water pollution control board annually, and may recommend any steps which might be taken to improve or protect the quality of such waters.

Report No. 3 identified 223 alluvium-filled valleys that were believed to be basins with usable groundwater in storage. A statewide numbering system was created in cooperation with the State Water Pollution Control Board (now the State Water Resources Control Board) based on the boundaries of the nine Regional Water Quality Control Boards. In 1992, Water Code Section 229 was amended, resulting in the elimination of the annual reporting requirements.

In 1975, DWR published Bulletin 118, *California's Ground Water*, (referred to in this report as Bulletin 118-75). Bulletin 118-75 summarized available information from DWR, U.S. Geological Survey, and other agencies for individual groundwater basins to "help those who must make decisions affecting the protection, additional use, and management of the State's ground water resources."

Bulletin 118-75 contains a summary of technical information for 248 of the 461 identified groundwater basins, subbasins, and what were referred to as "areas of potential ground water storage" in California as well as maps showing their location and extent. The Bulletin 118-75 basin boundaries were based on geologic and hydrogeologic conditions except where basins were defined by a court decision.

In 1978, Section 12924 was added to the California Water Code:

> The Department shall, in conjunction with other public agencies, conduct an investigation of the State's groundwater basins. The Department shall identify the State's groundwater basins on the basis of geologic and hydrogeologic conditions and consideration of political boundary lines whenever practical. The Department shall also investigate existing general patterns of groundwater pumping and groundwater recharge within such basins to the extent necessary to identify basins which are subject to critical conditions of overdraft.

DWR published the report in 1980 as *Ground Water Basins in California: A Report to the Legislature in Response to Water Code Section 12924* (referred to in this report as Bulletin 118-80). The bulletin included 36 groundwater basins with boundaries different from Bulletin 118-75. The changed boundaries resulted by combining several basins based on geologic or political considerations and by dividing the San Joaquin Valley groundwater basin into many smaller subbasins based primarily on political boundaries. These changes resulted in the identification of 447 groundwater basins, subbasins, and areas of potential groundwater storage. Bulletin 118-80 also identified 11 basins as subject to critical conditions of overdraft.

Box A Which Bulletin 118 Do You Mean?

Mention of an update to Bulletin 118 causes some confusion about which Bulletin 118 the California Department of Water Resources (DWR) has updated. In addition to the statewide Bulletin 118 series (Bulletin 118-75, Bulletin 118-80, and Bulletin 118-03), DWR released several other publications in the 118 series that evaluate groundwater basins in specific areas of the State. Region-specific Bulletin 118 reports are listed below.

- Bulletin 118-1. Evaluation of Ground Water Resources: South San Francisco Bay
  Appendix A. Geology, 1967
  Volume 1. Fremont Study Area, 1968
  Volume 2. Additional Fremont Study Area, 1973
  Volume 3. Northern Santa Clara County, 1975
  Volume 4. South Santa Clara County, 1981
- Bulletin 118-2. Evaluation of Ground Water Resources: Livermore and Sunol Valleys, 1974
  Appendix A. Geology, 1966
- Bulletin 118-3. Evaluation of Ground Water Resources: Sacramento County, 1974
- Bulletin 118-4. Evaluation of Ground Water Resources: Sonoma County
  Volume 1. Geologic and Hydrologic Data, 1975
  Volume 2. Santa Rosa Plain, 1982
  Volume 3. Petaluma Valley, 1982
  Volume 4. Sonoma Valley, 1982
  Volume 5. Alexander Valley and Healdsburg Area, 1983
- Bulletin 118-5. Bulletin planned but never completed.
- Bulletin 118-6. Evaluation of Ground Water Resources: Sacramento Valley, 1978

The Need for Bulletin 118 Update 2003

Despite California's heavy reliance on groundwater, basic information for many of the groundwater basins is lacking. Particular essential data necessary to provide for both the protection and optimal use of this resource is not available. To this end, the California Legislature mandated in the Budget Act of 1999 that DWR prepare:

> ...the statewide update of the inventory of groundwater basins contained in Bulletin 118-80, which includes, but is not limited to, the following: the review and summary of boundaries and hydrographic features, hydrogeologic units, yield data, water budgets, well production characteristics, and water quality and active monitoring data; development of a water budget for each groundwater basin; development of a format and procedures for publication of water budgets on the Internet; development of the model groundwater management ordinance; and development of guidelines for evaluating local groundwater management plans.

The information on groundwater basins presented in Bulletin 118 Update 2003 is mostly limited to the acquisition and compilation of existing data previously developed by federal, State, and local water agencies. While this bulletin is a good starting reference for basic data on a groundwater basin, more recent data and more information about the basin may be available in recent studies conducted by local water management agencies. Those agencies should be contacted to obtain the most recent data.

Report Organization

Bulletin 118 Update 2003 includes this report and supplemental material consisting of individual descriptions and a Geographic Information System-compatible map of each of the delineated groundwater basins in California. The basin descriptions will be updated as new information becomes available, and can be viewed or downloaded at http://www.waterplan.water.ca.gov/groundwater/118index.htm (Appendix A). Basin descriptions will not be published in hard copy.

This report is organized into the following topics:

- Groundwater is one of California's most important natural resources, and our reliance on it has continued to grow (Chapter 1).
- Groundwater has a complex legal and institutional framework in California that has shaped the groundwater management system in place today (Chapter 2).
- Groundwater management occurs primarily at the local water agency level, but may also be instituted at the local government level. At the request of the Legislature, DWR has developed some recommendations for a model groundwater management ordinance and components for inclusion in a groundwater management plan (Chapter 3).
- Groundwater has had a flurry of activity in the Legislature and at the ballot box in recent years that will affect the way groundwater is managed in California (Chapter 4).
- Groundwater programs with a variety of objectives exist in many State and federal agencies (Chapter 5).
- Groundwater concepts and definitions should be made available to a wide audience (Chapter 6).
- Groundwater basins with a wide range of characteristics and concerns exist in each of California's 10 hydrologic regions (Chapter 7).

Chapter 1
Groundwater – California's Hidden Resource

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Groundwater – California's Hidden Resource

In 1975, *California's Ground Water – Bulletin 118* described groundwater as "California's hidden resource." Today, those words ring as true as ever. Because groundwater cannot be directly observed, except under a relatively few conditions such as at a spring or a wellhead, most Californians do not give much thought to the value that California's vast groundwater supply has added to the State. It is unlikely that California could have achieved its present status as the largest food and agricultural economy in the nation and fifth largest overall economy in the world without groundwater resources. Consider that about 43 percent of all Californians obtain drinking water from groundwater. California is not only the single largest user of groundwater in the nation, but the estimated 14.5 million acre-feet (maf) of groundwater extracted in California in 1995 represents nearly 20 percent of all groundwater extracted in the entire United States (Solley and others 1998).

California's Hydrology

California's climate is dominated by the Pacific storm track. Numerous mountain ranges cause orographic lifting of clouds, producing precipitation mostly on the western slopes and leaving a rain shadow on most eastern slopes (Figure 1 and Figure 2). These storms also leave tremendous accumulations of snow in the Sierra Nevada during the winter months. While the average annual precipitation in California is about 23 inches (DWR 1998), the range of annual rainfall varies greatly from more than 140 inches in the northwestern part of the State to less than 4 inches in the southeastern part of the State.

Snowmelt and rain falling in the mountains flow into creeks, streams, and rivers. The average annual runoff in California is approximately 71 maf (DWR 1998). As these flows make their way into the valleys, much of the water percolates into the ground. The vast majority of California's groundwater that is accessible in significant amounts is stored in alluvial groundwater basins. These alluvial basins, which are the subject of this report, cover nearly 40 percent of the geographic area of the State (Figure 3).

This bulletin focuses on groundwater resources, but in reality groundwater and surface water are inextricably linked in the hydrologic cycle. As an example, groundwater may be recharged by spring runoff in streams, but later in the year the base flow of a stream may be provided by groundwater. So, although the land surface is a convenient division for categorizing water resources, it is a somewhat arbitrary one. It is essential that water managers recognize and account for the relationship between groundwater and surface water in their planning and operations.

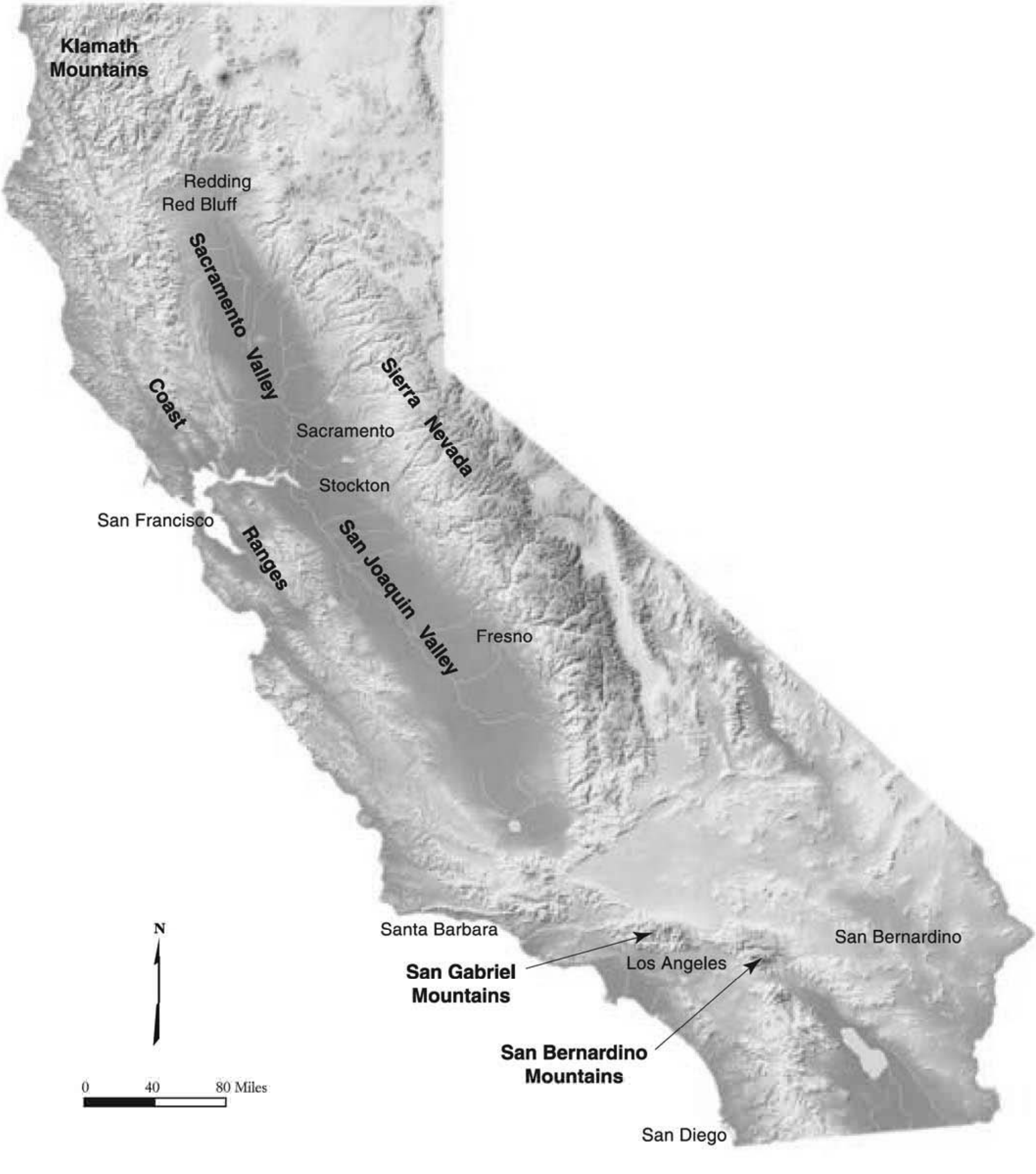

Figure 1 Shaded relief map of California

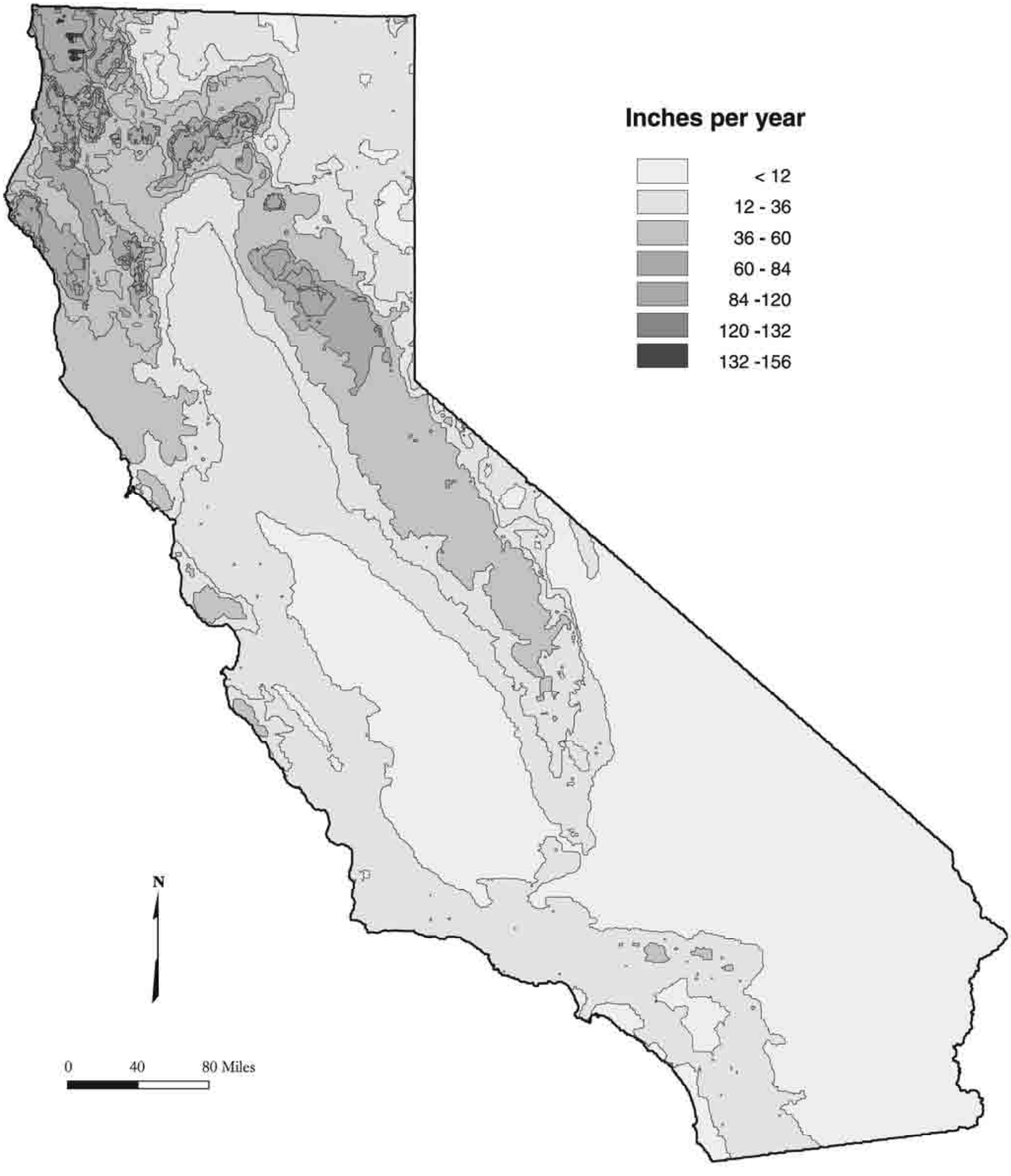

Figure 2 Mean annual precipitation in California, 1961 to 1990

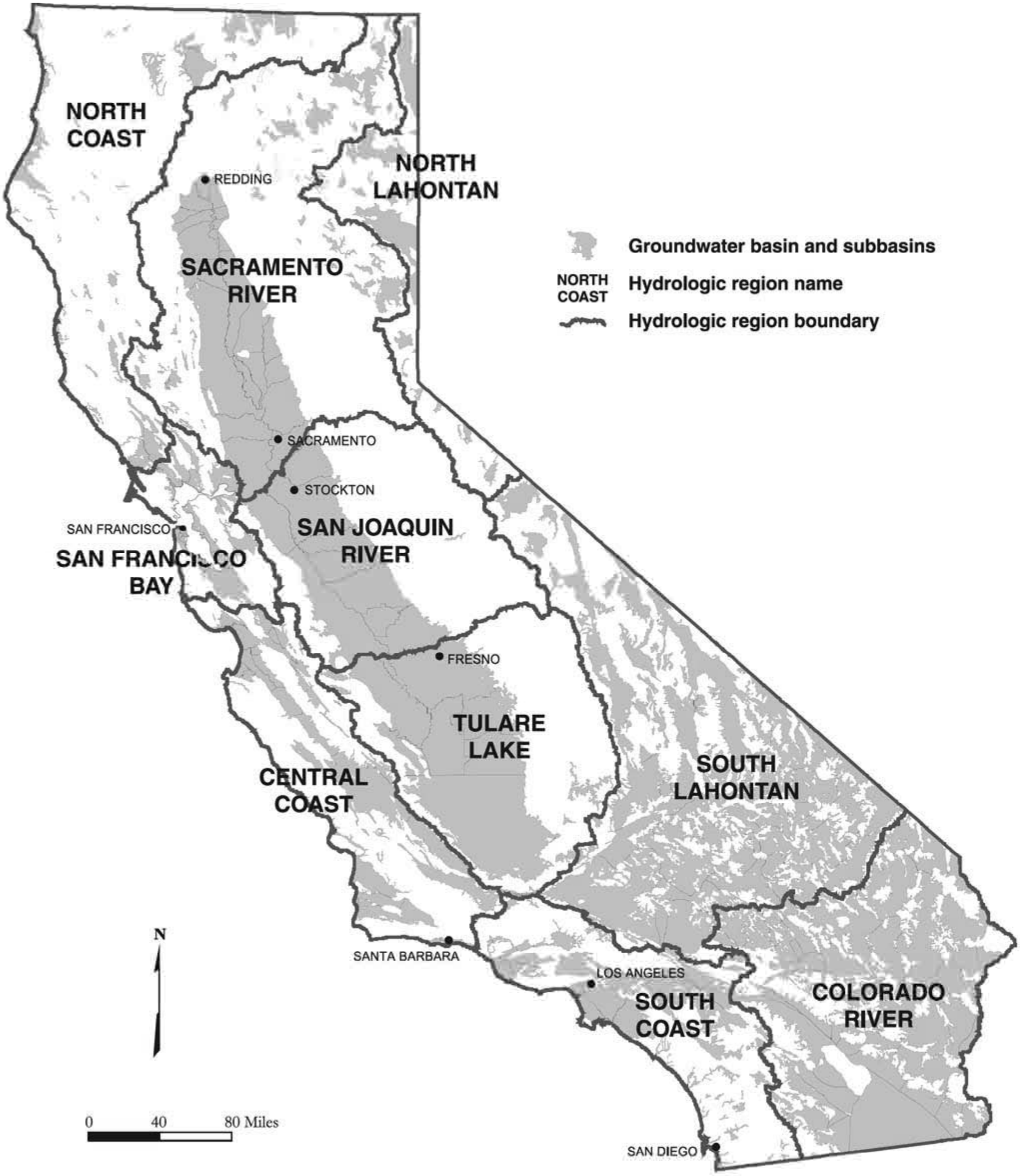

Figure 3 Groundwater basins, subbasins and hydrologic regions

California's Water Supply System

The economic success achieved in California could not have been foreseen a century ago. California's natural hydrologic system appeared too limited to support significant growth in population, industry, and agriculture. The limitations revolved around not only the relative aridity of the State, but the geographic, seasonal, and climatic variability that influence California's water supply. Approximately 70 percent of the State's average annual runoff occurs north of Sacramento, while about 75 percent of the State's urban and agricultural water needs are to the south. Most of the State's precipitation falls between October and April with half of it occurring December through February in average years. Yet, the peak demand for this water occurs in the summer months. Climatic variability includes dramatic deviations from average supply conditions by way of either droughts or flooding. In the 20th century alone, California experienced multiyear droughts in 1912–1913, 1918–1920, 1922–1924, 1929–1934, 1947–1950, 1959–1961, 1976–1977, and 1987–1992 (DWR 1998).

California has dealt with the limitations resulting from its natural hydrology and achieved its improbable growth by developing an intricate system of reservoirs, canals, and pipelines under federal, State and local projects (Figure 4). However, a significant portion of California's water supply needs is also met by groundwater. Typically, groundwater supplies about 30 percent of California's urban and agricultural uses. In dry years, groundwater use increases to about 40 percent statewide and 60% or more in some regions.

The importance of groundwater to the State's development may have been underestimated at the beginning of the 20th century. At that time, groundwater was seen largely as just a convenient resource that allowed for settlement in nearly any part of the State, given groundwater's widespread occurrence. Significant artesian flow from confined aquifers in the Central Valley allowed the early development of agriculture. When the Water Commission Act defined the allocation of surface water rights in 1914, it did not address allocation of the groundwater resource. In the 1920s, the development of the deep-well turbine pump and the increased availability of electricity led to a tremendous expansion of agriculture, which used these high-volume pumps and increased forever the significance of groundwater as a component of water supply in California.

Figure 4 Water projects in California

Box B Will Climate Change Affect California's Groundwater?

California's water storage and delivery system can be thought of as including three reservoir systems—the snowpack of the Sierra Nevada, an extensive system of dams, lakes, and conveyance systems for surface water, and finally the aquifers that store groundwater. Precipitation in the form of snow is stored in the Sierra in winter and early spring and under ideal conditions melts in a manner that allows dams to capture the water for use during California's dry season. When snow melts faster, the dams act as flood control structures to prevent high runoff from flooding lowland areas. Water storage and delivery infrastructure—dams and canals—has been designed largely around the historical snowpack, while aquifers have played a less formal and less recognized role.

What will be the effect of climate change on California's water storage system? How will groundwater basins and aquifers be affected?

The latest report of the Intergovernmental Panel on Climate Change (2001) reaffirms that climate is changing in ways that cannot be accounted for by natural variability and that "global warming" is occurring. Studies by the National Water Assessment Team for the U.S. Global Change Research Program's National Assessment of the Potential Consequences of Climate Variability and Change identify potential changes that could affect water resources systems. For California, these include higher snow levels leading to more precipitation in the form of rain, earlier runoff, a rise in sea level, and possibly larger floods. In addition to affecting the balance between storage and flood control of our reservoirs, such changes in hydrology would affect wildlands, resulting in faunal and floral displacement and resulting in changes in vegetative water consumption. These changes would also affect patterns of both irrigated and dryland farming.

A warmer, wetter winter would increase the amount of runoff available for groundwater recharge; however, this additional runoff in the winter would be occurring at a time when some basins, particularly in Northern California, are either being recharged at their maximum capacity or are already full. Conversely, reductions in spring runoff and higher evapotranspiration because of warmer temperatures could reduce the amount of water available for recharge and surface storage.

The extent to which climate will change and the impact of that change are both unknown. A reduced snowpack, coupled with increased seasonal rainfall and earlier snowmelt may require a change in the operating procedures for existing dams and conveyance facilities. Furthermore, these changes may require more active development of successful conjunctive management programs in which the aquifers are more effectively used as storage facilities. Water managers might want to evaluate their systems to better understand the existing snowpack-surface water-groundwater relationship, and identify opportunities that may exist to optimize groundwater and other storage capability under a new hydrologic regime that may result from climate change. If more water was stored in aquifers or in new or reoperated surface storage, the additional water could be used to meet water demands when the surface water supply was not adequate because of reduced snowmelt.

Recent Groundwater Development Trends

While development of California's surface water storage system has slowed significantly, groundwater development continues at a strong pace. A review of well completion reports submitted to the California Department of Water Resources (DWR) provides data on the number and type of water wells drilled in California since 1987. For the 14-year period, DWR received 127,616 well completion reports for water supply wells that were newly constructed, reconditioned, or deepened—an average of 9,115 annually[1]. Of these, 82 percent were drilled for individual domestic uses; 14 percent for irrigation; and about 4 percent for a combined group of municipal and industrial uses (Figure 5). Although domestic wells predominate, individual domestic use makes up a small proportion of total groundwater use in the State.

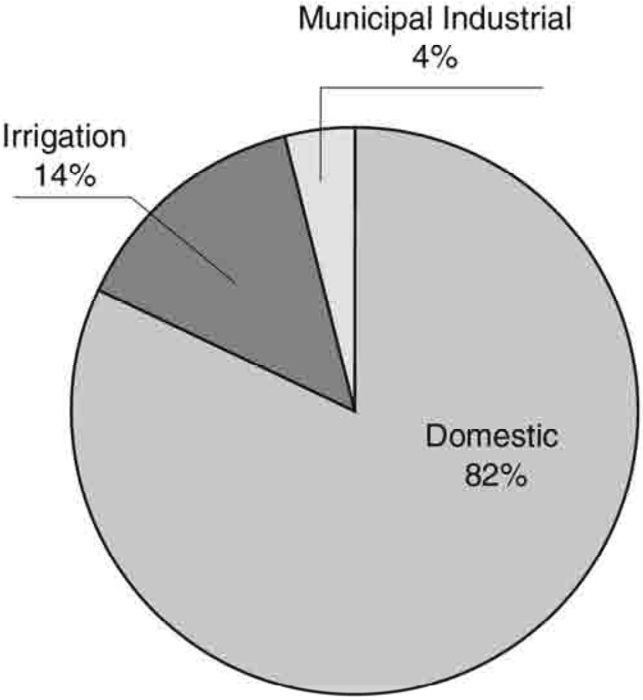

Figure 5 Well completion reports filed with DWR from 1987 through 2000

The most evident influence on the number of wells constructed is hydrologic conditions. The number of wells constructed and modified increases dramatically with drought conditions (Figure 6). The number of wells constructed and modified annually from 1987 through 1992 is more than double the annual totals for 1995 through 2000. Each year from 1987 through 1992 was classified as either dry or critically dry; water years 1995 through 2000 were either above normal or wet, based on measured unimpaired runoff in the Sacramento and San Joaquin valleys. In addition to providing an indication of the growth of groundwater development, well completion reports are a valuable source of information on groundwater basin conditions.

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[1] DWR also received an average of 4,225 well completion reports for monitoring, which were not included above because they do not extract groundwater for supply purposes.

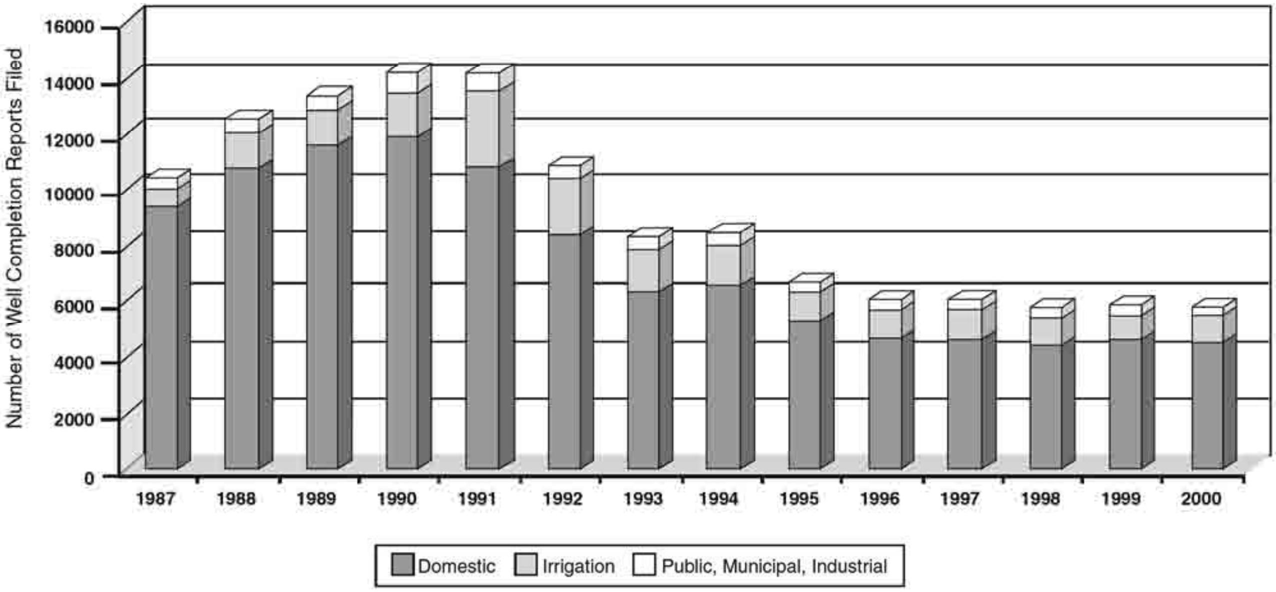

Figure 6 Well completion reports filed annually from 1987 through 2000

The Need for Groundwater Monitoring and Evaluation

Some 34 million people called California their home in the year 2000, and a population of nearly 46 million is expected by 2020. The increased population and associated commercial, industrial, and institutional growth will bring a substantially greater need for water. This need will be met in part by improved water use efficiency, opportunities to reoperate or expand California's surface water system, and increased desalination and recycling of water sources not currently considered usable. This need will also be met by storing and extracting additional groundwater. However, the sustainability of the groundwater resource, both in terms of what is currently used and future increased demand, cannot be achieved without effective groundwater management. In turn, effective groundwater management cannot be achieved without a program of groundwater data collection and evaluation.

Perhaps surprising to many, California does not have a comprehensive monitoring network for evaluating the health of its groundwater resource, including quantity and quality of groundwater. The reasons for this are many with the greatest one being that information on groundwater levels and groundwater quality is primarily obtained by drilling underground, which is relatively expensive. Given that delineated groundwater basins cover about 40 percent of the State's vast area, the cost of a dedicated monitoring network would be prohibitive. The other important reason for the lack of a comprehensive network is that, as will be discussed later in this report, groundwater is a locally controlled resource. State and federal agencies become involved only when a groundwater issue is directly related to the mission of a particular agency or if a local agency requests assistance. For these and other reasons, California lacks a cohesive, dedicated monitoring network.

Box C What about Overdraft?

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts.

The California Water Plan Update, Bulletin 160-98 (DWR 1998) estimated that groundwater overdraft in California in 1995 was nearly 1.5 million acre-feet annually, with most of the overdraft occurring in the Tulare Lake, San Joaquin River, and Central Coast hydrologic regions. The regional and statewide estimates of overdraft are currently being revised for the 2003 update of Bulletin 160. While these estimates are useful from a regional and statewide planning perspective, the basin water budgets calculated for this update of Bulletin 118 clearly indicate that information is insufficient in many basins to quantify overdraft that has occurred, project future impacts on groundwater in storage, and effectively manage groundwater. Further technical discussion of overdraft is provided in Chapter 6 of this bulletin.

When DWR and other agencies involved in groundwater began to collect data in the first half of the 20th century, it quickly became evident that there were insufficient funds to install an adequate number of monitoring wells to accurately determine changes in the condition of groundwater basins. Consequently, to create a serviceable monitoring network, the agencies asked owners of irrigation or domestic wells for permission to measure water levels and to a lesser extent to monitor water quality. These have been called "wells of opportunity." In many areas, this approach has led to a network of wells that provide adequate information to gain a general understanding of conditions in the subsurface and to track changes through time. In some areas, groundwater studies were conducted and often included the construction of a monitoring well network. These studies have gradually contributed to a more detailed understanding of some of California's groundwater basins, particularly the most heavily developed basins.

Given the combination of monitoring wells of opportunity and dedicated monitoring wells, it might be assumed that an adequate monitoring network in California will eventually accumulate. However, several factors contribute to reducing the effectiveness of the monitoring network for data collection and evaluation: (1) The funding for data programs in many agencies, which was generally insufficient in the first place, has been reduced significantly. (2) When private properties change ownership, some new owners rescind permission for agency personnel to enter the property and measure the well. (3) The appropriateness of using these private wells is questionable because they are often screened over long intervals encompassing multiple aquifers in the subsurface, and in some cases construction details for the well are unknown. (4) Some wells with long-term records actually reach the end of their usefulness because the casing collapses or something falls into the well, making it unusable. In some cases, groundwater levels may drop below the well depth. (5) As water quality or water quantity conditions change, the monitoring networks may no longer be adequate to provide necessary data to manage groundwater.

The importance of long-term monitoring networks cannot be overstated. Sound groundwater management decisions require observation of trends in groundwater levels and groundwater quality. Only through these long-term evaluations can the question of sustainability of groundwater be answered. For example, this report contains a summary of groundwater contamination in public water supply wells throughout the State collected from 1994 through 2000. While this provides a "snapshot" of the suitability of the groundwater currently developed for public supply needs, it does not address sustainability of groundwater for public uses. Sustainability can only be determined by observing groundwater quality over time. If conditions worsen, local managers will need to take steps to prevent further harm to groundwater quality. Long-term groundwater records require adequate funding and staff to develop groundwater monitoring networks and to collect, summarize, and evaluate the data.

Chapter 2
Groundwater Management in California

Chapter 2
Groundwater Management in California

Groundwater management, as defined in this report, is the planned and coordinated monitoring, operation, and administration of a groundwater basin or portion of a groundwater basin with the goal of long-term sustainability of the resource. Throughout the history of water management in California, local agencies have practiced an informal type of groundwater management. For example, since the early 20th century, when excess surface water was available, some agencies intentionally recharged groundwater to augment their total water supply. In 1947, the amount of groundwater used was estimated at 9 million to 10 million acre-feet. By the beginning of the 21st century, the amount of groundwater used had increased to an estimated 15 million acre-feet. Better monitoring would provide more accurate information. This increased demand on California's groundwater resources, when coupled with estimates of population growth, has resulted in a need for more intensive groundwater management.

In 1914, California created a system of appropriating surface water rights through a permitting process (Stats 1913, ch. 586), but groundwater use has never been regulated by the State. Though the regulation of groundwater has been considered on several occasions, the California Legislature has repeatedly held that groundwater management should remain a local responsibility (Sax 2002). Although they are treated differently legally, groundwater and surface water are closely interconnected in the hydrologic cycle. Use of one resource will often affect the other, so that effective groundwater management must consider surface water supplies and uses.

Figure 7 depicts the general process by which groundwater management needs are addressed under existing law. Groundwater management needs are identified at the local water agency level and may be directly resolved at the local level. If groundwater management needs cannot be directly resolved at the local agency level, additional actions such as enactment of ordinances by local governments, passage of laws by the Legislature, or decisions by the courts may be necessary to resolve the issues. Upon implementation, local agencies evaluate program success and identify additional management needs. The State's role is to provide technical and financial assistance to local agencies for their groundwater management efforts, such as through the Local Groundwater Assistance grant program (see Chapter 4, AB 303).

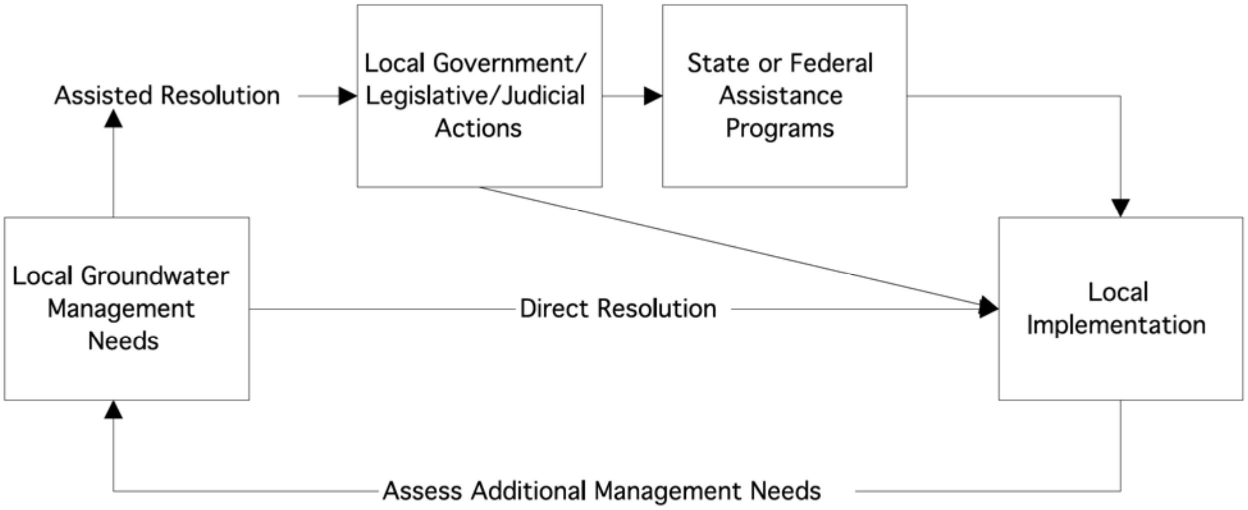

Figure 7 Process of addressing groundwater management needs in California

How Groundwater is Managed in California

There are three basic methods available for managing groundwater resources in California: (1) management by local agencies under authority granted in the California Water Code or other applicable State statutes, (2) local government groundwater ordinances or joint powers agreements, and (3) court adjudications. Table 1 shows how often each of these methods has been used, and each method is discussed briefly below. No law requires that any of these forms of management be applied in a basin. Management is often instituted after local agencies or landowners recognize a specific groundwater problem. The level of groundwater management in any basin or subbasin is often dependent on water availability and demand.

Table 1 Groundwater management methods

Method	Frequency of use[a]
Local water agencies	Undetermined number of agencies with authority to manage some aspect of groundwater under general powers associated with a particular type of district.
	Thirteen agencies with specially legislated authority to limit or regulate extraction.
	Seven agencies with adopted plans under authority from Water Code Section 10750 et seq.[b] (AB 255 of 1991).
	More than 200 agencies with adopted plans under authority from Water Code Section 10750 et seq. (AB 3030 of 1992).
Local groundwater management ordinances	Currently adopted in 27 counties.
Court adjudication	Currently decided in 19 groundwater basins, mostly in Southern California. Three more basins are in court.

a. The numbers for some methods are unknown because reporting to the California Department of Water Resources is not required.
b. Section 10750 *et seq*. was amended in 1992.

Groundwater Management through Authority Granted to Local Water Agencies

More than 20 types of local agencies are authorized by statute to provide water for various beneficial uses. Many of these agencies also have statutory authority to institute some form of groundwater management. For example, a Water Replenishment District (Water Code, § 60000 et seq.) is authorized to establish groundwater replenishment programs and collect fees for that service. A Water Conservation District (Water Code, § 75500 et seq.) can levy groundwater extraction fees. Table 2 lists these and other types of local agencies that deliver water and may have authority to institute some form of groundwater management. Most of these agencies are identified in the Water Code, but their specific authority related to groundwater management varies. The Water Code does not require that the agencies report their activities to the California Department of Water Resources (DWR).

Table 2 Local agencies with authority to deliver water for beneficial uses, which may have authority to institute groundwater management

Local agency	Authority	Number of agencies[a]
Community Services District	Gov. Code § 61000 et seq.	313
County Sanitation District	Health and Safety Code § 4700 et seq.	91
County Service Area	Gov. Code § 25210.1 et seq.	897
County Water Authority	Water Code App. 45.	30
County Water District	Water Code § 30000 et seq.	174
County Waterworks District	Water Code § 55000 et seq.	34
Flood Control and Water Conservation District	Water Code App. 38.	39
Irrigation District	Water Code § 20500 et seq.	97
Metropolitan Water District	Water Code App 109.	1
Municipal Utility District	Pub. Util. Code § 11501 et seq.	5
Municipal Water District	Water Code § 71000 et seq.	40
Public Utility District	Pub. Util. Code § 15501 et seq.	54
Reclamation District	Water Code § 50000 et seq.	152
Recreation and Park District	Pub. Resources Code § 5780 et seq.	110
Resort Improvement District	Pub. Resources Code § 13000 et seq.	-
Resource Conservation District	Pub. Resources Code § 9001 et seq.	99
Water Conservation District	Water Code App. 34; Wat. Code § 74000 et seq.	13
Water District	Water Code § 34000 et seq.	141
Water Replenishment District	Water Code § 60000 et seq.	1
Water Storage District	Water Code § 39000 et seq.	8

a. From State Controller's Office Special Districts Annual Report, 49th Edition.

Greater authority to manage groundwater has been granted to a small number of local agencies or districts created through special acts of the Legislature. For example, the Sierra Valley Groundwater Basin Act of 1980 (Water Code, App. 119) created the first two groundwater management districts in California. Currently, 13 local agencies have specific groundwater management authority as a result of being special act districts. The specific authority of each agency varies, but they can generally be grouped into two categories. Most of the agencies formed since 1980 have the authority to limit export and even control some in-basin extraction upon evidence of overdraft or the threat of overdraft. These agencies can also generally levy fees for groundwater management activities and for water supply replenishment. Agencies formed prior to 1980 do not have authority to limit extraction from a basin. However, the groundwater users in these areas are generally required to report extractions to the agency, and the agency can levy fees for groundwater management or water supply replenishment. Some of these agencies have effectively used a tiered fee structure to discourage excessive groundwater extraction in the basin. Table 3 lists the names of special act districts with legislative authority to manage groundwater.

Table 3 Special act districts with groundwater management authority in California

District or agency	Water Code citation[a]	Year agency established in Code[b]
Desert Water Agency	App. 100	1961
Fox Canyon Groundwater Management Agency	App. 121.	1982
Honey Lake Groundwater Management District	App. 129.	1989
Long Valley Groundwater Management District	App. 119.	1980
Mendocino City Community Services District	Section 10700 et seq.	1987
Mono County Tri-Valley Groundwater Management District	App. 128.	1989
Monterey Peninsula Water Management District	App. 118.	1977
Ojai Groundwater Management Agency	App. 131.	1991
Orange County Water District	App. 40.	1933
Pajaro Valley Water Management Agency	App. 124.	1984
Santa Clara Valley Water District	App. 60.	1951
Sierra Valley Groundwater Management District	App. 119.	1980
Willow Creek Groundwater Management Agency	App. 135.	1993

a. From West's Annotated California Codes (1999 update)

b. This represents the year the agency was established in the Water Code. Specific authorities, such as those for groundwater management activities, may have been granted through later amendments.

In 1991, AB 255 (Stats. 1991, Ch. 903) was enacted authorizing local agencies overlying basins subject to critical conditions of overdraft, as defined in DWR's Bulletin 118-80, to establish programs for groundwater management within their service areas. Water Code section 10750 et seq. provided these agencies with the powers of a water replenishment district to raise revenue for facilities to manage the basin for the purposes of extraction, recharge, conveyance, and water quality. Seven local agencies adopted plans under this authority.

The provisions of AB 255 were repealed in 1992 with the passage of AB 3030 (Stats. 1992, Ch. 947). This legislation was significant in that it greatly increased the number of local agencies authorized to develop a groundwater management plan and set forth a common framework for management by local agencies throughout California. AB 3030, which is codified in Water Code section 10750 et seq., provides a systematic procedure to develop a groundwater management plan by local agencies overlying the groundwater basins defined by Bulletin 118-75 (DWR 1975) and updates. Upon adoption of a plan, these agencies could possess the same authority as a water replenishment district to "fix and collect fees and assessments for groundwater management" (Water Code, § 10754). However, the authority to fix and collect these fees and assessments is contingent on receiving a majority of votes in favor of the proposal in a local election (Water Code, § 10754.3). More than 200 agencies have adopted an AB 3030 groundwater management plan. None of these agencies is known to have exercised the authority of a Water Replenishment District.

Water Code section 10755.2 expands groundwater management opportunities by encouraging coordinated plans and by authorizing public agencies to enter into a joint powers agreement or memorandum of understanding with public or private entities that provide water service. At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.

Local Groundwater Ordinances

A second general method of managing groundwater in California is through ordinances adopted by local governments such as cities or counties. Twenty-seven counties have adopted groundwater ordinances, and others are being considered (Figure 8). The authority of counties to regulate groundwater has been challenged, but in 1995 the California Supreme Court declined to review an appeal of a lower court decision *Baldwin v. County of Tehama* (1994) that holds that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. However, the precise nature and extent of the police power of cities and counties to regulate groundwater is uncertain.

The Public Policy Institute of California recently performed a study of California's water transfer market, which included a detailed investigation of the nature of groundwater ordinances by counties in California. The report found that 22 counties had adopted ordinances requiring a permit to export groundwater. In all but three cases, restricting out-of-county uses appears to be the only purpose (Hanak 2003). One ordinance, adopted recently in Glenn County (Box D, "Basin Management Objectives for Groundwater Management"), takes a comprehensive approach by establishing management objectives for the county's groundwater basins. Several other counties in Northern California are considering adopting similar management objective based ordinances.

Ordinances are mostly a recent trend in groundwater management, with 24 of the 27 ordinances enacted since 1990. Local ordinances passed during the 1990s have significantly increased the potential role of local governments in groundwater management. The intent of most ordinances has been to hold project proponents accountable for impacts that may occur as a result of proposed export projects. Because adoption of most of these ordinances is recent, their effect on local and regional groundwater management planning efforts is not yet fully known. However, it is likely that future groundwater development will take place within the constraints of local groundwater management ordinances. Table 4 lists counties with groundwater management ordinances and their key elements.

Figure 8 Counties with groundwater ordinances

Box D Basin Management Objectives for Groundwater Management

Most county groundwater management ordinances require that an export proponent prove the project will not deplete groundwater, cause groundwater quality degradation, or result in land subsidence. Although these factors could be part of any groundwater management plan, these ordinances do not require that a groundwater management plan be developed and implemented.

The only ordinance requiring development and adoption of objectives to be accomplished by management of the basin was adopted by the Glenn County Board of Supervisors in 2000. The action came after a citizens committee spent five years working with stakeholders. The process of developing a groundwater management ordinance for Glenn County began in 1995 when local landowners and county residents became concerned about plans to export groundwater or substitute groundwater for exported surface water. Control of exports was the focus of early ordinance discussions.

After long discussions and technical advice from groundwater specialists, the committee realized that goals and objectives must be identified for effective management of groundwater in the county. What did the county want to accomplish by managing groundwater within the county? What did groundwater management really mean?

The concept of establishing basin management objectives emerged (BMOs). BMOs would establish threshold values for groundwater levels, groundwater quality, and land surface subsidence. When a threshold level is reached, the rules and regulations require that groundwater extraction be adjusted or stopped to prevent exceeding the threshold.

The Glenn County Board of Supervisors has adopted BMOs, which were developed by an advisory committee, for groundwater levels throughout the county. While currently there are 17 BMOs representing the 17 management areas in the county, the goal is to begin managing the entire county in a manner that benefits each of the local agencies and their landowners, as well as landowners outside of an agency boundary. The committee is now developing BMOs for groundwater quality and land surface subsidence.

There is no single set of management objectives that will be successful in all areas. Groundwater management must be adapted to an area's political, institutional, legal, and technical constraints and opportunities. Groundwater management must be tailored to each basin or subbasin's conditions and needs. Even within a single basin, the management objectives may change as more is learned about managing the resource within that basin. Flexibility is the key, but that flexibility must operate within a framework that ensures public participation, monitoring, evaluation, feedback on management alternatives, rules and regulations, and enforcement.

Table 4 Counties with ordinances addressing groundwater management

County	Year enacted	Key elements (refer to ordinances for exemptions and other details)
Butte	1996	Export permit required (extraction & substitute pumping), Water Commission and Technical Advisory Committee, groundwater planning reports (county-wide monitoring program)
Calaveras	2002	Export permit required (extraction & substitute pumping)
Colusa	1998	Export permit required (extraction & substitute pumping)
Fresno	2000	Export permit required (extraction & substitute pumping)
Glenn	1990 rev. 2000	Water Advisory Committee and Technical Advisory Committee, basin management objectives and monitoring network, export permit required (1990)
Imperial	1996	Commission established to manage groundwater, including controlling exports (permit required), overdraft, artificial recharge, and development projects
Inyo	1998	Regulates (1) water transfers pursuant to Water Code Section 1810, (2) sales of water to the City of Los Angeles from within Inyo Co., (3) transfer or transport of water from basins within Inyo County to another basin with the County, and (4) transfers of water from basins within Inyo Co. to any area outside the County.
Kern	1998	Conditional use permit for export to areas both outside county and within watershed area of underlying aquifer in county. Only applies to southeastern drainage of Sierra Nevada and Tehachapi mountains.
Lake	1999	Export permit required (extraction & substitute pumping)
Lassen	1999	Export permit required (extraction & substitute pumping)
Madera	1999	Permit required for export, groundwater banking, and import for groundwater banking purposes to areas outside local water agencies
Mendocino	1995	Mining of groundwater regulated for new developments in Town of Mendocino
Modoc	2000	Export permit required for transfers out of basin
Mono	1988	Permit required for transfers out of basin
Monterey	1993	Water Resources Agency strictly regulates extraction facilities in zones with groundwater problems
Napa	1996	Permits for local groundwater extractions; exemptions for single parcels and agricultural use
Sacramento	1952 rev. 1985	Water Agency established to manage and protect groundwater management zones; replenishment charges
San Benito	1995	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use, injecting imported water; influence of well pumping restrictions
San Bernardino	2002	Permit required for any new groundwater well within the desert region of the county
San Diego	1991	Provides for mapping of groundwater impacted basins (defined); projects within impacted basins require groundwater investigations
San Joaquin	1996	Export permit required (extraction & substitute pumping)
Shasta	1997	Export permit required (extraction & substitute pumping)
Sierra	1998	Export permit required or for off-parcel use
Siskiyou	1998	Permit required for transfers out of basin
Tehama	1992	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use; influence of well pumping restrictions
Tuolumne	2001	Export permit required (extraction & substitute pumping)
Yolo	1996	Export permit required (extraction & substitute pumping)

Adjudicated Groundwater Basins

A third general form of groundwater management in California is court adjudication. In some California groundwater basins, as the demand for groundwater exceeded supply, landowners and other parties turned to the courts to determine how much groundwater can rightfully be extracted by each user. The courts study available data to arrive at a distribution of the groundwater that is available each year, usually based on the California law of overlying use and appropriation. This court-directed process can be lengthy and costly. As noted in Table 5, the longest adjudication took 24 years. Many of these cases have been resolved with a court-approved negotiated settlement, called a stipulated judgment. Unlike overlying and non-overlying rights to groundwater, such decisions guarantee to each party a proportionate share of the groundwater that is available each year. The intense technical focus on the groundwater supply and restrictions on groundwater extraction for all parties make adjudications one of the strongest forms of groundwater management in California.

There are 19 court adjudications for groundwater basins in California, mostly in Southern California (see Table 5). Eighteen of the adjudications were undertaken in State Superior Court and one in federal court. For each adjudicated groundwater basin, the court usually appoints a watermaster to oversee the court judgment. In 15 of these adjudications, the court judgment limits the amount of groundwater that can be extracted by all parties based on a court-determined safe yield of the basin. The basin boundaries are also defined by the court. The Santa Margarita Basin was adjudicated in federal court. That decision requires water users to report the amount of surface water and groundwater they use, but groundwater extraction is not restricted.

Most basin adjudications have resulted in either a reduction or no increase in the amount of groundwater extracted. As a result, agencies often import surface water to meet increased demand. The original court decisions provided watermasters with the authority to regulate extraction of the quantity of groundwater; however, they omitted authority to regulate extraction to protect water quality or to prevent the spread of contaminants in the groundwater. Because water quantity and water quality are inseparable, watermasters are recognizing that they must also manage groundwater quality.

Box E Adjudication of Groundwater Rights in the Raymond Basin

The first basin-wide adjudication of groundwater rights in California was in the Raymond Basin in Los Angeles County in 1949 (*Pasadena v. Alhambra*). The first water well in Raymond Basin was drilled in 1881; 20 years later, the number of operating wells grew to about 140. Because of this pumping, the City of Pasadena began spreading water in 1914 to replenish the groundwater, and during the next 10 years the city spread more than 20,000 acre-feet.

Pumping during 1930 through 1937 caused water levels to fall 30 to 50 feet in wells in Pasadena. After attempting to negotiate a reduction of pumping on a cooperative basis, the City of Pasadena, on September 23, 1937, filed a complaint in Superior Court against the City of Alhambra and 29 other pumpers to quiet title to the water rights within Raymond Basin. The court ruled that the city must amend its complaint, making defendants of all entities pumping more than 100 acre-feet per year, and that it was not a simple quiet title suit but, a general adjudication of the water rights in the basin.

In February 1939, a court used the reference procedure under the State Water Code to direct the State Division of Water Resources, Department of Public Works (predecessor to the Department of Water Resources) as referee to review all physical facts pertaining to the basin, determine the safe yield, and ascertain whether there was a surplus or an overdraft. The study took 2-1/2 years to complete and cost more than $53,000, which was paid by the parties. The resulting Report of Referee submitted to the court in July 1943 found that the annual safe yield of the basin was 21,900 acre-feet but that the actual pumping and claimed rights were 29,400 acre-feet per year.

Most parties agreed to appoint a committee of seven attorneys and engineers to work out a stipulated agreement. In 1944, the court designated the Division of Water Resources to serve as watermaster for the stipulated agreement, which all but one of the parties supported. On December 23, 1944, the judge signed the judgment that adopted the stipulation.

The stipulation provided that (1) the water was taken by each party openly, notoriously, and under a claim of right, which was asserted to be, and was adverse to each and all other parties; (2) the safe yield would be divided proportionally among the parties; and (3) each party's right to a specified proportion of the safe yield would be declared and protected. It also established an arrangement for the exchange of pumping rights among parties.

Based on the stipulation, the court adopted a program of proportionate reductions. In so doing, the court developed the doctrine of mutual prescription, whereby the rights were essentially based on the highest continual amount of pumping during the five years following the beginning of the overdraft, and under conditions of overdraft, all of the overlying and appropriative water users had acquired prescriptive rights against each other, that is, mutual prescription.*

In 1945, one party appealed the judgment, and in 1947, the District Court of Appeals reversed and remanded *Pasadena v. Alhambra*. However, on June 3, 1949, the State Supreme Court overturned the appellate court's decision and affirmed the original judgment. In 1950, the court granted a motion by the City of Pasadena that there be a review of the determination of safe yield, and in 1955, the safe yield and the total decreed rights were increased to 30,622 acre-feet per year. In 1984, watermaster responsibilities were assigned to the Raymond Basin Management Board.

*In City of Los Angeles v. City of San Fernando (1975) the California Supreme Court rejected the doctrine of mutual prescription and held that a groundwater basin should be adjudicated based on the correlative rights of overlying users and prior appropriation among non-overlying users. For further discussion, see Appendix B.

Table 5 List of adjudicated basins

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
1—Scott River Stream System	Scott River Valley; Siskiyou	1-5	1970	1980	Two local irrigation districts
2—Santa Paula Basin	Subbasin of Santa Clara River; Ventura	4-4	1991	1996	Three-person technical advisory committee from United Water CD, City of Ventura, and Santa Paula Basin Pumpers Association; www.unitedwater.org
3—Central Basin	Northeast part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1962	1965	DWR—Southern District; wwwdpla.water.ca.gov/sd/watermaster/watermaster.html
4—West Coast Basin	Southwest part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1946	1961	DWR—Southern District; wwwdpla.water.ca.gov/sd/watermaster/watermaster.html
5—Upper Los Angeles River Area	San Fernando Valley Basin (entire watershed); Los Angeles	4-12	1955	1979	Superior Court appointee
6—Raymond Basin	Northwest part of San Gabriel Valley Basin; Los Angeles	4-13	1937	1944	Raymond Basin Management Board
7—Main San Gabriel Basin	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1968	1973	Water purveyors and water districts elect a nine-member board; www.watermaster.org/
Puente Narrows, *Addendum to Main San Gabriel Basin decision*			1972	1972	Two consulting engineers
8—Puente	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1985	1985	Three consultants
9—Cummings Basin	Cummings Valley Basin; Kern	5-2	1966	1972	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
10—Tehachapi Basin	Tehachapi Valley West Basin and Tehachapi Valley East Basin; Kern	5-28 6-45	1966	1973	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
11—Brite Basin	Brite Valley; Kern	5-80	1966	1970	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm

Table 5 List of adjudicated basins (continued)

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
12—Mojave Basin Area Adjudication	Lower, Middle & Upper Mojave River Valley Basins; El Mirage & Lucerne valleys; San Bernardino	6-40, 6-41, 6-42	1990	1996	Mojave Water Agency; www.mojavewater.org/mwa700.htm
13—Warren Valley Basin	Part of Warren Valley Basin; San Bernardino	7-12	1976	1977	Hi-Desert Water District; www.mojavewater.org
14—Chino Basin	Northwest part of Upper Santa Ana Valley Basin; San Bernardino and Riverside	8-2	1978	1978	Nine people, recommended by producers and appointed by the court; www.cbwm.org/
15—Cucamonga Basin	North central part of Upper Santa Ana Valley Basin; San Bernardino	8-2	1975	1978	Not yet appointed, operated as part of Chino Basin
16—San Bernardino Basin Area	Northeast part of Upper Santa Ana Basin; San Bernardino and Riverside	8-2	1963	1969	One representative each from Western Municipal Water District of Riverside County & San Bernardino Valley Municipal Water District
17—Six Basins	Six subbasins in northwest upper Santa Ana Valley; Upper & Lower Claremont Heights, Canyon, Pomona, Live Oak & Ganesha; Los Angeles. Small portions of Upper Claremont Heights and Canyon are in San Bernardino County	4-14, 8-2	1998	1998	Nine-member board representing all parties to the judgment
18—Santa Margarita River watershed	The Santa Margarita River watershed, including 3 groundwater basins: Santa Margarita Valley, Temecula Valley and Cahuilla Valley Basins; San Diego and Riverside.	9-4, 9-5, 9-6	1951	1966	U.S. District Court appointee
19—Goleta	Goleta Central Basin; judgment includes North Basin; Santa Barbara	3-16	1973	1989	No watermaster appointed; the court retains jurisdiction

How Successful Have Groundwater Management Efforts Been?

This chapter describes the opportunities for local agencies to manage their groundwater resources. Many have questioned whether these opportunities have led to an overall successful system of groundwater management throughout California. How successful groundwater management has been throughout the State is a difficult question and cannot be answered at present. While there are many examples of local agency successes (see Box F, "Managing through a Joint Powers Agreement," Box G, "Managing a Basin through Integrated Water Management," and Box H, "Managing Groundwater Using both Physical and Institutional Solutions"), there are neither mandates to prepare groundwater management plans nor reporting requirements when plans are implemented, so a comprehensive assessment of local planning efforts is not possible. Additionally, many plans have been adopted only recently, during a period of several consecutive wet years, so many of the plan components are either untested or not implemented.

At a minimum, successful groundwater management should be defined as maintaining and maximizing long-term reliability of the groundwater resource, focused on preventing significant depletion of groundwater in storage over the long term and preventing significant degradation of groundwater quality. A review of some of the groundwater management plans prepared under AB 3030 reveals that some plans are simply brief recitations about continuing the agency's existing programs. Not all agencies that enacted groundwater management plans under AB 3030 are actively implementing the plan.

Despite this apparent lack of implementation of groundwater management plans prepared under AB 3030, the bill has certainly increased interest in more effective groundwater management. With more than 200 agencies participating in plans and more than 120 of those involved in coordinated plans with other agencies, AB 3030 has resulted in a heightened awareness of groundwater management. Additionally, annual reports published by a few water agencies indicate that they are indeed moving toward better coordination throughout the basin and more effective management of all water supplies. Given the history of groundwater management in California, these seemingly small steps toward better management may actually represent giant strides forward.

More recently, financial incentives have played a large role in driving groundwater management activities. For example, under grant and loan programs resulting from Proposition 13 of 2000 (see description in Chapter 4), local agencies submitted applications proposing a total increase in annual water yield of more than 300,000 acre-feet through groundwater storage projects. Additional projects and programs would be developed with sufficient funding for feasibility and pilot studies. Unfortunately, not enough funding exists for all of the proposed projects, and many other legal and institutional barriers remain (see Box I, "Impediments to Conjunctive Management Programs in California"). It is clear, however, that further incentives would help agencies move ahead more aggressively in their groundwater management planning efforts.

Additional progress in groundwater management is reflected by passage of amendments to the Water Code (§§ 10753.4 and 10795.4 as amended, §§ 10753.7, 10753.8, and 10753.9 as amended and renumbered, and §§ 10753.1 and 10753.7 as added) through SB 1938 of 2002. The amendments require that groundwater management plans include specific components for agencies to be eligible for some public funds for groundwater projects. The provisions of SB 1938 (2001) are fully described in Chapters 3 and 4.

This evaluation of groundwater management success has not really considered ordinances and adjudications. Adjudications have been successful at maintaining the groundwater basin conditions, often restricting pumping for all basin users. In some cases, adjudication provides the necessary framework for more proactive management as well. Ordinances have successfully restricted exports from basins, but have not

Box F Managing through a Joint Powers Agreement

In 1993, representatives from business, environmental, public, and water purveyor interests formed the Sacramento Area Water Forum to develop a plan to protect the region's water resources from the effects of prolonged drought as the demand for water continues to grow. The Water Forum was founded on two co-equal objectives: (1) to provide a reliable and safe water supply for the region's economic health and planned development to the year 2030 and (2) to preserve the fishery, wildlife, recreational and aesthetic values of the lower American River.

After a six-year consensus-based process of education, analysis and negotiation, the participants signed a Water Forum agreement to meet these objectives. The agreement provides a framework for avoiding future water shortages, environmental degradation, groundwater contamination, threats to groundwater reliability, and limits to economic prosperity.

The Sacramento Groundwater Authority (SGA) was formed to fulfill a key Water Forum goal of protecting and managing the north-area groundwater basin. The SGA is a joint powers authority formed for the purpose of collectively managing the region's groundwater resources. This authority permits SGA to make contractual arrangements required to implement a conjunctive use program, and also provides potential partners with the legal and political certainty for entering into long-term agreements.

SGA's regional banking and exchange program is designed to provide long-term supply benefits for local needs, but also will have the potential to provide broader statewide benefits consistent with American River environmental needs. Water stored in Folsom Lake would be conjunctively used with groundwater in order to reduce surface water diversions in dry years and to achieve in-lieu recharge of the basin in wet years. The conjunctive use program participants include 16 water providers in northern Sacramento and southern Placer counties that serve water to more than half a million people.

Two of three implementation phases of the program are complete. In the first phase, program participants identified long-term water supply needs and conducted an inventory of existing infrastructure that could be used to implement the program. In the second phase, SGA completed two pilot banking and exchange projects, demonstrating the technical, legal, and institutional viability of a regional conjunctive use program. In the first pilot study, water agencies worked with the U.S. Bureau of Reclamation and the Sacramento Area Flood Control Agency to bank 2,100 acre-feet of groundwater, providing additional flood storage capacity in Folsom Lake. In the second pilot study, Citrus Heights and Fair Oaks water districts and the city of Sacramento extracted and used 7,143 acre-feet of groundwater, forgoing a portion of their rights to surface water, making this water available to the Environmental Water Account. The third phase of the SGA program is to further solidify the institutional framework and construct facilities to implement a full-scale regional conjunctive use program. These facilities, that will result in an average annual yield of 21,400 acre-feet, are currently under construction, funded in part by a $21.6 million grant under Proposition 13 of 2000.

Box G Managing a Basin through Integrated Water Management

Orange County Water District (OCWD) was established in 1933 by an uncodified Act (Water Code App. 40) to manage Orange County's groundwater basin and protect the Santa Ana River rights of water users of north-central Orange County. The district manages the groundwater basin, which provides as much as 75 percent of the water supply for its service area. The district strives for a groundwater-based water supply with enough reserves to provide a water supply through drought conditions. An integrated set of water management practices helps achieve this, including the use of recharge, alternative sources, and conservation.

Recharge

The Santa Ana River provides the main natural recharge source for the county's groundwater basin. Increased groundwater use and lower-than-average rainfall during the late 1980s and early 1990s forced the district to rely on an aggressive program to enhance recharge of the groundwater basin. Programs used today to optimize water use and availability include:

- Construction of levees in the river channel to increase infiltration.
- Construction of artificial recharge basins within the forebay.
- Development of an underwater basin cleaning vehicle that removes a clogging layer at the bottom of the recharge basin and extends the time between draining the basin for cleaning by a bulldozer.
- Use of storm water captured behind Prado Dam that would otherwise flow to the ocean.
- Use of imported water from the State Water Project and Colorado River.
- Injection of treated recycled water to form a seawater intrusion barrier.

Alternative Water Use and Conservation

OCWD has successfully used nontraditional sources of water to help satisfy the growing need for water in Orange County. Projects that have added to the effective supply of groundwater are:

- Use of treated recycled water for irrigation and industrial use.
- In-lieu use to reduce groundwater pumping.
- Change to low-flow toilets and showerheads.
- Participation of 70 percent of Orange County hotels and motels in water conservation programs.
- Change to more efficient computerized irrigation.

Since 1975, Water Factory 21 has provided recycled water that meets all primary and secondary drinking water standards set by the California Department of Health Services. OCWD has proposed a larger, more efficient membrane purification project called the Groundwater Replenishment System (GWRS), which is scheduled to begin operating at 70,000 acre-feet per year in 2007. By 2020 the system will annually supply 121,000 acre-feet of high quality water for recharge, for injection into the seawater intrusion barrier, and for direct industrial uses.

This facility will use a lower cost microfiltration and reverse osmosis treatment process that produces water of near distilled quality, which will help reverse the trend of rising total dissolved solids (TDS) in groundwater caused by the recharge of higher TDS-content Santa Ana River and Colorado River waters. The facility will use about half the energy required to import an equivalent amount of water to Orange County from Northern California. The GWRS will be funded, in part, by a $30 million grant under Proposition 13 of 2000.

Source: Orange County Water District

Box H Managing Groundwater using both Physical and Institutional Solutions

Four agencies share responsibility for groundwater management in Ventura County. Coordination and cooperation between these agencies focus on regular meetings, attendance at each other's board meetings, joint projects, watershed committees, and ongoing personal contacts to discuss water-related issues. The agencies and their areas of responsibility are:

- United Water Conservation District – physical solutions, monitoring, modeling, reporting, administering management plans and adjudication;
- Fox Canyon Groundwater Management Agency – pumping allocations, credits and penalties, abandoned well destruction, data for irrigation efficiency;
- County of Ventura – well permits, well construction regulations, tracking abandoned wells; and
- Calleguas Municipal Water District – groundwater storage of imported water.

In Ventura County 75% to 80% of the extracted groundwater is for agriculture; the remainder is for municipal and industrial use. Seawater intrusion into the aquifers was recognized in the 1940s and was the driving force behind a number of groundwater management projects and policies in the county's groundwater basins. As groundwater issues became more complicated at the end of the 20th century, these groundwater management projects and policies were useful in solving a number of problems.

Physical Solutions

Physical solutions substitute supplemental surface water for groundwater pumping near coastal areas, increase basin recharge, and increase the reliability of imported water. Projects include:

- Winter flood-flow storage for dry season release
- Wells and pipelines to move pumping for drinking water away from the coast
- Diversion structures to supply surface water to spreading grounds and irrigation
- Pipelines to convey surface water to coastal areas
- Las Posas Basin Aquifer Storage and Recovery project

Institutional Solutions

Institutional solutions focus on developing and implementing effective groundwater management programs, reducing pumping demands, tracking groundwater levels and water quality, managing groundwater pumping patterns, and destroying abandoned wells to prevent cross-contamination of aquifers. Solutions include:

- Creation of Fox Canyon Groundwater Management Agency (GMA), which represents each major pumping constituency
- Use of irrigation efficiency (agriculture), water conservation, and alternative sources of water (urban) to reduce pumping by 25%
- Manage outside the GMA area through an AB 3030 plan and a court adjudication
- Limit new permits for wells in specific aquifers to avoid seawater intrusion
- Creation of a program to destroy abandoned wells
- Creation of a database of historical groundwater levels and quality information collected since the 1920s
- Development of a regional groundwater flow model and a regional master plan for groundwater projects
- Creation of an irrigation weather station to assist in irrigation efficiency

Implementation of these physical and institutional management tools has resulted in the reversal of seawater intrusion in key coastal monitoring wells. These same tools are being used to mitigate saline intrusion (not seawater) in two inland basins and to reduce seasonal nitrate problems in the recharge area. Work is being expanded to help reduce loading of agricultural pesticides and nutrients. Without close coordination and cooperation of the county's water related agencies, municipalities, and landowners, it would have been very difficult to implement most of these solutions. Although such coordination takes time, the investment has paid off in solutions that help provide a sustainable water supply for all water users in Ventura County.

Source: United Water Conservation District necessarily improved groundwater management. The primary intent of most ordinances is to ensure that proponents of projects are held accountable for potential impacts of the proposed export projects. As studies lead to a better understanding of local water resources, development of pilot export and transfer projects, with appropriate monitoring, may lead to greater certainty in managing groundwater resources. Areas managed under adjudications and ordinances will continue to develop more active management approaches. Population growth and its accompanying increased demand on the resources is a certainty. Most geographic areas in California are not immune to this growth, so strategies for more than just maintaining existing groundwater supply through extraction or export restrictions need to be implemented.

Box I Impediments to Conjunctive Management Programs in California

In 1998 the National Water Research Institute, in cooperation with the Association of Ground Water Agencies and the Metropolitan Water District of Southern California, conducted a workshop to determine the biggest impediments to implementing a cost-effective conjunctive water management program in California.

Since that time, some steps have been taken to overcome those impediments, but several important barriers remain. Workshop participants identified the 10 most significant obstacles:

1) Inability of local and regional water management governance entities to build trust, resolve differences (internally and externally), and share control.
2) Inability to match benefits and funding burdens in ways that are acceptable to all parties, including third parties.
3) Lack of sufficient federal, State, and regional financial incentives to encourage groundwater conjunctive use to meet statewide water needs.
4) Legal constraints that impede conjunctive use, regarding storage rights, basin judgments, area of origin, water rights, and indemnification.
5) Lack of statewide leadership in the planning and development of conjunctive use programs as part of comprehensive water resources plans, which recognize local, regional, and other stakeholders' interests.
6) Inability to address quality difference in "put" versus "take"; standards for injection, export, and reclaimed water; and unforeseeable future groundwater degradation.
7) Risk that water stored cannot be extracted when needed because of infrastructure, water quality or water level, politics, and institutional or contractual provisions.
8) Lack of assurances to prevent third-party impacts and assurances to increase willingness of local citizens to participate.
9) Lack of creativity in developing lasting "win-win" conjunctive use projects, agreements, and programs.
10) Supplemental suppliers and basin managers have different roles and expectations in relation to conjunctive use.

[**Editor's note**: The California Department of Water Resources' Conjunctive Water Management program has taken significant steps to overcome several of these impediments, using a combination of California Bay-Delta Authority, DWR, Proposition 13, and AB 303 funds to promote locally planned and controlled conjunctive use programs.]

Future Groundwater Management in California

Trying to predict what will happen with groundwater management in California is difficult given that actions by all of the involved groups—landowners, local governments, local, State, and federal agencies, and the courts—will continue to shape groundwater management in the future. However, the increasing population and its demands on California's water supply will accelerate the rate at which groundwater management issues become critical and require resolution. Some general conclusions are:

- Groundwater management will continue to be a local responsibility with increasing emphasis on how actions in one part of a basin impact groundwater resources throughout the basin. Regional cooperation and coordination of groundwater management activities will increase.

- As the State's population continues to grow, the increased reliance on groundwater will keep the topic of groundwater management at the forefront of legislative interest.

- Coordinated management of groundwater and surface water resources, through further development of conjunctive water management programs and projects, will become increasingly important.

- The increased reliance on groundwater in the future will necessitate a more direct link between land use planning, watershed management, floodplain management, and groundwater management plans.

- Current trends indicate that financial incentives in the form of loans and grants are increasing groundwater management planning and implementation at the local level. These successes will only continue at the current pace with increased funding to local agencies.

- Management of groundwater will increasingly include consideration of groundwater quality and groundwater quantity.

- Groundwater will be an important element in the trend toward an integrated water management approach that considers the full range of demand management and supply alternatives.

- Understanding of the relationship of groundwater and surface water and the role of groundwater in the environment will continue to grow.

Box J Managing Groundwater Quantity and Quality

When people hear the words "groundwater monitoring"' they may think either of measuring groundwater levels or of analyzing for groundwater quality. In reality, monitoring and management of groundwater quantity and groundwater quality are inseparable components of a management plan.

Although the primary focus of the California Department of Water Resources (DWR) is on groundwater quantity and the measures taken by local agencies to manage supply, management must also consider groundwater quality. Natural or anthropogenic contamination and pumping patterns that are not managed to protect groundwater quality may limit the quantity of groundwater that is available for use in a basin.

Several State programs provide useful data as well as regulatory direction on groundwater quality that managers can use in managing their groundwater supply. One program is the Drinking Water Source Assessment and Protection Program prepared by the California Department of Health Services in response to 1996 amendments to the federal Safe Drinking Water Act. The DWSAP requires water purveyors to assess sources of drinking water, develop zones indicating time of travel of groundwater, and identify potentially contaminating activities around supply wells. The goal is to ensure that the quality of drinking water sources is maintained and protected. Other useful water quality data for groundwater managers is collected by the agencies within the California Environmental Protection Agency, including the State Water Resources Control Board, Department of Pesticide Regulation and the Department of Toxic Substances Control, which are discussed in more detail in Chapter 5. Each of these agencies has a specific statutory responsibility to collect groundwater quality information and protect water quality.

Protection of Recharge Areas

Groundwater recharge areas, and the human activities that can render them unusable, are an example of the need to coordinate land use activities to protect both groundwater quality and quantity. Protection of recharge areas, whether natural or man-made, is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. Existing and potential recharge areas must be protected so that they remain functional, that is they continue to provide recharge to the aquifer and they are not contaminated with chemical or microbial constituents. Land-use practices should be implemented so that neither the quantity nor quality of groundwater is reduced. A lack of protection of recharge areas could decrease the availability of usable groundwater and require the substitution of a more expensive water supply.

Many potentially contaminating activities have routinely been practiced in recharge areas, leading to the presence of contaminants in groundwater. In many areas, groundwater obtained from aquifers now requires remediation. Recent studies in some areas show that recharge areas are contaminated, but down-gradient wells are not, indicating that it is only a matter of time before contaminants in wells reach concentrations that require treatment of the groundwater.

In addition to quality impacts, urban development, consisting of pavement and buildings on former agricultural land, lining of flood control channels, and other land use changes have reduced the capacity of recharge areas to replenish groundwater, effectively reducing the safe yield of some basins.

Box J Managing Groundwater Quantity and Quality (continued)

To ensure that recharge areas continue to replenish high quality groundwater, water managers and land use planners should work together to:

- Identify recharge areas so the public and local zoning agencies are aware of the areas that need protection from paving and from contamination;
- Include recharge areas in zoning categories that eliminate the possibility of contaminants entering the subsurface;
- Standardize guidelines for pre-treatment of the recharge water, including recycled water;
- Build monitoring wells to collect data on changes in groundwater quality that may be caused by recharge; and
- Consider the functions of recharge areas in land use and development decisions.

Chapter 3

Groundwater Management Planning and Implementation

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The 1990s were a very important decade in the history of groundwater management in California. In 1992, the State Legislature provided an opportunity for more formal groundwater management with the passage of AB 3030 (Water Code § 10750 et seq.). More than 200 agencies have adopted an AB 3030 groundwater management plan. Additionally, 24 of the 27 counties with ordinances related to groundwater management adopted those laws during the 1990s. Plans prepared under AB 3030 certainly brought unprecedented numbers of water agencies into the groundwater management arena, and counties are now heavily involved in groundwater management, primarily through ordinances. However, many plans prepared under AB 3030 have had little or no implementation, and many counties focus primarily on limiting exports rather than on a comprehensive management program. As a result, the California Budget Act of 1999 (Stats. 1999, ch. 50), which authorized this update to Bulletin 118, directed the California Department of Water Resources (DWR) to complete several tasks, including developing criteria for evaluating groundwater management plans and developing a model groundwater management ordinance. This chapter presents the results of these directives. The intent is to provide a framework that will assist local agencies in proactively planning and implementing effective groundwater management programs.

Criteria for Evaluating Groundwater Management Plans—Required and Recommended Components

In 2002, the Legislature passed SB 1938 (Stats 2002, ch 603), which amended Water Code section 10750 et seq to require that groundwater management plans adopted by local agencies include certain components to be eligible for public funds administered by DWR for construction of groundwater projects; the statute applies to funds authorized or appropriated after September 1, 2002. In addition to the required components, DWR worked with representatives from local water agencies to develop a list of additional recommended components that are common to effective groundwater management.

Both the “required” and the “recommended” components are tools that local agencies can use either to institute a groundwater management plan for the first time or to update existing groundwater management plans. These components are discussed below and listed in Appendix C, which can be used as a checklist by local agencies to assess whether their groundwater management plans are addressing these issues.

Required Components of Local Groundwater Management Plans

As of January 1, 2003, amendments to Water Code Section 10750 et seq., resulting from the passage of SB 1938, require new groundwater management plans prepared under section 10750, commonly referred to as AB 3030 plans, to include the first component listed below.

Groundwater management plans prepared under any statutory authority must include components 2 through 7 to be eligible for the award of public funds administered by DWR for the construction of groundwater projects or groundwater quality projects. These requirements apply to funds authorized or appropriated after September 1, 2002. Funds appropriated under Water Code section 10795 et seq. (AB 303 – Local Groundwater Assistance Fund) are specifically excluded.

1) Documentation that a written statement was provided to the public “describing the manner in which interested parties may participate in developing the groundwater management plan” (Water Code, § 10753.4 (b)).

2) Basin management objectives (BMOs) for the groundwater basin that is subject to the plan (Water Code, § 10753.7 (a)(1)).
3) Components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping (Water Code, § 10753.7 (a)(1)).
4) A plan by the managing entity to "involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin" (Water Code, § 10753.7 (a)(2)). A local agency includes "any local public agency that provides water service to all or a portion of its service area" (Water Code, § 10752 (g)).
5) Adoption of monitoring protocols (Water Code, § 10753.7 (a)(4)) for the components in Water Code section 10753.7 (a)(1). Monitoring protocols are not defined in the Water Code, but the section is interpreted to mean developing a monitoring program capable of tracking changes in conditions for the purpose of meeting BMOs.
6) A map showing the area of the groundwater basin as defined by DWR Bulletin 118 with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan (Water Code, § 10753.7 (a)(3)).
7) For local agencies not overlying groundwater basins, plans shall be prepared including the above listed components and using geologic and hydrologic principles appropriate to those areas (Water Code, § 10753.7 (a)(5)).

Recommended Components of Groundwater Management Plans

Although the seven components listed above are required only under certain conditions, they should always be considered for inclusion in any groundwater management planning process. In addition to the required components of a groundwater management plan resulting from the passage of SB 1938, it is recommended that the components listed below be included in any groundwater management plan adopted and implemented by a local managing entity. These additional components were developed in accord with the Budget Act of 1999 and with the assistance of stakeholder groups. The components should be considered and developed for specific application within the basin, subbasin, or agency service area covered by the plan. Additional components will likely be needed in specific areas. The level of detail for each component will vary from agency to agency. None of the suggested data reporting in the components should be construed to require disclosure of information that is confidential under State law. Local agencies should consider both the benefits of public dissemination of information and water supply security in developing reporting requirements.

Manage with the Guidance of an Advisory Committee

The managing entity should establish an advisory committee of interested parties that will help guide the development and implementation of the plan. The committee can benefit management in several ways. First, the committee can bring a variety of perspectives to the management team. As the intent of local groundwater management is to maintain and expand local benefits from the availability of the resource, it makes sense that the intended beneficiaries are a part of the management process. Second, the committee is free to focus on the specifics of groundwater management without being distracted by the many operational activities that the managing entity (such as a water district) must complete. Third, some parties could be negatively impacted by certain groundwater management decisions, and these actions and potential adverse impacts should be a part of the decision-making process to help reduce future conflicts. Finally, the advisory committee helps the managing entity gain the confidence of the local constituency by providing the opportunity for interested parties to participate in the management process.

Many managing entities have already elected to use advisory committees for implementation of their groundwater management plans. The composition of these committees varies widely. Some groups consist entirely of stakeholders, others add local or State government representatives or academic members as impartial third parties, and some have included consultants as technical advisers. Some plans use multiple advisory committees to manage unique subareas. Some plans appoint advisory committees with different objectives, such as one that deals with technical issues and another that deals with policy issues. There is no formula for the composition of an advisory committee because it should ultimately be based on local management needs and should include representation of diverse local interests.

The Tulare Lake Bed Coordinated Management Plan provides an example of the benefit of an advisory committee. The plan includes nine groups of participants, making coordination and communication a complicated issue. To allow for greater communication, an executive committee was established consisting of one voting member from each public agency participating in the plan and one voting member representing a combined group of private landowner plan participants. The committee administers groundwater management activities and programs for the plan (TLBWSD 2002).

Describe the Area to Be Managed under the Plan

The plan should include a description of the physical setting and characteristics of the aquifer system underlying the plan area in the context of the overall basin. The summary should also include a description of historical data, including data related to groundwater levels, groundwater quality, subsidence, and groundwater-surface water interaction; known issues of concern with respect to the above data; and a general discussion of historical and projected water demands and supplies. All of these data are critical to effective groundwater management because they demonstrate the current understanding of the system to be managed and serve as a point of departure for monitoring activities as part of plan implementation.

Create a Link Between Management Objectives and Goals and Actions of the Plan

The major goal of any groundwater management plan is to maintain a reliable supply of groundwater for long-term beneficial uses of groundwater in the area covered by the plan. The plan should clearly describe how each of the adopted management objectives helps attain that goal. Further, the plan should clearly describe how current and planned actions by the managing entity help meet the adopted management objectives. The plan will have a greater chance of success by developing an understanding of the relationship between each action, management objectives, and the goal of the groundwater management plan.

For example, prevention of contamination of groundwater from the land surface is a management objective that clearly supports the goal of groundwater sustainability. Management actions that could help support this objective include (1) educating the public through outreach programs that explain how activities at the surface ultimately impact groundwater, (2) developing wellhead protection programs or re-evaluating existing programs, (3) working with the local responsible agency to ensure that permitted wells are constructed, abandoned, and destroyed according to State well standards, (4) investigating whether local conditions necessitate higher standards than those adopted by the local permitting agency for the construction, abandonment, or destruction of wells, and (5) working with businesses engaged in practices that might impact groundwater to reduce the risks of contamination.

The concept of having a management objective is certainly not new. While many existing plans do not clearly include management objectives nor specifically identify actions to achieve objectives, some plans indirectly include these components. As an example, Eastern Municipal Water District's (EMWD) Groundwater Management Plan states that its goal includes maximizing "the use of groundwater for all beneficial uses in such a way as to lower the cost of water supply and to improve the reliability of the total water supply for all users." To achieve this goal, EMWD has listed several issues to be addressed. One is the prevention of long-term depletion of groundwater. This can be defined as a management objective even though it is not labeled as such. Where this management objective is currently unmet in the North San Jacinto watershed portion of the plan area, EMWD has identified specific actions to achieve that objective including the reduction of groundwater extraction coupled with pursuing the construction of a pipeline to act as an alternative source of surface water for the impacted area (EMWD 2002).

Describe the Plan Monitoring Program

The groundwater management plan should include a map indicating the locations of any applicable monitoring sites for groundwater levels, groundwater quality, subsidence, stream gaging, and other applicable monitoring. The groundwater management plan should summarize the type of monitoring (for example, groundwater level, groundwater quality, subsidence, streamflow, precipitation, evaporation, tidal influence), type of measurements, and the frequency of monitoring for each location. Site specific monitoring information should be included in each groundwater management plan. The plan should include the well depth, screened interval(s) and aquifer zone(s) monitored and the type of well (public, irrigation, domestic, industrial, monitoring). These components will serve as a tool for the local managing entity to assess the adequacy of the existing monitoring network in tracking the progress of plan activities.

The groundwater management plan developed for the Scotts Valley Water District (SVWD) provides a detailed description of the monitoring program in Santa Cruz County (Todd Engineers 1994) Table 6 is SVWD's monitoring table, which serves as an example of the level of detail that is useful in a plan (Todd Engineers 2003a). Figure 9 shows the locations and types of monitoring points for each monitoring site. The monitoring table specifies in detail the data available and the planned monitoring. These serve as useful tools for SVWD to visualize the types and distribution of data available for their groundwater management activities. In addition to the minimum types of monitoring, SVWD summarizes other types of data that are relevant to their groundwater management effort.

Describe Integrated Water Management Planning Efforts

Water law in California treats groundwater and surface water as two separate resources with the result that they have largely been managed separately. Such management does not represent hydrologic reality. Recently, managers of a number of resources are becoming increasingly aware of how their planning activities could impact or be impacted by the groundwater system. Because of this, the local managing entity should describe any current or planned actions to coordinate with other land use, zoning, or water management planning entities.

Integrated management is addressed in existing groundwater management plans in several ways, including conjunctively managing groundwater with surface water supplies, recharging water from municipal sewage treatment plants, and working with local planning agencies to provide comments when a project is proposed that could impact the groundwater system.

Examples of planning efforts that should be integrated with groundwater management may include watershed management, protection of recharge areas, agricultural water management, urban water management, flood management, drinking water source assessment and protection, public water system emergency and disaster response, general plans, urban development, agricultural land preservation, and environmental habitat protection or restoration. Another example that may appear insignificant is transportation infrastructure. However, local impacts on smaller aquifers could be significant when landscaping of medians and interchanges requires groundwater pumping for irrigation or when paved areas are constructed over highly permeable sediments that act as recharge zones for the underlying aquifer.

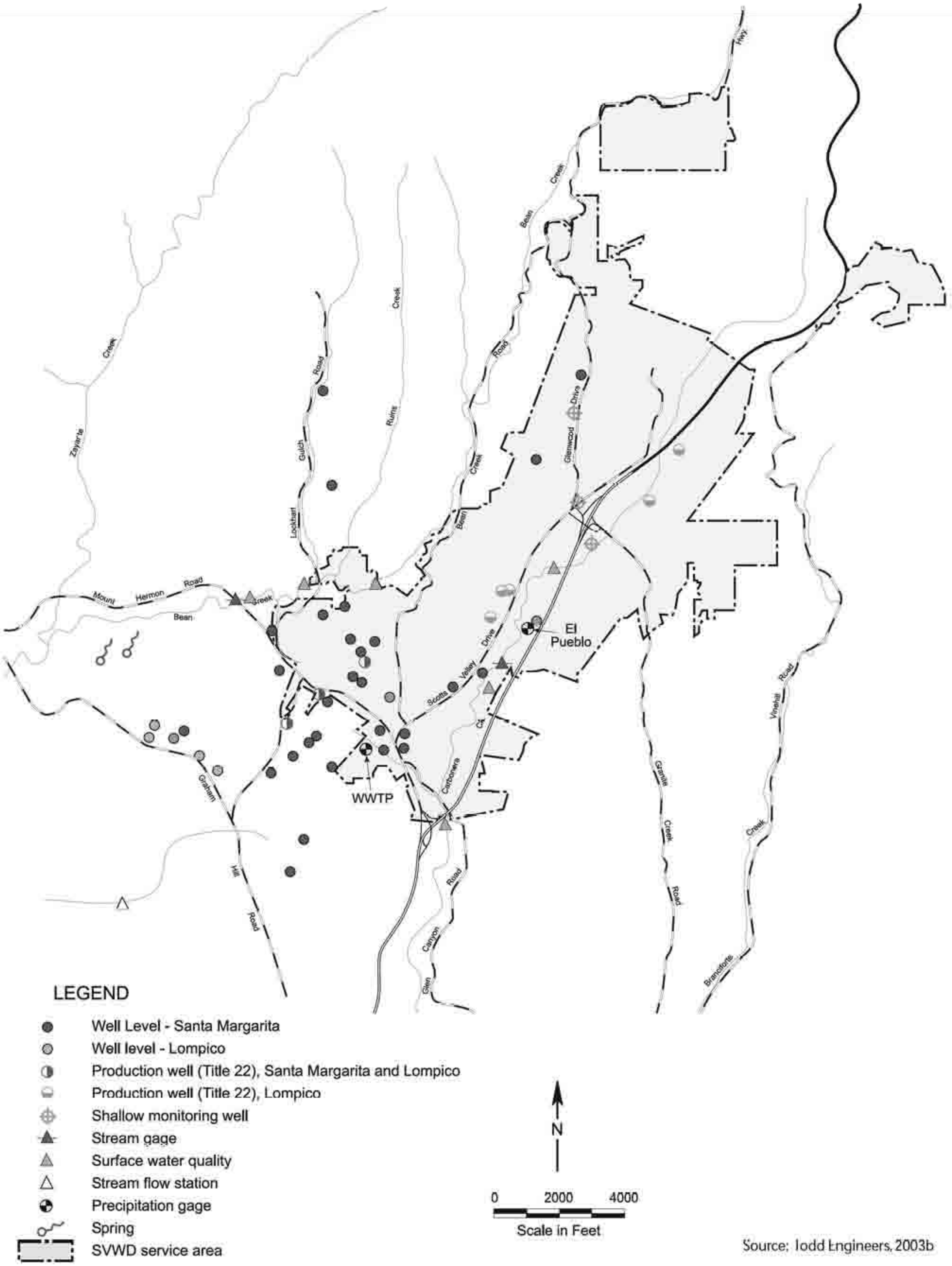
Table 6 Scotts Valley Water District's Groundwater Monitoring Plan

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Precipitation	El Pueblo Yard	15-minute recording	Feb-85	Daily/District, Monthly/City	Other historic gages:(1) Blair site on Granite Ck. Rd. (Jan. 1975 - Dec. 1980) (2) Hacienda Dr. (Jul. 1974 - Mar. 1979) (3) El Pueblo Yard bucket gage (Jan. 1981 - Jan. 1985)
	WWTP	5-minute recording	1990	Daily/City	
Evaporation	El Pueblo Yard	Pan	Jan-86	Daily/District	Evaporation pan raw data not compiled after July 1990
Evapotranspiration	De Laveaga Park, Santa Cruz	Automated active weather station	Sep-90	California Irrigation Management Information System/Monthly	Data available on-line through CIMIS
Streamflow	Carbonera Ck at Scotts Valley @ Cabonera Way Bridge (#111613000)	15-minute recording	Jan-85	USGS/ Daily	Other historic gages: (1) Carbonera Ck @ Santa Cruz (#11161400) 150 feet upstream from mouth (1974-1976 partial data)
	Bean Ck near Scotts Valley @ Hermon Crossing (#11160430)	15-minute recording	Dec-88	USGS/ Daily	(2) Bean Ck near Felton (#11160320) (1973-1978 partial data), low flows at same location (1983-1988)
	Eagle Creek In Henry Cowell Redwoods State Park	Bucket-Fall, Flow Meter-Spring	Mar-01	Semi-annually/ Todd Engineers	(3) Carbonera Creek @ Glen Canyon (1990-1994?)
Well Inventory	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36	Over 400 wells: location, log, type, capacity, etc. stored in GIS, and Access database	1950s	Logs from DWR maintained by Todd Engineers	
Groundwater Levels	~34 Santa Magarita aquifer and ~14 Lompico formation wells	Depth to water	1968	Quarterly/ District and cooperators	Data from over 75 wells, as early as 1968, bi-monthly 1983-1989
Pumpage	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36 District wells in production and on standby	Metered	1975	Monthly/ Scotts Valley Water District, Mt. Hermon Association, Hanson Aggregates West, San Lorenzo Valley Water District	Other historic pumpage data: Manana Woods (1988-1996 partial data)

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan (continued)

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Groundwater Quality	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14,23-26, 36 District wells in production	Title 22 constituents	1963	At least semi-annual/ District and others	Data from over 80 wells, as early as 1963, monitoring frequency similar to groundwater level program
	North Scotts Valley 3 shallow monitoring wells	Metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Surface Water Quality	4 sites on Carbonera and 3 sites on Bean Creek	Grab samples - metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Wastewater Outflows	City of Scotts Valley WWTP @ Lundy Lane	Wastewater outflow volume and effluent quality	1965	Daily/City of Scotts Valley	Plant operational in 1965 (septic systems pre-1965)
Recycled Water Production	Scotts Valley WWTP	Recycled water quantity and quality	2002	At least quarterly/ WWTP	

Source: Todd Engineering 2003a



Source: Todd Engineers, 2003b

Figure 9 Scotts Valley Water District's Groundwater Management Plan monitoring locations

Box K What are Management Objectives?

Management objectives are the local managing entity's way of identifying the most important issues in meeting local resource needs; they can be seen as establishing a "value system" for the plan area. There is no fixed set of management objectives for any given plan area. Some of the more commonly recognized management objectives include the monitoring and managing of groundwater levels, groundwater quality, inelastic land subsidence, and changes in streamflow and surface water quality where they impact or are impacted by groundwater pumping. Management objectives may range from being entirely qualitative to strictly quantified.

Each management objective would have a locally determined threshold value associated with it, which can vary greatly. For example, in establishing a management objective for groundwater quality, one area may simply choose to establish an average value of total dissolved solids as the indicator of whether a management objective is met, while another agency may choose to have no constituents exceeding the maximum contaminant level for public drinking water standards. While there is great latitude in establishing management objectives, local managers should remember that the objectives should serve to support the goal of a sustainable supply for the beneficial use of the water in their particular area.

An example of an alternative management objective is Orange County Water District's (OCWD) objective of maintaining available storage space in its management area at 200,000 acre-feet. The objective does not require that groundwater elevations be fixed at any particular location, although managing to this objective would likely have the net benefit of stabilizing water levels. Groundwater storage is a dynamic value, so attempting to meet this management objective is an ongoing challenge. OCWD has implemented many management actions directly aimed at managing the basin to meet this objective.

The Deer Creek and Tule River Authority provides an excellent example of how groundwater management activities can be coordinated with other resources. The authority, in conjunction with the U.S. Bureau of Reclamation, has constructed more than 200 acres of recharge basins as part of its Deer Creek Recharge-Wildlife Enhancement Project. When available, the project takes surplus water during winter months and delivers it to the basins, which serve as winter habitat for migrating waterfowl, creating a significant environmental benefit. Most of the water also recharges into the underlying aquifer, thereby benefiting the local groundwater system.

Report on Implementation of the Plan

The managing entity should produce periodic reports—annually or at other frequencies determined by the local managing entity—summarizing groundwater basin conditions and groundwater management activities. For the period since the previous update, the reports should include:

- A summary of monitoring results, including historical trends,
- A summary of actual management actions,
- A summary, supported by monitoring results, of whether management actions are achieving progress in meeting management objectives,
- A summary of proposed management actions, and
- A summary of any plan component changes, including addition or modification of management objectives.

Unfortunately, many plans were prepared in the mid-1990s with little or no follow-up documentation of whether the plan is actually being implemented. This makes it difficult to determine what progress has been achieved in managing the groundwater resource. Periodic reports will serve as a tool for the managing entity to organize its many activities to implement the plan, act as a driving force for plan implementation, and help interested parties understand the progress made by local entities in managing their groundwater resource.

Progress reports on SVWD (Todd Engineers 2002) and EMWD (2002) groundwater management plans serve as excellent examples of the value of such an exercise. Both reports effectively portray the results of management actions: progress toward achieving objectives and specific recommendations for future management actions. An example of reporting on the modification of a management objective for water quality can be found in EMWD's 2000 Annual Report (EMWD 2001). A task force of more than 20 water suppliers and wastewater agencies, including EMWD, worked to update the Regional Water Quality Control Board's Region 5 Basin Plan objectives for nitrogen and total dissolved solids in water, effectively changing EMWD's management objectives for those constituents.

Evaluate the Plan Periodically

The managing entity and advisory committee should re-evaluate the entire plan. Periodic evaluation of the entire management plan is essential to define successes and failures under the plan and identify changes that may be needed. Additionally, re-evaluation of the plan should include assessment of changing conditions in the basin that may warrant modification of the plan or management objectives. Adjustment of components in the plan should occur on an ongoing basis if necessary. The re-evaluation of the plan should focus on determining whether the actions under the plan are meeting the management objectives and whether the management objectives are meeting the goal of sustaining the resource.

While there are several examples of existing groundwater management plans that demonstrate ongoing changes to plan activities, there are no known examples of such an approach to entirely re-evaluate an existing plan. This is likely due in part to the occurrence of several consecutive wet years in the mid- and late-1990s. The abundant surface water supplies reduced the need to actively manage groundwater supplies in many cases. More recent dry conditions and the recent passage of SB 1938 will create an excellent opportunity for managing entities to begin a re-evaluation of existing plans.

Model Groundwater Management Ordinance

As discussed in the previous chapter, ordinances are groundwater management mechanisms enacted by local governments through exercise of their police powers to protect the health and safety of their citizens. In Baldwin v. Tehama County (1994), the appellate court declared that State law does not preempt the field of groundwater management.

In the mid- to late-1990s, many counties adopted ordinances that effectively prevented export of groundwater from the county, even though none specifically prohibited export. The intent of each of these ordinances is to sustain groundwater as a viable local resource. To ensure that goal, an export project proponent is required by most of the ordinances to show that the proposed project will not cause depletion of the groundwater, degradation of groundwater quality, or subsidence before a permit to export groundwater can be issued. Although these ordinances do not specifically require threshold limits for each of these potential negative impacts, a project proponent can really only show that these negative effects will not occur if the proponent develops a groundwater management plan.

Many of these ordinances were developed in response to the plans of some agencies or landowners to export groundwater or develop a groundwater substitution project where surface water is exported and groundwater is substituted for local use. In some cases, short-term export actually took place, leading to a number of claims of negative third party impacts. Residents of some counties became concerned because no one knew how much groundwater was available for local use and how much groundwater was available for export. In short, details of the hydrology of the basin, including surface water and groundwater availability, water quality, and the interaction of surface water and groundwater were not known. This lack of detailed knowledge about the operating potential of their groundwater resources led counties to take what they viewed as protective action, which consisted of requiring a permit before anyone could export groundwater from the county.

From the perspective of DWR, groundwater should be managed in a manner that ensures long-term sustainability of the resource for beneficial uses. Those beneficial uses are to be decided by the local stakeholders within the basin. In some areas, there may be an ample supply of water, so groundwater exports or substitution projects are feasible while local beneficial uses of the water supply are maintained. In other areas, limiting exports may be necessary to maintain local beneficial uses. Such determinations can be made only after the data are collected and evaluated and the results are used to develop management objectives for the basin.

While developing both the criteria for evaluating groundwater management plans and the model groundwater management ordinance, DWR staff has borne two principles in mind. First, the goal of groundwater management, whether accomplished by a plan or by an ordinance, is to sustain and often expand a groundwater resource. Second, groundwater management, whether accomplished by a plan or by an ordinance, requires that local agencies address and resolve the same or similar issues within the boundaries of the agencies. To say it in different words, whether it is a plan or an ordinance, good groundwater management should address the same issues and problems and arrive at the same conclusions and solutions to satisfy the needs of the local area. While some areas may allow or promote exports, others may not.

As stated above, the Legislature required a model ordinance as one of the elements of this update of Bulletin 118. The model ordinance is included as Appendix D and can be used by local governments that have identified a need to adopt a groundwater management ordinance. The model is an example of what a local ordinance might include. Local conditions will require some additions, modifications, or deletions. The variety of political, institutional, legal, technical, and economic opportunities and constraints throughout California guarantees that there will be differences to which the model will have to be adapted. Local governments interested in adopting a groundwater management ordinance are encouraged to consider all components included in the model.

Water Code section 10753.7(b)(1)(A) allows an agency to participate in or consent to be subject to a groundwater management plan, a basin-wide management plan, or other integrated regional water management plan in order to meet the funding eligibility requirements that resulted from passage of SB 1938 (2001). A local government that adopts an ordinance should consider whether or not it will have local agencies that do not have their own groundwater management plan, but consent to be managed under the ordinance. If this situation is anticipated, the ordinance should include the required components described in the Water Code so State funding can be pursued.

Chapter 4

Recent Actions Related to Groundwater Management

Chapter 4
Recent Actions Related to Groundwater Management

The past few years have seen significant actions that impact groundwater management in California. Below are several examples of recent actions including legislation, ballot measures, and executive orders that show the State Legislature and the citizens of California clearly recognize the importance of groundwater and its appropriate management in meeting the present and future water supply needs of the State.

Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13)

On March 7, 2000, California voters approved a $1.97-billion general obligation bond known as the Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act (Proposition 13). Of the nearly $2 billion, $230 million was earmarked for groundwater programs. The act authorizes $200 million for grants for feasibility studies, project design, and construction of conjunctive use facilities (Water Code, § 79170 et seq.) and $30 million in loans for local agency acquisition and construction of groundwater recharge facilities and feasibility study grants for projects potentially eligible for the loan program (Water Code, § 79161 et seq.). More than $120 million have been awarded in grants and loans to local agencies in the first two years of implementation of these programs.

California Bay-Delta Record of Decision

The goal of the California Bay-Delta (formerly CALFED) program is to restore ecosystem health and improve water management in the Bay-Delta system. The program has four primary objectives:

- Provide good water quality for all beneficial uses
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species
- Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system
- Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees

The Record of Decision (ROD), released in August 2000, sets forth a 30-year plan to address ecosystem health and water supply reliability problems in the Bay-Delta system. The ROD lays out specific actions and investments over the first seven years to meet program goals. Most important, with respect to groundwater is the California Bay-Delta program's commitment to local groundwater management. The ROD states, "CALFED will work with local governments and affected stakeholders to develop legislation to strengthen AB 3030 and provide technical and financial incentives to encourage more effective basin-wide groundwater management plans…" (CALFED 2000). The ROD encourages basin management that is developed at the subbasin level so that it addresses local needs, but is coordinated at the basin-wide level so that it considers impacts to other users in the basin. The ROD also commits Bay-Delta agencies to "facilitate and fund locally supported, managed, and controlled groundwater and conjunctive use projects with a total of 500,000 acre-feet to 1 million acre-feet (maf) of additional storage capacity by 2007" (CALFED 2000).

Local Groundwater Management Assistance Act of 2000 (AB 303, Water Code Section 10795 et seq.)

The goal of the Local Groundwater Management Assistance Act is to help local agencies better understand how to manage groundwater resources effectively to ensure the safe production, quality, and proper storage of groundwater in the State. The act created the Local Groundwater Assistance Fund, which must be appropriated annually. In three years, more than $15 million in grants were awarded for 71 projects. Grants went to local agencies for groundwater studies and projects that contribute to basin and subbasin management objectives, including but not limited to groundwater monitoring and groundwater basin management. Grants are available to all geographic areas of the State. This act serves to emphasize that groundwater is recognized as an important local resource and, to the extent that groundwater is properly managed at the local level, serves to benefit all Californians.

Groundwater Quality Monitoring Act of 2001 (AB 599, Water Code Section 10780 et seq.)

Assembly Bill 599, known as the Groundwater Quality Monitoring Act of 2001, set a goal to establish comprehensive groundwater monitoring and increase the availability of information about groundwater quality to the public. The objective of the program is to highlight those basins in which contamination has occurred or is likely to occur and provide information that will allow local managers to develop programs to curtail, treat, or avoid additional contamination. The act required the State Water Resources Control Board (SWRCB), in coordination with an Interagency Task Force (ITF) and a Public Advisory Committee (PAC), to integrate existing monitoring programs and design new program elements, as necessary, to establish a comprehensive statewide groundwater quality monitoring program.

Through the ITF and PAC, the Comprehensive Groundwater Quality Monitoring Program was developed. The program will seek to:

- Accelerate the monitoring and assessment program already established by the SWRCB,
- Implement monitoring and assessment in accordance with a prioritization of basins/subbasins,
- Increase coordination and data sharing among groundwater agencies, and
- Maintain groundwater data in a single repository to provide useful access by the public while maintaining appropriate security measures.

The Comprehensive Groundwater Quality Monitoring Program is expected to provide the following key benefits:

- A common base communications medium for agencies to utilize and supply groundwater quality data at multiple levels,
- A mechanism to unite local, regional and statewide groundwater programs in a common effort,
- Better understanding of local, regional and statewide water quality issues and concerns that in turn can provide agencies at all levels with better information to deal with the concerns of consumers and consumer advocate groups,
- Groundwater agencies with trend and long-term forecasting information, essential for groundwater management plan preparation and implementation, and
- The motivation for small- and medium-sized agencies to begin or improve their own groundwater monitoring and management programs.

Water Supply Planning

Three bills enacted by the Legislature to improve water supply planning processes at the local level became effective January 1, 2002. In general, the new laws are intended to improve the assessment of water supplies during the local planning process before land use projects that depend on water are approved. The new laws require the verification of sufficient water supplies as a condition for approving developments, and they compel urban water suppliers to provide more information on the reliability of groundwater if used as a supply.

SB 221 (Bus. and Prof. Code, § 11010 as amended; Gov. Code, § 65867.5 as amended; Gov. Code, §§ 66455.3 and 66473.7) prohibits approval of subdivisions consisting of more than 500 dwelling units unless there is verification of sufficient water supplies for the project from the applicable water supplier(s). This requirement also applies to increases of 10 percent or more of service connections for public water systems with less than 500 service connections. The law defines criteria for determining "sufficient water supply," such as using normal, single-dry, and multiple-dry year hydrology and identifying the amount of water that the supplier can reasonably rely on to meet existing and future planned uses. Rights to extract additional groundwater must be substantiated if used for the project.

SB 610 (Water Code, §§ 10631, 10656, 10910, 10911, 10912, and 10915 as amended; Pub. Resources Code, § 21151.9 as amended) and AB 901 (Water Code, §§ 10610.2 and 10631 as amended; Water Code § 10634) make changes to the Urban Water Management Planning Act to require additional information in Urban Water Management Plans (UWMP) if groundwater is identified as a source available to the supplier. Required information includes a copy of any groundwater management plan adopted by the supplier, proof that the developer or agency has rights to the groundwater, a copy of the adjudication order or decree for adjudicated basins, and if not adjudicated, whether the basin has been identified as being overdrafted or projected to be overdrafted in the most current DWR publication on the basin. If the basin is in overdraft, the UWMP must include current efforts to eliminate any long-term overdraft. A key provision in SB 610 requires that any project subject to the California Environmental Quality Act supplied with water from a public water system be provided a water supply assessment, except as specified in the law. AB 901 requires the plan to include information relating to the quality of existing sources of water available to an urban water supplier over given periods and include the manner in which water quality affects water management strategies and supply reliability.

Emergency Assistance to the Klamath Basin

On May 4, 2001, the Governor proclaimed a State of Emergency in the Klamath Basin in Siskiyou and Modoc counties. The proclamation included disaster assistance of up to $5 million under authority of the State Natural Disaster Assistance Act. This assistance went directly into constructing wells to extract groundwater for use on cover crops to avoid loss of critical topsoil. The Governor's proclamation also included $1 million for a study of the Klamath River Basin to determine the long-term water supply in the California portion of the basin.

Governor's Drought Panel

The Governor's Advisory Drought Planning Panel was formed in 2000 to develop a contingency plan to address the impacts of critical water shortages in California. The panel formed with the recognition that critical water shortages may severely impact the health, welfare, and economy of California. Panel recommendations included securing funding for the Local Groundwater Management Assistance Act (described above), continued support of critical groundwater monitoring in basins with inadequate data, and the formation of a technical assistance and education program for "rural homeowners and small domestic water systems relying on self-supplied groundwater" (GADPP 2000).

Sacramento Valley Water Management Agreement

On May 22, 1995, SWRCB adopted the "Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary" (the 1995 WQCP). Following this action, SWRCB initiated a water rights hearing process with the intent of allocating responsibility for meeting the standards of the 1995 WQCP among water right holders in areas tributary to the Delta. The water rights hearing was conducted in phases with all phases being resolved with the exception of Phase 8, which involved water rights holders in the Sacramento Valley.

Proceeding with Phase 8 may have involved litigation and judicial review for years. That extended process could have resulted in adverse impacts to the environment and undermined progress on other statewide water management initiatives. To avoid the consequences of delay, the Sacramento Valley Water Users, DWR, the U.S. Bureau of Reclamation (USBR), and export water users developed the Sacramento Valley Water Management Agreement. The agreement became effective April 20, 2001. At that time SWRCB issued an order staying the Phase 8 hearing for 18 months. The parties negotiated a short-term settlement agreement that obligated DWR and USBR to continue to fully meet the Bay-Delta water quality standards while providing for the development of conjunctive use and system improvement projects by participating upstream water rights holders that would make water available to help meet water quality standards while improving the reliability of local water supplies. SWRCB has subsequently dismissed the Phase 8 proceedings, and work is being undertaken on both short-term and long-term activities included in the Sacramento Valley Water Management Agreement.

Groundwater Management Water Code Amendments

In September 2002, SB 1938 (Water Code, § 10753.4 and § 10795.4 as amended; Water Code, § 10753.7, § 10753.8 and § 10753.9 as amended and renumbered; Water Code, § 10753.1 and § 10753.7 as added) was signed into law. The act amends existing law related to groundwater management by local agencies. The law requires any public agency seeking State funds administered through DWR for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan with certain specified components. Prior to this, there were no required plan components. New requirements include establishing basin management objectives, preparing a plan to involve other local agencies in a cooperative planning effort, and adopting monitoring protocols that promote efficient and effective groundwater management. The requirements apply to agencies that have already adopted groundwater management plans as well as agencies that do not overlie groundwater basins identified in Bulletin 118 and its updates when these agencies apply for state funds. The requirements do not apply to funds administered through the AB 303-Local Groundwater Management Assistance Act (Water Code, § 10795 et seq.) or to funds authorized or appropriated prior to September 1, 2002. Further discussion of the requirements is included in Chapter 3 and Appendix C.

Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50)

California voters approved the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50; Water Code, § 79500 et seq.) in the November 2002 elections. The initiative provides for more than $3.4 billion of funding, subject to appropriation by the Legislature, for a number of land protection and water management activities.

Several chapters of Proposition 50 allocate funds for specified water supply and water quality projects, including:

- Chapter 3 Water Security. Provides $50 million to protect State, local, and regional drinking water systems from terrorist attack or deliberate acts of destruction or degradation.

- Chapter 4 Safe Drinking Water. Provides $435 million for grants and loans for infrastructure improvements to meet safe drinking water standards.
- Chapter 5 Clean Water and Water Quality. Provides $390 million for a number of water quality and environmental improvements.
- Chapter 6 Contaminant and Salt Removal Technologies. Provides $100 million for desalination of ocean or brackish waters as well as treatment and removal of contaminants.
- Chapter 7 California Bay-Delta program. Provides $825 million for continuing implementation of all elements of the program.
- Chapter 8 Integrated Regional Water Management. Provides $500 million for many categories of water management projects that will protect communities from drought, protect and improve water quality, and reduce dependence on imported water supplies.
- Chapter 9 Colorado River. Provides $70 million for canal-lining projects necessary to reduce water use and to meet commitments related to California's allocation of water from the Colorado River.

Chapter 5

The Roles of State and Federal Agencies in California Groundwater Management

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The Roles of State and Federal Agencies in California Groundwater Management

Even though groundwater management is a local responsibility and mostly voluntary, several State and federal agencies have key roles in California groundwater management. Some of these roles may not be immediately recognized, but because they work toward the goal of maintaining a reliable groundwater supply, they are closely related to groundwater management. Some of the programs available through the California Department of Water Resources (DWR) and other agencies that assist local agencies in managing groundwater resources are described below.

Local Groundwater Management Assistance from DWR

DWR's role in groundwater management begins with the fundamental understanding that groundwater management is locally driven and management programs should respond to local needs and concerns. DWR recognizes that when groundwater is effectively managed at the local level, benefits are realized at a statewide level.

DWR has historically maintained many programs that directly benefit local groundwater management efforts including:

- Providing assistance to local agencies to assess basin hydrogeologic characteristics,
- Assisting local agencies to identify opportunities to develop additional groundwater supply,
- Monitoring groundwater levels and quality,
- Providing watermaster services for court-adjudicated basins,
- Providing standards for well construction and destruction,
- Managing the State's extensive collection of well completion reports, and
- Reviewing proposals and distributing grant funds and low-interest loans for conjunctive use projects, as well as local groundwater management and monitoring programs.

Conjunctive Water Management Program

DWR's Conjunctive Water Management Program consists of a number of integrated efforts to assist local agencies in improving groundwater management and increasing water supply reliability.

One goal of the Integrated Storage Investigations (ISI) Program, an element of the Bay-Delta program, is to increase water supply reliability statewide through the planned, coordinated management and use of groundwater and surface water resources. The effort emphasizes forming working partnerships with local agencies and stakeholders to share technical data and costs for planning and developing locally controlled and managed conjunctive water management projects.

Toward that end, the Conjunctive Water Management Program has:

- Developed a vision in which DWR would assist local agencies throughout the State so that these agencies can effectively manage groundwater resources,
- Adopted a set of working principles to ensure local planning; local control, operation, and management of conjunctive use projects; voluntary implementation of projects; and local benefits from the proposed projects,
- Executed memoranda of understanding with 30 local agency partners and provided technical and financial assistance to study groundwater basins and assess opportunities for conjunctive water management,

- Provided technical assistance in the form of groundwater monitoring, groundwater modeling, and local water management planning, as well as a review of numerous regional and statewide planning efforts on a variety of water issues, and
- Provided facilitation assistance to promote broad stakeholder involvement in regional water management planning processes.

DWR staff review proposals and distribute grants pursuant to the Local Groundwater Management Assistance Act of 2000 (AB 303). To date, DWR has awarded more than $15 million to local agencies to fund 71 projects dealing with groundwater investigation, monitoring, or management.

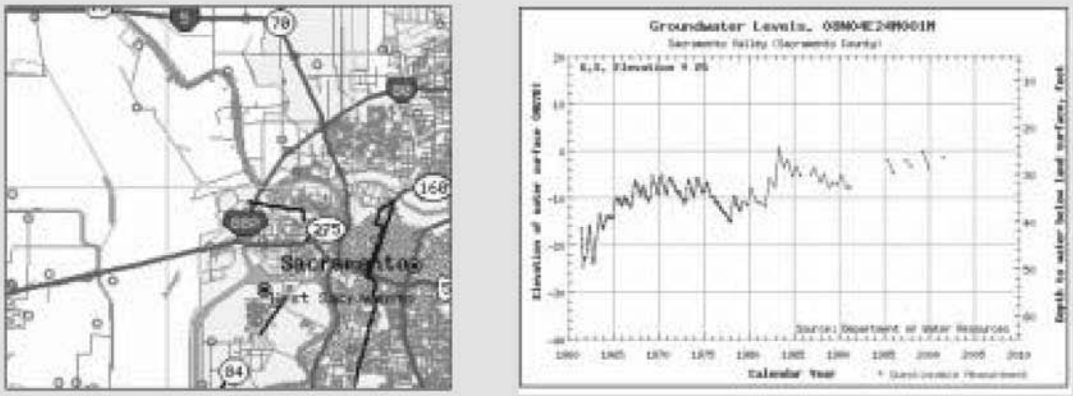
With funds provided under Proposition 13, DWR has awarded more than $170 million in loans and grants for groundwater recharge and storage studies and projects to local agencies throughout the State. Applicant estimates of the water supply reliability increases that will be realized from these projects exceeds 150 thousand acre-feet annually. Recipients of loans and grants must provide progress reports to allow an evaluation of the successes of the various programs. Figure 10 shows the distribution of loan and grant awardees throughout the State.

Both grant programs have active outreach efforts to inform and to assist agencies in preparation of applications. Selection of projects for funding relies in part on input from advisory committees composed of stakeholders from throughout the State.

Box L Providing Data:

The Internet Makes Groundwater Elevation Data Readily Accessible to the Public

In 1996, the California Department of Water Resources (DWR) began providing Internet access to groundwater level data and hydrographs for wells in groundwater basins throughout California. The website, which distributes historical data for more than 35,000 wells monitored by DWR and its many cooperators, has proven very popular, with more than 60,000 visits to date. Options include a form or map interface to locate wells with water level data and the ability to download long-term water levels for specific wells or seasonal measurements for specific areas to create groundwater contour maps. The accessibility of this data makes it a significant resource for local agencies in making sound groundwater management decisions. The address of the site is http://wdl.water.ca.gov/.



Wells can be located with a map interface. By clicking on a well, a hydrograph with the latest data available is automatically generated.

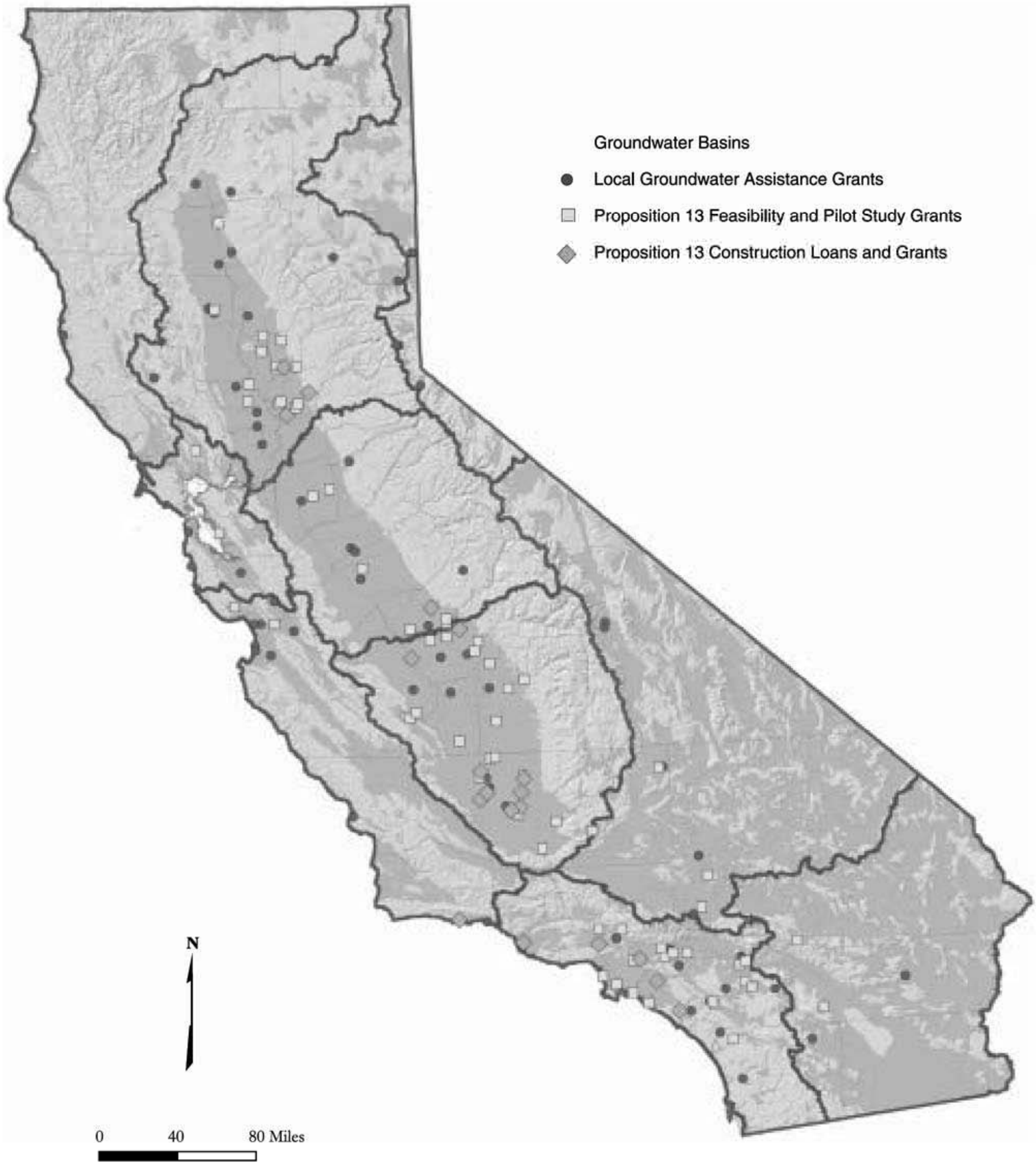


Figure 10 Broad distribution of grant and loan awardees for 2001 through 2003

Assistance from Other State and Federal Agencies

Many other State and federal agencies provide groundwater management assistance to local agencies. Some of those roles are described below. For more information on the roles of various agencies in protecting the groundwater resource, see the California Department of Health Services' Drinking Water Source Assessment and Protection Program Document (DHS 2000), California Groundwater Management (Bachman and others 1997), or the individual agency websites.

State Water Resources Control Board and Regional Water Quality Control Boards

http://www.swrcb.ca.gov The mission of the State Water Resources Control Board (SWRCB) is to ensure the highest reasonable quality of waters of the State, while allocating those waters to achieve the optimum balance of beneficial uses. In turn, the nine Regional Water Quality Control Boards (RWQCB) develop and enforce water quality objectives and implement plans to protect the beneficial uses of the State's waters, recognizing differences in climate, topography, geology, and hydrology.

SWRCB has many responsibilities regarding the protection of the groundwater resource. One of the more notable is the Groundwater Ambient Monitoring and Assessment (GAMA) Program. GAMA is a recently enacted program that will provide a comprehensive assessment of water quality in water wells throughout the state. GAMA has two main components: the California Aquifer Susceptibility (CAS) Assessment and the Voluntary Domestic Well Assessment Project.

The CAS combines age dating of water and sampling for low-level volatile organic compounds (VOCs), such as methyl tertiary-butyl ether (MTBE), to assess the relative susceptibility of all of approximately 16,000 public supply wells throughout the State. Age dating provides a general assessment of how quickly groundwater is moving through the system, while the sampling of low-level VOCs allows greater reaction time for potential remediation strategies before contaminants reach action levels. Sampling is being conducted by staff from the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The CAS Assessment was developed cooperatively with DHS and DWR.

The Voluntary Domestic Well Assessment Project will provide a previously unavailable sampling of water quality in domestic wells, which will assist in assessing the relative susceptibility of California's groundwater. Because water quality in individual domestic wells is unregulated, the program is voluntary and will focus, as resources permit, on specific areas of the state. Constituents to be analyzed include nitrate, total and fecal coliform bacteria, MTBE, and minerals. Additional constituents will be added in areas with known water quality problems.

Other SWRCB/RWQCB activities related to groundwater protection include developing basin plans that identify existing and potential beneficial uses of marine water, groundwater, and surface waters; regulating the discharge of waste that may affect water quality in California; monitoring of landfills and hazardous waste facilities; establishing standards for the construction and monitoring of underground storage tanks; establishing management plans for control of nonpoint source pollutants; and issuing cleanup and abatement orders that require corrective actions by the responsible party for a surface water or groundwater pollution problem or nuisance.

The Groundwater Quality Monitoring Act of 2001 (AB599, Water Code, § 10780 et seq.) required the SWRCB to develop a comprehensive monitoring program in a report to the Legislature. See Chapter 4 for details.

California Department of Health Services

http://www.dhs.ca.gov/ps/ddwem The DHS Drinking Water Program, part of the Division of Drinking Water and Environmental Management, is responsible for DHS implementation of the federal Safe Drinking Water Act, as well as California statutes and regulations related to drinking water. As part of this responsibility, DHS inspects and provides regulatory oversight of approximately 8,500 public water systems (and approximately 16,000 drinking water wells) to assure delivery of safe drinking water to all California consumers.

Public water system operators are required to regularly monitor their drinking water sources for microbiological, chemical and radiological contaminants to show that drinking water supplies meet regulatory requirements (called primary maximum contaminant levels–MCLs). Among these contaminants are approximately 80 specific inorganic and organic chemical contaminants and six radiological contaminants that reflect the natural environment as well as human activities.

Public water system operators also monitor their water for a number of other contaminants and characteristics that deal with the aesthetic properties of drinking water (known as secondary MCLs). They are also required by regulation to analyze for certain unregulated contaminants (to allow DHS to collect information on emerging contaminants, for example), and to report findings of other contaminants that may be detected during routine monitoring. The DHS water quality monitoring database contains the results of analyses since 1984. These data, collected for purposes of regulatory compliance with drinking water laws, also provide an extensive body of information on the quality of groundwater throughout the State.

California Department of Pesticide Regulation

http://www.cdpr.ca.gov/dprprograms.htm The California Department of Pesticide Regulation (DPR) protects human health and the environment by regulating pesticide sales and use and by promoting reduced-risk pest management. DPR plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the groundwater resource.

DPR conducts six types of groundwater monitoring:

1) Monitoring for pesticides on a DPR-determined Ground Water Protection List, which lists pesticides with the potential to pollute groundwater;
2) Four-section survey monitoring to verify a reported detection and to help determine if a detected pesticide resulted from legal agricultural use;
3) Areal extent monitoring to identify the extent of contaminated wells;
4) Adjacent section monitoring to identify additional areas sensitive to pesticide movement to groundwater;
5) Monitoring to repeatedly sample a network of wells to determine whether pesticide residues are declining; and
6) Special project monitoring.

When pesticides are found in groundwater, they are normally regulated in one-square mile areas identified in regulation as sensitive to groundwater pollution. These pesticides are subject to permitting by the county agricultural commissioner and to use restrictions specified in regulation. DPR maintains an extensive database of pesticide sampling in groundwater and reports a summary of annual sampling and detections to the State Legislature.

California Department of Toxic Substances Control

http://www.dtsc.ca.gov The California Department of Toxic Substances Control (DTSC) has two programs related to groundwater resources protection: the Hazardous Waste Management Program and the Site Mitigation Program. These programs are authorized under Division 20 of the California Health and Safety Code, and implementing regulations are codified in Title 22 of the California Code of Regulations.

A critical element of both programs is maintaining environmental quality and economic vitality through the protection of groundwater resources. This is accomplished through hazardous waste facility permitting and design; oversight of hazardous waste handling, removal, and disposal; oversight of remediation of hazardous substances releases; funding of emergency removal actions involving hazardous substances, including the cleanup of illegal drug labs; cleanup of abandoned hazardous waste sites; oversight of the closure of military bases; and pollution prevention.

If groundwater is threatened or impacted by a hazardous substance release, DTSC provides technical oversight for the characterization and remediation of soil and groundwater contamination. DTSC and the nine RWQCBs coordinate regulatory oversight of groundwater remediation. To ensure site-specific groundwater quality objectives are met, DTSC consults with RWQCB staff and appropriate groundwater basin plans.

Box M Improving Coordination of Groundwater Information

California's groundwater resources are addressed by an array of different State and federal agencies. Each agency approaches groundwater from a unique perspective, based on its individual statutory mandate. As a result, each agency collects different types of groundwater data and information. To facilitate the effective and efficient exchange of groundwater resource information, the State Water Resources Control Board (SWRCB) is coordinating the Groundwater Resources Information Sharing Team (GRIST), which is composed of representatives from various groundwater agencies. Agencies currently participating in GRIST are:

- State Water Resources Control Board
- Department of Health Services
- Department of Water Resources
- Department of Pesticide Regulation
- Lawrence Livermore National Laboratory
- U.S. Geological Survey

One of the tasks of the GRIST is to identify data relevant to California groundwater resources. A listing of the data, along with the appropriate agency contacts and Internet links, will be maintained by SWRCB on the Groundwater Resources Information Database. In addition, to facilitate effective information sharing and communication among stakeholders, groundwater data will be made available on the SWRCB GeoTracker system. GeoTracker is a geographic information system that provides Internet access to environmental data. The centralization of environmental data through GeoTracker will enable more in-depth geospatial and statistical analyses of groundwater data in the future. For more information about GeoTracker, visit the GeoTracker Internet site at http://geotracker.arsenautlegg.com.

California Bay-Delta Authority

http://calwater.ca.gov The California Bay-Delta program was initiated in 1994 to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Sacramento-San Joaquin Bay-Delta System. The partnership currently consists of more than 20 State and federal agencies. An important element of the program is to increase storage by developing an additional 500,000 acre-feet to 1.0 million acre-feet of groundwater storage capacity by the year 2007 (CALFED 2000).

Effective January 1, 2003, a newly formed State agency assumed responsibility for overseeing implementation of the Bay-Delta program. The California Bay-Delta Authority provides a permanent governance structure for the collaborative state-federal effort. The authority was established by enactment of Senate Bill 1653 in 2002. The legislation calls for the authority to sunset on January 1, 2006, unless federal legislation has been enacted authorizing the participation of appropriate federal agencies in the authority.

U.S. Environmental Protection Agency

http://www.epa.gov/safewater The U.S. Environmental Protection Agency (EPA) Office of Ground Water and Drinking Water, together with states, tribes, and many partners, protects public health by ensuring safe drinking water and protecting groundwater. The EPA's role in California groundwater is primarily related to protection of the resource and comes in the form of administering several federal programs in close coordination with State agencies such as SWRCB, DHS, and DTSC.

U.S. Geological Survey

http://ca.water.usgs.gov USGS has published results of many studies of California groundwater basins. USGS maintains an extensive groundwater level and groundwater quality monitoring network and has compiled this data in a database. The California District is working on cooperative programs with local, State, and other federal agencies. The most notable programs include three regional studies of the San Joaquin-Tulare Basin, the Sacramento River Basin, and the Santa Ana River basin under the National Water Quality Assessment Program. Results were published for the San Joaquin-Tulare Basin in 1995 and the Sacramento River Basin in 2000. The Santa Ana River basin study is in progress.

U.S. Bureau of Reclamation

http://www.usbr.gov The U.S. Bureau of Reclamation (USBR) operates the Central Valley Project (CVP), an extensive network of dams, canals, and related facilities that delivers about 7 maf during normal years for agricultural, urban, and wildlife use. USBR's role with respect to groundwater is generally limited to monitoring for impacts to the groundwater systems adjacent to its CVP facilities. Through the cooperative efforts of USBR, DWR, irrigation districts, farmers, and other local entities, groundwater level data have been collected continuously since project conception in the 1930s and 1940s.

In addition to CVP monitoring, USBR monitors groundwater levels to identify potential impacts as a result of two other projects in California. That monitoring includes the Santa Ynez basin as part of the Cachuma Project on the central coast, and the Putah Creek Cone as part of the Solano Project in the southwest Sacramento Valley. Both monitoring efforts are required as part of permitting for the projects.

USBR is planning to implement a groundwater information system to collect and distribute to the public the large volume of historical groundwater level data associated with its projects.

Chapter 6

Basic Groundwater Concepts

Chapter 6
Basic Groundwater Concepts

This chapter presents general concepts relating to the origin, occurrence, movement, quantity, and quality of groundwater. The concepts will be useful in providing the nontechnical reader with a basic understanding of groundwater. For more experienced readers, many topics are discussed specifically as they apply to California or as the terms are used in this report. A glossary of terms is included at the end of this report. For additional reading on basic groundwater concepts see *Basic Ground-Water Hydrology* (Heath 1983).

Origin of Groundwater

Groundwater is a component of the hydrologic cycle (Figure 11), which describes locations where water may occur and the processes by which it moves or is transformed to a different phase. In simple terms, water or one of its forms—water vapor and ice—can be found at the earth's surface, in the atmosphere, or beneath the earth's surface. The hydrologic cycle is a continuum, with no beginning or end; however, it is often thought of as beginning in the oceans. Water evaporates from a surface water source such as an ocean, lake, or through transpiration from plants. The water vapor may move over the land and condense to form clouds, allowing the water to return to the earth's surface as precipitation (rain or snow). Some of the snow will end up in polar ice caps or in glaciers. Most of the rain and snowmelt will either become overland flow in channels or will infiltrate into the subsurface. Some of the infiltrated water will be transpired by plants and returned to the atmosphere, while some will cling to particles surrounding the pore spaces in the subsurface, remaining in the vadose (unsaturated) zone. The rest of the infiltrated water will move gradually under the influence of gravity into the saturated zone of the subsurface, becoming groundwater. From here, groundwater will flow toward points of discharge such as rivers, lakes, or the ocean to begin the cycle anew. This flow from recharge areas to discharge areas describes the groundwater portion of the hydrologic cycle.

The importance of groundwater in the hydrologic cycle is illustrated by considering the distribution of the world's water supply. More than 97 percent of all earth's water occurs as saline water in the oceans (Fetter 1988). Of the world's fresh water, almost 75 percent is in polar ice caps and glaciers, which leaves a very small amount of fresh water readily available for use. Groundwater accounts for nearly all of the remaining fresh water (Alley and others 1999). All of the fresh water stored in the world's rivers and lakes accounts for less than 1 percent of the world's fresh water.

Occurrence of Groundwater

Groundwater is the water occurring beneath the earth's surface that completely fills (saturates) the void space of rocks or sediment. Given that all rock has some open space (voids), groundwater can be found underlying nearly any location in the State. Several key properties help determine whether the subsurface environment will provide a significant, usable groundwater resource. Most of California's groundwater occurs in material deposited by streams, called alluvium. Alluvium consists of coarse deposits, such as sand and gravel, and finer-grained deposits such as clay and silt. The coarse and fine materials are usually coalesced in thin lenses and beds in an alluvial environment. In this environment, coarse materials such as sand and gravel deposits usually provide the best source of water and are termed aquifers; whereas, the finer-grained clay and silt deposits are relatively poor sources of water and are referred to as aquitards. California's groundwater basins usually include one or a series of alluvial aquifers with intermingled aquitards. Less frequently, groundwater basins include aquifers composed of unconsolidated marine sediments that have been flushed by fresh water. We include the marine-deposited aquifers in the discussion of alluvial aquifers in this bulletin.

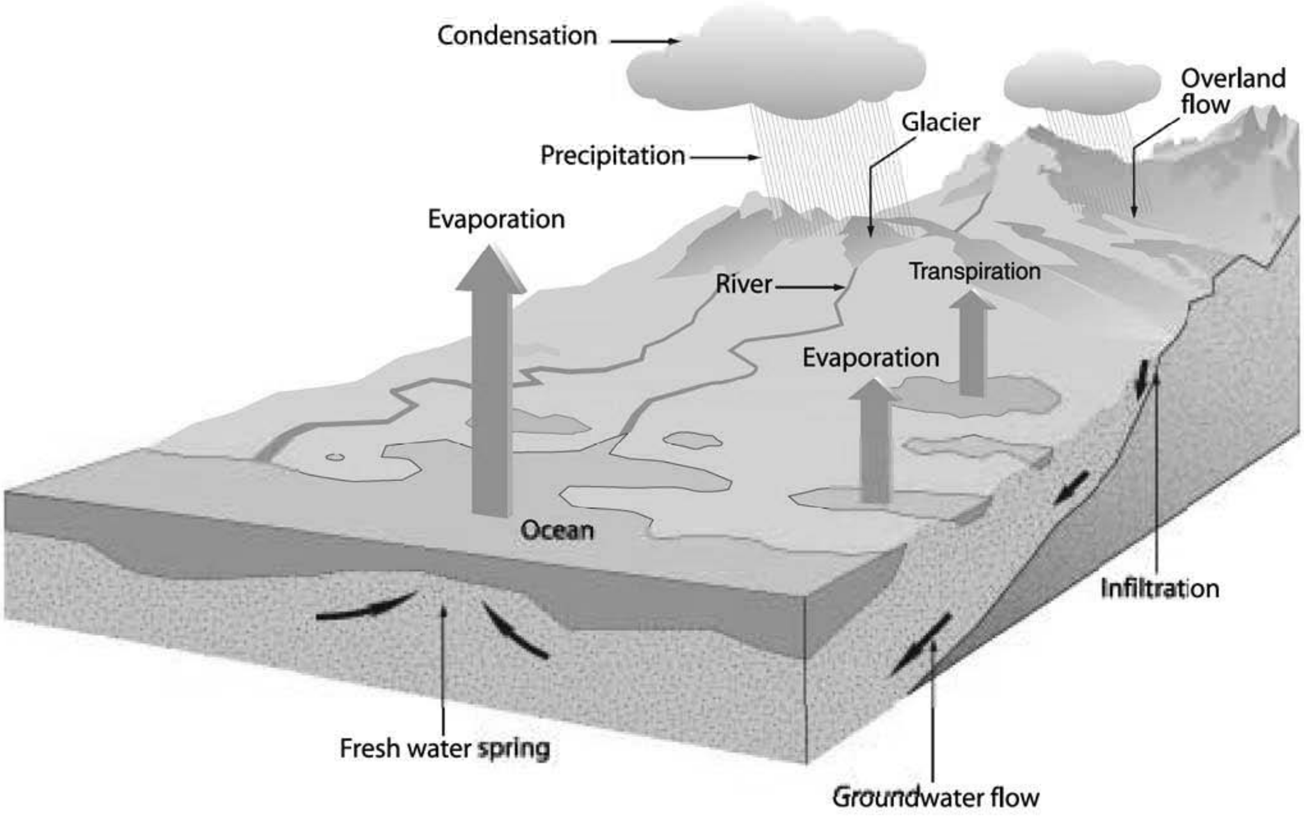


Figure 11 The Hydrologic Cycle

Although alluvial aquifers are most common in California, other groundwater development occurs in fractured crystalline rocks, fractured volcanics, and limestones. For this report, these nonalluvial areas that provide groundwater are referred to as "groundwater source areas," while the alluvial aquifers are called groundwater basins. Each of these concepts is discussed more fully below.

Groundwater and Surface Water Interconnection

Groundwater and surface water bodies are connected physically in the hydrologic cycle. For example, at some locations or at certain times of the year, water will infiltrate the bed of a stream to recharge groundwater. At other times or places, groundwater may discharge, contributing to the base flow of a stream. Changes in either the surface water or groundwater system will affect the other, so effective management requires consideration of both resources. Although this physical interconnection is well understood in general terms, details of the physical and chemical relationships are the topic of considerable research.

These details are the subject of significant recent investigations into the hyporheic zone, the zone of sand and gravel that forms the channel of a stream. As surface water flows downstream it may enter the gravels in the

Box N One Resource, Two Systems of Law

In California, two distinct legal regimes govern the appropriation of surface water and subterranean streams, and percolating groundwater. The California Water Code requires that water users taking water for beneficial use from surface watercourses and "subterranean streams flowing through known and definite channels" obtain water right permits or licenses from the State Water Resources Control Board (SWRCB) (Water Code § 1200 et seq.). Groundwater classified as percolating groundwater is not subject to the Water Code provisions concerning the appropriation of water, and a water user can take percolating groundwater without having a State-issued water right permit or license. Current Water Code section 1200 is derived from a provision in the Water Commission Act of 1913, which became effective on December 19, 1914.

The SWRCB developed a test to identify groundwater that is in a subterranean stream flowing through a known and definite channel and is therefore subject to the SWRCB's permitting authority. The physical conditions that must be present in a subterranean stream flowing in a known and definite channel are: (1) a subsurface channel must be present; (2) the channel must have relatively impermeable bed and banks; (3) the course of the channel must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel. Whether groundwater is subject to the SWRCB's permitting authority under this test is a factual determination. Water that does not fit this test is "percolating groundwater" and is not subject to the SWRCB's permitting authority.

The SWRCB has issued decisions that find that groundwater under the following streams constitutes a "subterranean stream flowing through known and definite channels" and is therefore subject to the SWRCB's permitting authority (Murphey 2003 pers com):

Los Angeles River in Los Angeles County
Sheep Creek in San Bernardino County
Mission Basin of the San Luis Rey River in San Diego County
Bonsall Basin of the San Luis Rey River in San Diego County
Pala Basin of the San Luis Rey River in San Diego County
Carmel River in Monterey County
Garrapata Creek in Monterey County
Big Sur River in Monterey County
Russian River
Chorro Creek in San Luis Obispo County
Morro Creek in San Luis Obispo County
North Fork Gualala River in Mendocino County

Contact the SWRCB, Division of Water Rights for specific stream reaches and other details of these decisions.

hyporheic zone, mix with groundwater, and re-enter the surface water in the stream channel. The effects of this interchange between surface water and groundwater can change the dissolved oxygen content, temperature, and mineral concentrations of the water. These changes may have a significant effect on aquatic and riparian biota.

Significantly, the physical and chemical interconnection of groundwater and surface water is not well represented in California's water rights system (see Box N "One Resource, Two Systems of Law").

Physical Properties That Affect Groundwater

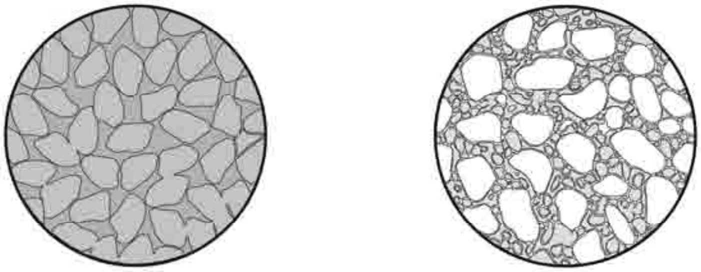
The degree to which a body of rock or sediments will function as a groundwater resource depends on many properties, some of which are discussed here. Two of the more important physical properties to consider are porosity and hydraulic conductivity. Transmissivity is another important concept to understand when considering an aquifer's overall ability to yield significant groundwater. Throughout the discussion of these properties, keep in mind that sediment size in alluvial environments can change significantly over short distances, with a corresponding change in physical properties. Thus, while these properties are often presented as average values for a large area, one might encounter different conditions on a more localized level. Determination of these properties for a given aquifer may be based on lithologic or geophysical observations, laboratory testing, or aquifer tests with varying degrees of accuracy.

Porosity

The ratio of voids in a rock or sediment to the total volume of material is referred to as porosity and is a measure of the amount of groundwater that may be stored in the material. Figure 12 gives several examples of the types of porosity encountered in sediments and rocks. Porosity is usually expressed as a percentage and can be classified as either primary or secondary. Primary porosity refers to the voids present when the sediment or rock was initially formed. Secondary porosity refers to voids formed through fracturing or weathering of a rock or sediment after it was formed. In sediments, porosity is a function of the uniformity of grain size (sorting) and shape. Finer-grained sediments tend to have a higher porosity than coarser sediments because the finer-grained sediments generally have greater uniformity of size and because of the tabular shape and surface chemistry properties of clay particles. In crystalline rocks, porosity becomes greater with a higher degree of fracturing or weathering. As alluvial sediments become consolidated, primary porosity generally decreases due to compaction and cementation, and secondary porosity may increase as the consolidated rock is subjected to stresses that cause fracturing.

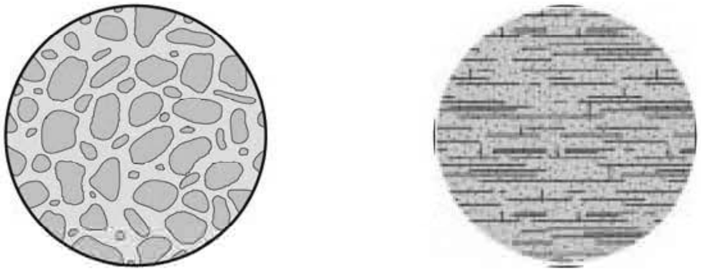
Porosity does not tell the entire story about the availability of groundwater in the subsurface. The pore spaces must also interconnect and be large enough so that water can move through the ground to be extracted from a well or discharged to a water body. The term "effective porosity" refers to the degree of interconnectedness of pore spaces. For coarse sediments, such as the sand and gravel encountered in California's alluvial groundwater basins, the effective porosity is often nearly equal to the overall porosity. In finer sediments, effective porosity may be low due to water that is tightly held in small pores. Effective porosity is generally very low in crystalline rocks that are not highly fractured or weathered.

While porosity measures the total amount of water that may be contained in void spaces, there are two related properties that are important to consider: specific yield and specific retention. Specific yield is the fractional amount of water that would drain freely from rocks or sediments due to gravity and describes the portion of the groundwater that could actually be available for extraction. The portion of groundwater that is retained either as a film on grains or in small pore spaces is called specific retention. Specific yield and specific retention of the aquifer material together equal porosity. Specific retention increases with decreasing grain size. Table 7 shows that clays, while having among the highest porosities, make poor sources of groundwater because they yield very little water. Sand and gravel, having much lower porosity than clay, make excellent sources of groundwater because of the high specific yield, which allows the groundwater to flow to wells. Rocks such as limestone and basalt yield significant quantities of groundwater if they are well-weathered and highly fractured.



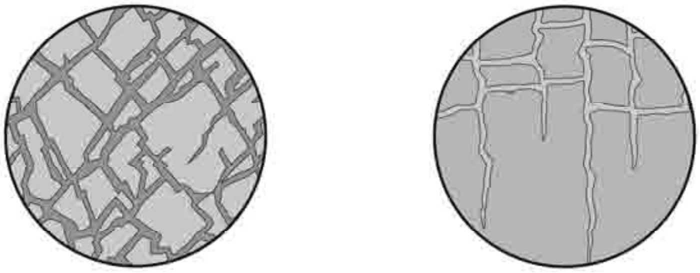
HIGH POROSITY
Sediments with uniform grain size

MODERATE POROSITY
Sediments with variable grain size



MINIMAL USABLE POROSITY
Cemented sediments of variable grain size

MINIMAL USABLE POROSITY
Fine sediments



LOW POROSITY
Fractured crystalline rock

LOW TO HIGH POROSITY
Fractured volcanic rocks

Figure 12 Examples of porosity in sediments and rocks

Table 7 Porosity (in percent) of soil and rock types

Material	Porosity	Specific yield	Specific retention
Clay	50	2	48
Sand	25	22	2
Gravel	20	19	1
Limestone	20	18	2
Sandstone (semiconsolidated)	11	6	5
Granite	0.1	0.09	0.01
Basalt (young)	11	8	3

Modified from Heath (1983)

Hydraulic Conductivity

Another major property related to understanding water movement in the subsurface is hydraulic conductivity. Hydraulic conductivity is a measure of a rock or sediment's ability to transmit water and is often used interchangeably with the term permeability. The size, shape, and interconnectedness of pore spaces affect hydraulic conductivity (Driscoll 1986).

Hydraulic conductivity is usually expressed in units of length/time: feet/day, meters/day, or gallons/day/square-foot. Hydraulic conductivity values in rocks range over many orders of magnitude from a low permeability unfractured crystalline rock at about 10^{-8} feet/day to a highly permeable well-sorted gravel at greater than 10^{4} feet/day (Heath 1983). Clays have low permeability, ranging from about 10^{-3} to 10^{-7} feet/day (Heath 1983). Figure 13 shows hydraulic conductivity ranges of selected rocks and sediments.

Transmissivity

Transmissivity is a measure of the aquifer's ability to transmit groundwater through its entire saturated thickness and relates closely to the potential yield of wells. Transmissivity is defined as the product of the hydraulic conductivity and the saturated thickness of the aquifer. It is an important property to understand because a given area could have a high value of hydraulic conductivity but a small saturated thickness, resulting in limited overall yield of groundwater.

Aquifer

An aquifer is a body of rock or sediment that yields significant amounts of groundwater to wells or springs. In many definitions, the word "significant" is replaced by "economic." Of course, either term is a matter of perspective, which has led to disagreement about what constitutes an aquifer. As discussed previously, coarse-grained sediments such as sands and gravels deposited in alluvial or marine environments tend to function as the primary aquifers in California. These alluvial aquifers are the focus of this report. Other aquifers, such as those found in volcanics, igneous intrusive rocks, and carbonate rocks are described briefly in the section Groundwater Source Areas.

Aquitard

An aquitard is a body of rock or sediment that is typically capable of storing groundwater but does not yield it in significant or economic quantities. Fine-grained sediments with low hydraulic conductivity, such as clays and silts, often function as aquitards. Aquitards are often referred to as confining layers because they retard the vertical movement of groundwater and under the right hydrogeologic conditions confine groundwater that is under pressure. Aquitards are capable of transmitting enough water to allow some flow between adjacent aquifers, and depending on the magnitude of this transfer of water, may be referred to as leaky aquitards.

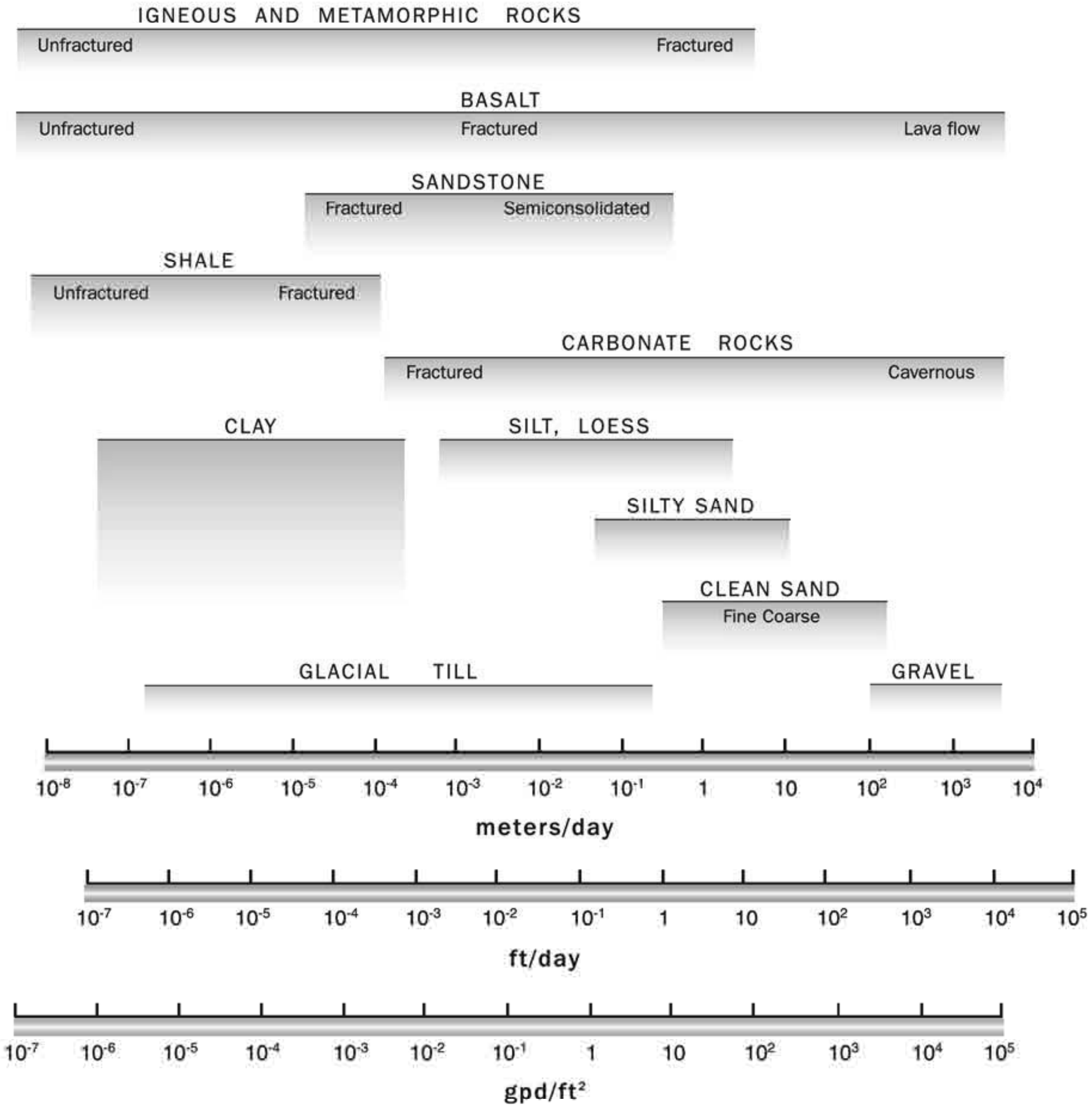


Figure 13 Hydraulic conductivity ranges of selected rocks and sediments

Unconfined and Confined Aquifers

In most depositional environments, coarser-grained deposits are interbedded with finer-grained deposits creating a series of aquifers and aquitards. When a saturated aquifer is bounded on top by an aquitard (also known as a confining layer), the aquifer is called a confined aquifer (Figure 14). Under these conditions, the water is under pressure so that it will rise above the top of the aquifer if the aquitard is penetrated by a well. The elevation to which the water rises is known as the potentiometric surface. Where an aquifer is not bounded on top by an aquitard, the aquifer is said to be unconfined. In an unconfined aquifer, the pressure on the top surface of the groundwater is equal to that of the atmosphere. This surface is known as the water table, so unconfined aquifers are often referred to as water table aquifers. The arrangement of aquifers and aquitards in the subsurface is referred to as hydrostratigraphy.

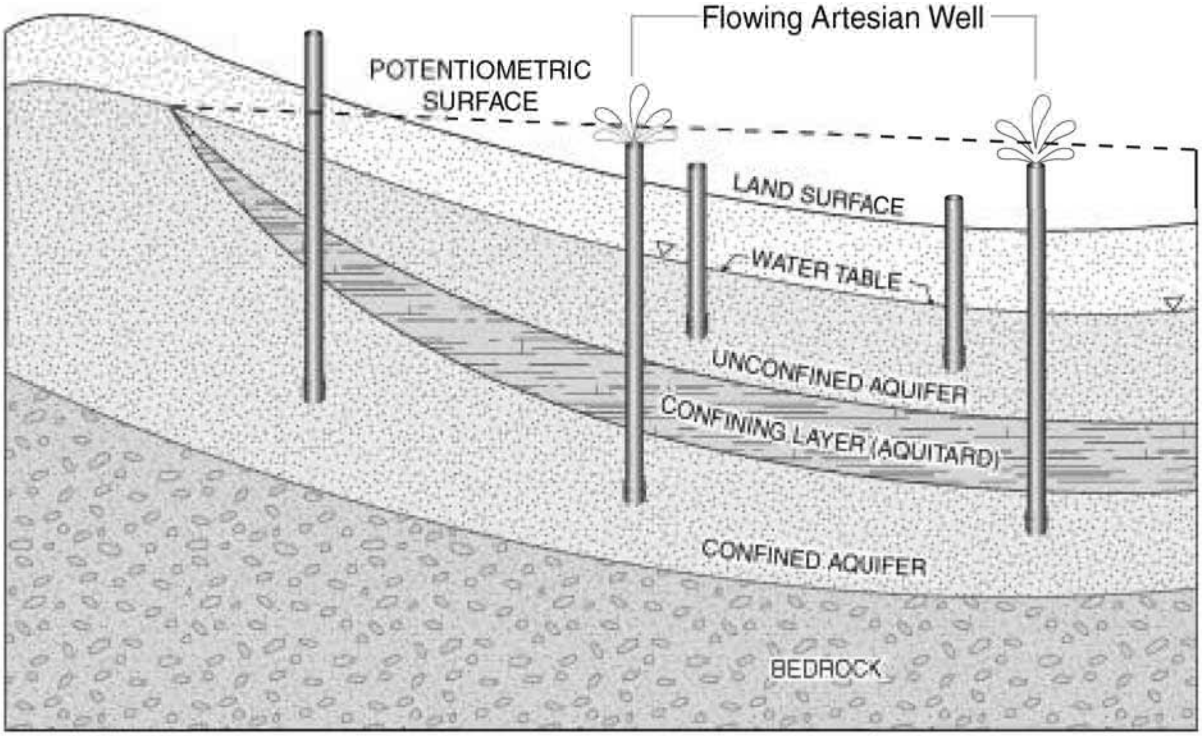


Figure 14 Interbedded aquifers with confined and unconfined conditions

With the notable exception of the Corcoran Clay of the Tulare Formation in the San Joaquin Valley and the aquitard in West Coast Basin in Los Angeles County, there are no clearly recognizable regional aquitards in California alluvial basins. Instead, due to the complexity of alluvial environments, it is the cumulative effect of multiple thin lenses of fine-grained sediments that causes increasing confinement of groundwater with increasing depth, creating what is often referred to as a semiconfined aquifer.

In some confined aquifers groundwater appears to defy gravity, but that is not the case. When a well penetrates a confined aquifer with a potentiometric surface that is higher than land surface, water will flow naturally to the surface. This is known as artesian flow, and results from pressure within the aquifer. The pressure results when the recharge area for the aquifer is at a higher elevation than the point at which discharge is occurring (Figure 14). The confining layer prevents the groundwater from returning to the surface until the confining layer is penetrated by a well. Artesian flow will discontinue as pressure in the aquifer is reduced and the potentiometric surface drops below the land surface elevation.

Groundwater Basin

A groundwater basin is defined as an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom. Lateral boundaries are features that significantly impede groundwater flow such as rock or sediments with very low permeability or a geologic structure such as a fault. Bottom boundaries would include rock or sediments of very low permeability if no aquifers occur below those sediments within the basin. In some cases, such as in the San Joaquin and Sacramento Valleys, the base of fresh water is considered the bottom of the groundwater basin. Table 8 is a generalized list of basin types and the features that define the basin boundaries.

Table 8 Types and boundary characteristics of groundwater basins

Characteristics of groundwater basins	
Groundwater basin	An aquifer or an aquifer system that is bounded laterally and at depth by one or more of the following features that affect groundwater flow: • Rocks or sediments of lower permeability • A geologic structure, such as a fault • Hydrologic features, such as a stream, lake, ocean, or groundwater divide
Types of basins and their boundaries	
Single simple basin	Basin surrounded on all sides by less permeable rock. Higher permeability near the periphery. Clays near the center. Unconfined around the periphery. Confined near the center. May have artesian flow near the center.
Basin open at one or more places to other basins	Many desert basins. Merged alluvial fans. Topographic ridges on fans. Includes some fault-bounded basins.
Basin open to Pacific Ocean	260 basins along the coast. Water-bearing materials extend offshore. May be in contact with sea water. Vulnerable to seawater intrusion.
Single complex basin	Basin underlain or surrounded by older water-bearing materials and water-bearing volcanics. Quantification is difficult because of unknown contacts between different rock types within the basin.
Groundwater in areas of volcanic rocks	Basin concept is less applicable in volcanic rocks. Volcanic rocks are highly variable in permeability.
Groundwater in weathered crystalline rocks (fractured hard rock)—not considered a basin	Small quantities of groundwater. Low yielding wells. Most wells are completed in the crystalline rock and rely on fractures to obtain groundwater.
Political boundaries or management area boundaries	Usually not related to hydrogeologic boundaries.Formed for convenience, usually to manage surface water storage and delivery.

Although only the upper surface of a groundwater basin can be shown on a map, the basin is three-dimensional and includes all subsurface fresh water-bearing material. These boundaries often do not extend straight down, but are dependent on the spatial distribution of geologic materials in the subsurface. In fact, in a few cases near California's coastal areas, aquifers in the subsurface are known to extend beyond the mapped surface of the basin and may actually be exposed under the ocean. Under natural conditions, fresh water flows from these aquifers into the ocean. If groundwater levels are lowered, sea water may flow into the aquifer. This has occurred in Los Angeles, Orange, Ventura, Santa Cruz and Monterey Counties, and some areas around San Francisco Bay. Depiction of a groundwater basin in three dimensions requires extensive subsurface investigation and data evaluation to delineate the basin geometry. Figure 15 is a cross-section showing how a coastal basin might appear in the subsurface.

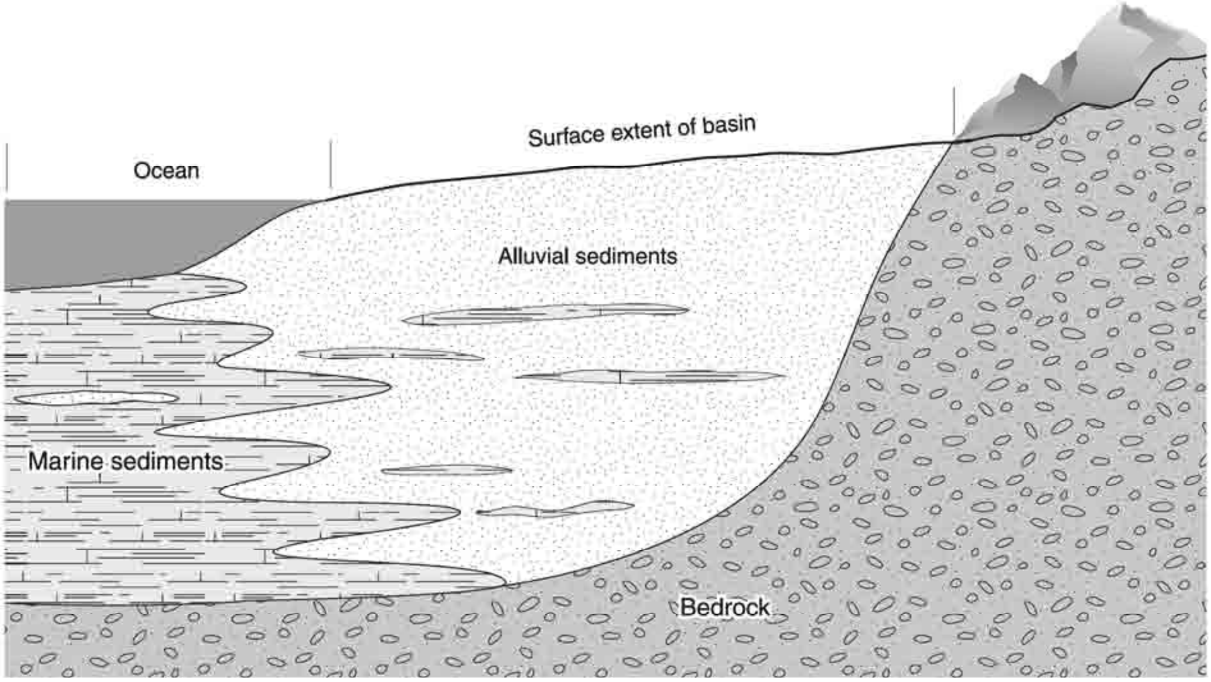


Figure 15 Groundwater basin near the coast with the aquifer extending beyond the surface basin boundary

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated. In many other basins where much less is known and understood about the basin, boundaries will probably change as a better understanding of the basin is developed. A procedure for collecting information from all the stakeholders should be developed for use statewide so that agreement on basin boundaries can be achieved.

Groundwater Subbasin

A subbasin is created by dividing a groundwater basin into smaller units using geologic and hydrologic barriers or, more commonly, institutional boundaries (see Table 8). These subbasins are created for the purpose of collecting and analyzing data, managing water resources, and managing adjudicated basins. As the definition implies, the designation of a subbasin boundary is flexible and could change in the future. The limiting rule for a subbasin is that it should not cross over a groundwater basin boundary.

An example of a hydrologic subbasin boundary would be a river or stream that creates a groundwater divide. While hydrologic boundaries may limit groundwater flow in the shallow subsurface, data indicate significant groundwater flow may occur across the boundary at greater depths. In addition, the location of the boundary may change over time if pumping or recharge patterns change. Institutional subbasin boundaries could be based on a political boundary, such as a county line or a water agency service area, or a legally mandated boundary such as a court adjudicated basin.

Groundwater Source Areas

Groundwater in California is also found outside of alluvial groundwater basins. Igneous extrusive (volcanic), igneous intrusive, metamorphic, and sedimentary rocks are all potential sources of groundwater. These rocks often supply enough water for domestic use, but in some cases can also yield substantial quantities. In this report the term groundwater source area is used for rocks that are significant in terms of being a local groundwater source, but do not fit the category of basin or subbasin. The term is not intended to imply that groundwater actually originates in these rocks, but that it is withdrawn from rocks underlying a generally definable area. Because of the increased difficulty in defining and understanding the hydrogeologic properties of these rocks, the limited data available for the areas in which these rocks occur, and the relatively small, though rapidly growing, segment of the population served by these water supplies, they are discussed separately from groundwater basins.

Volcanics

Groundwater in volcanics can occur in fractures that result from cooling or changes in stress in the crust of the Earth, lava tubes, tree molds, weathering surfaces, and porous tuff beds. Additionally, the volcanics could overlie other deposits from an alluvial environment. Flow in the fractures may approach the same velocities as that of surface water, but there is often very limited storage potential for groundwater. The tuff beds can act similarly to alluvial aquifers.

Some of the most productive volcanic rocks in the State include the Modoc Plateau volcanics in the northeast and the Napa-Sonoma volcanics northeast of San Francisco Bay (Figure 16). Wells in Modoc Plateau volcanics are commonly reported to yield between 100 and 1,000 gallons per minute, with some yields of 4,000 gpm (Planert and Williams 1995). Bulletin 118-75 assigned identification numbers to these volcanic rocks throughout the State (for example, Modoc Plateau Recent Volcanic Areas, 1-23). The numbers led some to interpret them as being groundwater basins. In this update, the numbers corresponding to the volcanics are being retired to eliminate this confusion.

Figure 16 Significant volcanic groundwater source areas

Igneous Intrusive, Metamorphic, and Sedimentary Rocks

Groundwater in igneous intrusive, metamorphic, and consolidated sedimentary rocks occurs in fractures resulting from tectonism and expansion of the rock as overburden pressures are relieved. Groundwater is extracted from fractured rock in many of the mountainous areas of the State, such as the Sierra Nevada, the Peninsular Range, and the Coast Ranges. Rocks in these areas often yield only enough supply for individual domestic wells, stock water wells, or small community water systems. Availability of groundwater in such formations can vary widely, even over a distance of a few yards. Areas of groundwater production from consolidated rocks were not defined in previous versions of Bulletin 118 and are not included in this update.

As population grows in areas underlain by these rocks, such as the foothills of the Sierra Nevada and southern California mountains, many new wells are being built in fractured rock. However, groundwater data are often insufficient to accurately estimate the long term reliability of groundwater supplies in these areas. Additional investigation, data evaluation, and management will be needed to ensure future sustainable supplies. The Legislature recognized both the complexity of these areas and the need for management in SB 1938 (2002), which amended the Water Code to require groundwater management plans with specific components be adopted for agencies to be eligible for certain funding administered by DWR for construction of groundwater projects. Water Code section 10753.7(a)(5) states:

> Local agencies that are located in areas outside the groundwater basins delineated on the latest edition of the department's groundwater basin and subbasin map shall prepare groundwater management plans incorporating the components in this subdivision, and shall use geologic and hydrologic principles appropriate to those areas.

In carbonate sedimentary rocks such as limestone, groundwater occurs in fractures and cavities formed as a result of dissolution of the rock. Flow in the largest fractures may approach the velocities of surface water, but where these rocks occur in California there is limited storage potential for groundwater. Carbonate rocks occur mostly in Inyo County near the Nevada border (USGS 1995), in the Sierra Nevada foothills, and in some parts of the Sacramento River drainage north of Redding. The carbonates near the Nevada state border in Inyo County are part of a regional aquifer that extends northeastward into Nevada. Springs in Nevada and in the Death Valley region in California are dependent on groundwater flow in this regional aquifer. In other parts of the country, such as Florida, carbonate rocks constitute significant sources of groundwater.

Movement of Groundwater

The movement of groundwater in the subsurface is quite complex, but in simple terms it can be described as being driven by potential energy. At any point in the saturated subsurface, groundwater has a hydraulic head value that describes its potential energy, which is the combination of its elevation and pressure. In an unconfined aquifer, the water table elevation represents the hydraulic head, while in a confined aquifer the potentiometric surface represents the hydraulic head (Figure 14). Water moves in response to the difference in hydraulic head from the point of highest energy toward the lowest. On a regional scale this results in flow of groundwater from recharge areas to discharge areas. In California, pumping depressions around extraction wells often create the discharge points to which groundwater flows. Groundwater may naturally exit the subsurface by flowing into a stream, lake, or ocean, by flowing to the surface as a spring or seep, or by being transpired by plants.

The rate at which groundwater flows is dependent on the hydraulic conductivity and the rate of change of hydraulic head over some distance. In the mid-19th century, Henry Darcy found through his experiments on sand filters that the amount of flow through a porous medium is directly proportional to the difference between hydraulic head values and inversely proportional to the horizontal distance between them (Fetter 1988). His conclusions extend to flow through aquifer materials. The difference between hydraulic heads divided by the distance between them is referred to as the hydraulic gradient. When combined with the hydraulic conductivity of the porous medium and the cross-sectional area through which the groundwater flows, Darcy's law states:

$$Q = KA(dh/dl) \text{ (volume/time)}$$

Where:

Q = flow discharging through a porous medium
K = hydraulic conductivity (length/time)
A = cross-sectional area (length^2)
dh = change in hydraulic head between two points (length)
dl = distance between two points (length)

This version of Darcy's law provides a volumetric flow rate. To calculate the average linear velocity at which the water flows, the result is divided by the effective porosity. The rate of movement of groundwater is very slow, usually less than 1,000 feet per year because of the great amount of friction resulting from movement through the spaces between grains of sand and gravel.

Quantity of Groundwater

Because groundwater is a precious resource, the questions of how much there is and how more can be made available are important. There are many terms and concepts associated with the quantity of groundwater available in a basin, and some controversy surrounding their definition. Some of these include groundwater storage capacity, usable storage capacity, groundwater budget, change in storage, overdraft, and safe yield. This section discusses some of the more common terms used to represent groundwater quantity in California.

Groundwater Storage Capacity

The groundwater storage capacity of an individual basin or within the entire State is one of the questions most frequently asked by private citizens, water resource planners, and politicians alike. Total storage capacity seems easy to understand. It can be seen as how much physical space is available for storing groundwater. The computation of groundwater storage capacity is quite simple if data are available: capacity is determined by multiplying the total volume of a basin by the average specific yield. The total storage capacity is constant and is dependent on the geometry and hydrogeologic characteristics of the aquifer(s) (Figure 17).

Estimates of total groundwater storage capacity in California are staggering. Previous estimates of total storage range from 850 million acre-feet (maf) to 1.3 billion acre-feet (DWR 1975, DWR 1994). However, due to incomplete information about many of the groundwater basins, there has never been an accurately quantified calculation of total storage capacity statewide. Even if such a calculation were possible, the utility of such a number is questionable because total storage capacity might lead to overly optimistic estimates of how much additional groundwater development can contribute to meeting future demands.

Total groundwater storage capacity is misleading because it only takes into account one aspect of the physical character of the basin. Many other factors limit the ultimate development potential of a groundwater basin. These limiting factors may be physical, chemical, economic, environmental, legal, and institutional (Table 9). Some of these factors, such as the economic and institutional ones, can change with time. However, there may remain significant physical and chemical constraints that will limit groundwater development.

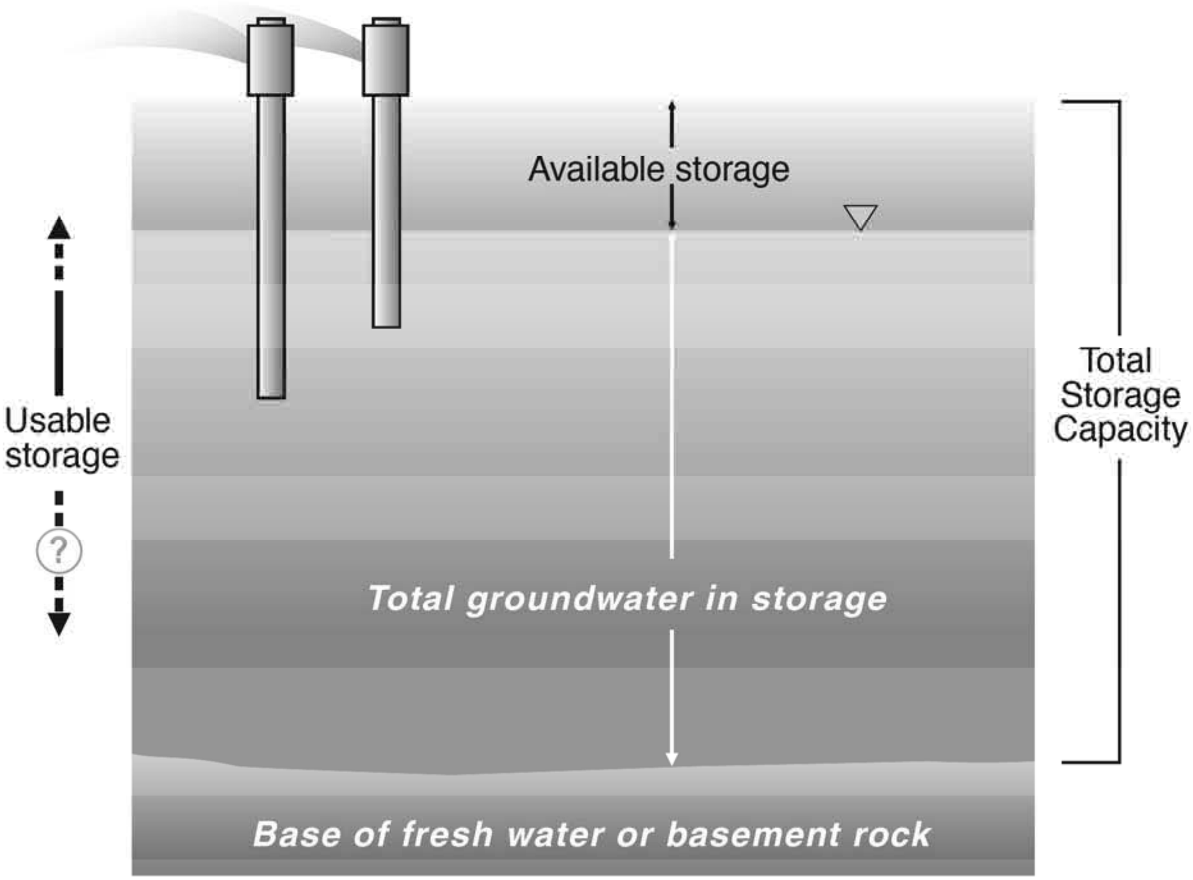


Figure 17 Schematic of total, usable, and available groundwater storage capacity

Table 9 Examples of factors that limit development of a groundwater basin

Limiting factor	Examples
Physical	Basin recharge area not adequate to sustain development; pumping too concentrated in a portion of basin; well yields too low for intended use.
Quality	Water quality not suitable for intended use; increased potential for seawater intrusion in coastal areas; upwelling of poorer quality water in deeper parts of basin.
Economic	Excessive costs associated with increased pump lifts and deepening of wells; cost of treating water if it does meet requirements for intended use.
Environmental	Need to maintain groundwater levels for wetlands, stream base flow, or other habitat.
Institutional	Local groundwater management plans or ordinances restricting use; basin adjudication; impacts on surface water rights of others.

Usable Groundwater Storage Capacity

Usable storage capacity is defined as the amount of groundwater of suitable quality that can be economically withdrawn from storage. It is typically computed as the product of the volume of the basin to some basin-specific depth that is considered economically available and the average specific yield of the basin (see Figure 17).

As more groundwater is extracted, groundwater levels may fall below some existing wells, which may then require replacement or deepening. This may be a consideration in management of the basin and will depend on the cost of replacement, the cost of pumping the water from deeper zones, and whether managers are willing to pay that cost. Other impacts that may increase the cost include subsidence and groundwater quality degradation. The usable storage may change because of changes in economic conditions.

Estimates of usable storage represent only the total volume of groundwater assumed to be usable in storage, not what would be available for sustained use on an annual basis. Previous estimates of usable groundwater storage capacity range from 143 to 450 maf (DWR 1975, DWR 1994). Unfortunately, the term "usable storage" is often used to indicate the amount of water that can be used from a basin as a source of long-term annual supply. However, the many limitations associated with total groundwater storage capacity discussed above may also apply to usable storage.

Available Groundwater Storage Capacity

Available storage capacity is defined as the volume of a basin that is unsaturated and capable of storing additional groundwater. It is typically computed as the product of the empty volume of the basin and the average specific yield of the unsaturated part of the basin (see Figure 17). The available storage capacity does not include the uppermost portion of the unsaturated zone in which saturation could cause problems such as crop root damage or increased liquefaction potential. The available storage will vary depending on the amount of groundwater taken out of storage and the recharge. The total groundwater in storage will change inversely as the available storage changes.

Available storage has often been used as a number to represent the potential for additional yield from a particular basin. Unfortunately, many of the limitations that exist in developing existing supply discussed above also limit taking advantage of available storage. Although limitations exist, looking only at available groundwater storage capacity may underestimate the potential for groundwater development. Opportunities to use groundwater already in storage and create additional storage space would be overlooked by this approach.

Groundwater Budget

A groundwater budget is an analysis of a groundwater basin's inflows and outflows to determine the change in groundwater storage. Alternatively, if the change in storage is known, the value of one of the inflows or outflows could be determined. The basic equation can be expressed as:

INFLOWS – OUTFLOWS = CHANGE IN STORAGE

Typical inflows include:

- natural recharge from precipitation;
- seepage from surface water channels;
- intentional recharge via ponds, ditches, and injection wells;
- net recharge of applied water for agricultural and other irrigation uses;
- unintentional recharge from leaky conveyance pipelines; and
- subsurface inflows from outside basin boundaries.

Outflows include:

- groundwater extraction by wells;
- groundwater discharge to surface water bodies and springs;
- evapotranspiration; and
- subsurface outflow across basin or subbasin boundaries.

Groundwater budgets can be useful tools to understand a basin, but detailed budgets are not available for most groundwater basins in California. A detailed knowledge of each budget component is necessary to obtain a good approximation of the change in storage. Absence or inaccuracy of one or more parameters can lead to an analysis that varies widely from a positive to a negative change in storage or vice versa. Since much of the data needed requires subsurface exploration and monitoring over a series of years, the collection of detailed field data is time-consuming and expensive. A management plan should develop a monitoring program as soon as possible.

Change in Groundwater Storage

As stated above, a groundwater budget is one potential way of estimating the change in storage in a basin, although it is limited by the accuracy and availability of data. There is a simpler way—by determining the average change in groundwater elevation over the basin, multiplied by the area overlying the basin and the average specific yield (or storativity in the case of a confined aquifer). The time interval over which the groundwater elevation change is determined is study specific, but annual spring-to-spring changes are commonly used. A change in storage calculation does not attempt to determine the volume of water in storage at any time interval, but rather the change from a previous period or baseline condition.

A change in storage calculation is a relatively quick way to represent trends in a basin over time. If change in storage is negligible over a representative period, the basin is in equilibrium under current use. Changes in storage calculations are more often available for a groundwater basin than groundwater budgets because water level measurements are available in many basins. Specific yield and storativity are readily estimated based on knowledge of the hydrogeologic setting and geologic materials or through aquifer pumping tests. Although simple, change in storage calculations have potential sources of error, so it is important to treat change in storage as just one of many tools in determining conditions in a groundwater basin. Well data sets must be carefully evaluated before use in these calculations. Mixing of wells constructed in confined and unconfined portions of the basin and measurement of different well sets over time can result in significant errors.

Although the change in storage calculation is a relatively quick and inexpensive method of observing changes in the groundwater system, the full groundwater budget is preferable. A detailed budget describes an understanding of the physical processes affecting storage in the basin, which the simple change in storage calculation does not. For example, the budget takes into account the relationship between the surface water and the groundwater system. If additional groundwater extraction induced additional infiltration of surface water, the calculated change in storage could be minimal. However, if the surface water is used as a source of supply downstream, the impact of reduced flows could be significant.

Overdraft

Groundwater overdraft is defined as the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions (DWR 1998). Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts.

Despite its common usage, the term overdraft has been the subject of debate for many years. Groundwater management is a local responsibility, therefore, the decision whether a basin is in a condition of overdraft is the responsibility of the local groundwater or water management agency. In some cases local agencies may choose to deliberately extract groundwater in excess of recharge in a basin (known as "groundwater mining") as part of an overall management strategy. An independent analysis of water levels in such a basin might conclude that the basin is in overdraft. In other cases, where basin management is less active or nonexistent, declining groundwater levels are not considered a problem until levels drop below the depth of many wells in the basin. As a result, overdraft may not be reported for many years after the condition began.

Water quality changes and subsidence may also indicate that a basin has been overdrafted. For example, when groundwater levels decline in coastal aquifers, seawater fills the pore spaces in the aquifer that are vacated by the groundwater, indicating that the basin is being overdrafted. Overdraft has historically led to as much as 30 feet of land subsidence in one area of the State and lesser amounts in other areas.

The word "overdraft" has been used to designate two unrelated types of water shortages. The first is "historical overdraft" similar to the type illustrated in Figure 18, which shows that ground water levels began to decline in the mid 1950s and then leveled off in the mid 1980s, indicating less groundwater extraction or more recharge. The second type of shortage is "projected overdraft" as used in the *California Water Plan Update* (DWR 1998). In reality, this is an estimate of future water shortages based on an assumed management program within the basin, including projected supply and projected demand. If water management practices change in those basins in which a water shortage is projected, the amount of projected shortage will change.

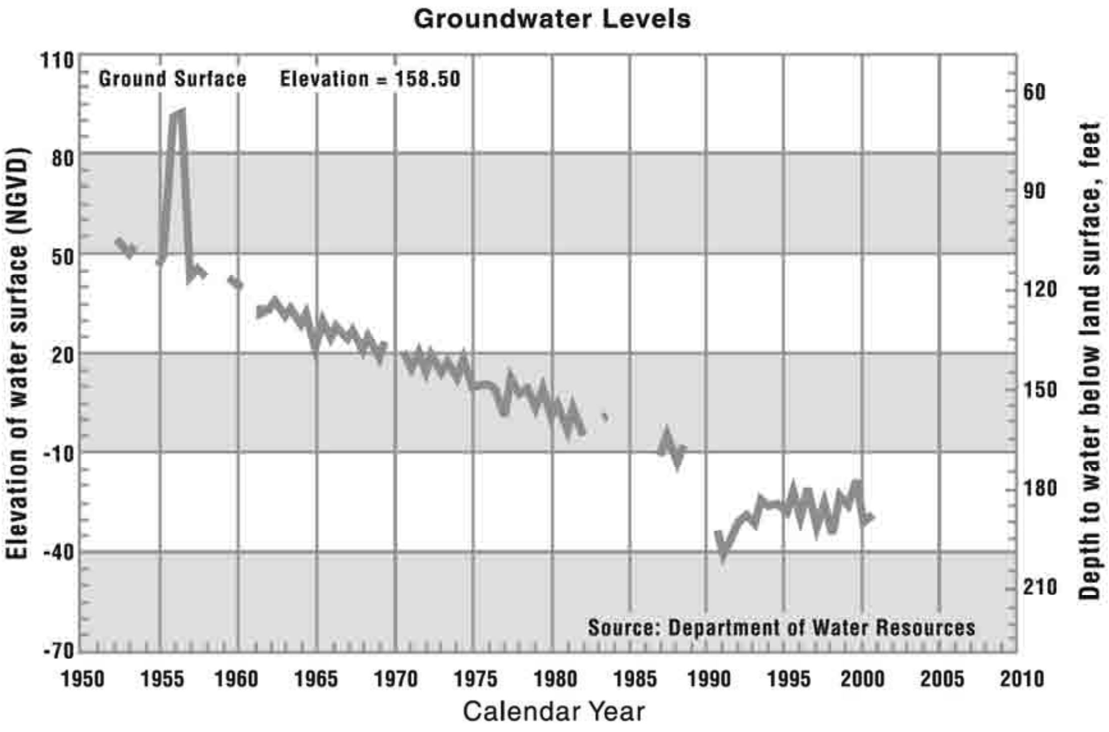


Figure 18 Hydrograph Indicating Overdraft

In some basins or subbasins, groundwater levels declined steadily over a number of years as agricultural or urban use of groundwater increased. In response, managing agencies developed surface water import projects to provide expanded water supplies to alleviate the declining groundwater levels. Increasing groundwater levels, or refilling of the aquifer, demonstrate the effectiveness of this approach in long-term water supply planning. In some areas of the State, the past overdraft is now being used to advantage. When the groundwater storage capacity that is created through historical overdraft is used in coordination with surface water supplies in a conjunctive management program, local and regional water supplies can be augmented.

In 1978 DWR was directed by the legislature to develop a definition of critical overdraft and to identify basins that were in a condition of critical overdraft (Water Code § 12924). The process that was followed and the basins that were deemed to be in a condition of critical overdraft are discussed in Box O, "Critical Conditions of Overdraft." This update to Bulletin 118 did not include similar direction from the legislature, nor funding to undertake evaluation of the State's groundwater basins to determine whether they are in a state of overdraft.

Box O Critical Conditions of Overdraft

In 1978 DWR was directed by the legislature to develop a definition of critical overdraft and to identify those basins in a critical condition of overdraft (Water Code §12924). DWR held public workshops around the state to obtain public and water managers' input on what the definition should include, and which basins were critically overdrafted. Bulletin 118-80, *Ground Water Basins in California* was published in 1980 with the results of that local input. The definition of critical overdraft is:

> *A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.*

No time is specified in the definition. Definition of the time frame is the responsibility of the local water managers, as is the definition of significant adverse impacts, which would be related to the local agency's management objectives.

Eleven basins were identified as being in a critical condition of overdraft. They are:

Pajaro Basin
Ventura Central Basin
Chowchilla Basin
Kings Basin
Tulare Lake Basin
Kern County Basin
Cuyama Valley Basin
Eastern San Joaquin County Basin
Madera Basin
Kaweah Basin
Tule Basin

The task was not identified by the Legislature, nor was the funding for this update (2003) sufficient to consult with local water managers and fully re-evaluate the conditions of the 11 critically overdrafted basins. Funding and duration were not sufficient to evaluate additional basins with respect to conditions of critical overdraft.

If a basin lacks existing information, the cost of a thorough evaluation of overdraft conditions in a single basin could exceed $1 million. In this update of Bulletin 118, DWR has included groundwater budget information for each basin description, where available. In most cases, however, sufficient quantitative information is not available, so conditions of overdraft or critical overdraft were not reported.

While this bulletin does not specifically identify overdrafted basins (other than the 11 basins from Bulletin 118-80), the negative effects of overdraft are occurring or may occur in the future in many basins throughout the State. Declining water levels, diminishing water quality, and subsidence threaten the availability of groundwater to meet current and future demands. A thorough understanding of overdraft can help local groundwater managers minimize the impacts and take advantage of the opportunity created by available groundwater storage capacity. Local groundwater managers and DWR should seek funding and work cooperatively to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts. Beginning with the most heavily used basins and relying to the extent possible on available data collected by DWR and through local groundwater management programs, current or projected conditions of critical overdraft should be identified. If local agencies take the lead in collecting and analyzing data to fully understand groundwater basin conditions, DWR can use the information to update the designations of critically overdrafted basins. This can be a cost effective approach since much of the data needed to update the overdraft designations are the same data that agencies need to effectively manage groundwater.

Safe Yield

Safe yield is defined as the amount of groundwater that can be continuously withdrawn from a basin without adverse impact. Safe yield is commonly expressed in terms of acre-feet per year. Depending on how it is applied, safe yield may be an annual average value, or may be calculated based on changed conditions each year. Although safe yield may be indicated by stable groundwater levels measured over a period of years, a detailed groundwater budget is needed to accurately estimate safe yield. Safe yield has commonly been determined in groundwater basin adjudications.

Proper application of the safe yield concept requires that the value be modified through time to reflect changing practices within the basin. One of the common misconceptions is that safe yield is a static number. That is, once it has been calculated, the amount of water can be extracted annually from the basin without any adverse impacts. An example of a situation in which this assumption could be problematic is when land use changes. In some areas, where urban development has replaced agriculture, surface pavement, storm drains, and sewers have increased runoff and dramatically reduced recharge into the basin. If extraction continued at the predetermined safe yield of the basin, water level decline and other negative impacts could occur.

Figure 19 Photograph of extensometer

An extensometer is a well with a concrete bench mark at the bottom. A pipe extends from the concrete to the land surface. If compaction of the finer sediments occurs, leading to land surface subsidence, the pipe in the well will appear to rise out of the well casing. When this movement is recorded, the data show how much the land surface has subsided.

Subsidence

When groundwater is extracted from some aquifers in sufficient quantity, compaction of the fine-grained sediments can cause subsidence of the land surface. As the groundwater level is lowered, water pressure decreases and more of the weight of the overlying sediments is supported by the sediment grains within the aquifer. If these sediments have not previously been surcharged with an equivalent load, the overlying load will compact them. Compaction decreases the porosity of the sediments and decreases the overall volume of the finer grain sediments, leading to subsidence at the land surface. While the finer sediments within the aquifer system are compacted, the usable storage capacity of the aquifer is not greatly decreased.

Data from extensometers (Figure 19) show that as groundwater levels decline in an aquifer, the land surface falls slightly. As groundwater levels rise, the land surface also rises to its original position. This component of subsidence is called elastic subsidence because it recovers. Inelastic subsidence, the second component of subsidence, is what occurs when groundwater levels decline to the point that the finer sediments are compacted. This compaction is not recoverable.

Conjunctive Management

Conjunctive management in its broadest definition is the coordinated and combined use of surface water and groundwater to increase the overall water supply of a region and improve the reliability of that supply. Conjunctive management may be implemented to meet other objectives as well, including reducing groundwater overdraft and land subsidence, protecting water quality, and improving environmental conditions. Although surface water and groundwater are sometimes considered to be separate resources, they are connected in the hydrologic cycle. By using or storing additional surface water when it is plentiful, and relying more heavily on groundwater during dry periods, conjunctive management can change the timing and location of water so it can be used more efficiently.

Although a specific project or program may be extremely complex, there are several components common to conjunctive management projects. The first is to recharge surplus surface water when it is available to increase groundwater in storage. Recharge may occur through surface spreading, by injection wells, or by reducing groundwater use by substituting surface water. The surplus surface water used for recharge may be local runoff, imported water, stored surface water, or recycled water. The second component is to reduce surface water use in dry years or dry seasons by switching to groundwater. This use of the stored groundwater may take place through direct extraction and use, pumping back to a conveyance facility, or through exchange of another water supply. A final component that should be included is an ongoing monitoring program to evaluate operations and allow water managers to respond to changes in groundwater, surface water, or environmental conditions that could violate management objectives or impact other water users.

Quality of Groundwater

All water contains dissolved constituents. Even rainwater, often described as being naturally pure, contains measurable dissolved minerals and gases. As it moves through the hydrologic cycle, water dissolves and incorporates many constituents. These include naturally occurring and man-made constituents.

Most natural minerals are harmless up to certain levels. In some cases higher mineral content is preferable to consumers for taste. For example, minerals are added to many bottled drinking waters after going through a filtration process. At some level, however, most naturally occurring constituents, along with those introduced by human activities, are considered contaminants. The point at which a given constituent is considered a contaminant varies depending on the intended use of the groundwater and the toxicity level of the constituents.

Beneficial Uses

For this report, water quality is a measure of the suitability of water for its intended use, with respect to dissolved solids and gases and suspended material. An assessment of water quality should include the investigation of the presence and concentration of any individual constituent that may limit the water's suitability for an intended use.

The SWRCB has identified 23 categories of water uses, referred to as beneficial uses. The beneficial use categories and a brief description of each are presented in Appendix E. The actual criteria that are used to evaluate water quality for each of the beneficial uses are determined by the nine Regional Water Quality Control Boards, resulting in a range of criteria for some of the uses. These criteria are published in each of the Regional Boards' Water Quality Control Plans (Basin Plans)[1].

A summary of water quality for all of the beneficial uses of groundwater is beyond the scope of this report. Instead, water quality criteria for two of the most common uses—municipal supply (referred to as public drinking water supply in this report) and agricultural supply—are described below.

Public Drinking Water Supply

Standards for maximum contaminant levels (MCLs) of constituents in drinking water are required under the federal Safe Drinking Water Act of 1974 and its updates. There are primary and secondary standards. Primary standards are developed to protect public health and are legally enforceable. Secondary standards are generally for the protection of aesthetic qualities such as taste, odor, and appearance, and cosmetic qualities, such as skin or tooth discoloration, and are generally non-enforceable guidelines. However, in California secondary standards are legally enforceable for all new drinking water systems and new sources developed by existing public water suppliers (DWR 1997). Under these primary and secondary standards, the U.S. Environmental Protection Agency regulates more than 90 contaminants, and the California Department of Health Services regulates about 100. Federal and State primary MCLs are listed in Appendix F.

Agricultural Supply

An assessment of the suitability of groundwater as a source of agricultural supply is much less straightforward than that for public water supply. An evaluation of water supply suitability for use in agriculture is difficult because the impact of an individual constituent can vary depending on many factors, including soil chemical and physical properties, crop type, drainage, and irrigation method. Elevated levels of constituents usually do not result in an area being taken entirely out of production, but may lower crop yields. Management decisions will determine appropriate land use and irrigation methods.

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[1] Digital versions of these plans are available online at http://www.swrcb.ca.gov/plnspols/index.html

There are no regulatory standards for water applied on agriculture. Criteria for crop water have been provided as guidelines. Many constituents have the potential to negatively impact agriculture, including more than a dozen trace elements (Ayers and Westcot 1985). Two constituents that are commonly considered with respect to agricultural water quality are salinity—expressed as total dissolved solids (TDS)—and boron concentrations.

Increasing salinity in irrigation water inhibits plant growth by reducing a plant's ability to absorb water through its roots (Pratt and Suarez 1996). While the impact will depend on crop type and soil conditions, it is useful to look at the TDS of the applied water as a general assessment tool. A range of values for TDS with their estimated suitability for agricultural uses is presented in Table 10. These ranges are modified from criteria developed for use in the San Joaquin Valley by the San Joaquin Valley Drainage Program. However, they are similar to values presented in Ayers and Westcot (1985).

Table 10 Range of TDS values with estimated suitability for agricultural uses

Range of TDS (mg/L)	Suitability
<500	Generally no restrictions on use
500 – 1,250	Generally slight restrictions on use
1,250 – 2,500	Generally moderate restrictions on use
>2,500	Generally severe restrictions on use

Modified from SJVDP (1990)
TDS = total dissolved solids

High levels of boron can present toxicity problems in plants by damaging leaves. The boron is absorbed through the root system and transported to the leaves. Boron then accumulates during plant transpiration, resulting in leaf burn (Ayers and Westcot 1985). Boron toxicity is highly dependent on a crop's sensitivity to the constituent. A range of values of dissolved boron in irrigation water, with their estimated suitability on various crops is presented in Table 11. These ranges are modified from Ayers and Westcot (1985).

Table 11 Range of boron concentrations with estimated suitability on various crops

Range of dissolved boron (mg/L)	Suitability
<0.5	Suitable on all but most highly boron sensitive crops
0.5 – 1.0	Suitable on most boron sensitive crops
1.0 – 2.0	Suitable on most moderately boron sensitive crops
>2.0	Suitable for only moderately to highly boron tolerant crops

Source: Modified from Ayers and Westcot 1985

Contaminant Groups

Because there are so many potential individual constituents to evaluate, researchers have often summarized contaminants into groups depending on the purpose of the study. Recognizing that there are exceptions to any classification scheme, this update considered groups according to their common sources of contamination—those naturally occurring and those caused by human activities (anthropogenic). Each of these sources includes more than one contaminant group. A listing of the contaminant groups and the individual constituents belonging to those groups, summarized in this report, is included in Appendix F.

Naturally Occurring Sources

In this report, naturally occurring sources include three primary groups: (1) inorganic constituents with primary MCLs, (2) inorganic constituents with secondary MCLs, and (3) radiological constituents. Inorganics primarily include naturally occurring minerals such as arsenic or mercury, although human activities may certainly contribute to observed concentrations. Radiological constituents include primarily naturally occurring constituents such as radon, gross alpha, and uranium. Although radioactivity is not considered a significant contaminant statewide, it can be locally important, particularly in communities in the Sierra Nevada.

Anthropogenic Sources

Anthropogenic contaminants include pesticides, volatile organic compounds (VOCs), and nitrates. Pesticides and VOCs are often grouped together into an organic contaminant group. However, separating the two gives a general idea of which contaminants are primarily from agricultural activities (pesticides) and which are primarily from industrial activities (VOCs). One notable exception to the groupings is dibromochloropropane (DBCP). Even though this compound is a VOC, DBCP is a soil fumigant and is included with pesticides. Nitrates are a surprising anthropogenic class to some observers. Nitrogen is certainly a naturally occurring inorganic constituent. However, because most nitrates are associated with agriculture (see Box P, "Focused on Nitrates: Detailed Study of a Contaminant") and nitrates are among California's leading contaminants, it is appropriate to consider them separately from inorganics.

Box P Focused on Nitrates: Detailed Study of a Contaminant

Because water has so many potential uses, the study of water quality means different things to different people. Thomas Harter, a professor at the University of California at Davis, has chosen to focus on nitrates as one of his research interests. Harter's monitoring network consists of 79 wells on 5 dairies in the San Joaquin Valley.

A common result of dairy activities is the release of nitrogen into the surroundings, which changes to nitrate in groundwater. Nitrates are notorious for their role in interfering with oxygen transport in babies, a condition commonly referred to as "blue baby syndrome." Nitrates are also of interest because more public supply wells have been closed due to nitrate contamination than from any other contaminant (Bachman and others 1997).

Harter's study has focused on two primary activities. The first is a meticulous examination of nitrogen at the surface and nitrates in the uppermost 25 feet of the subsurface. This monitoring has been ongoing since 1993, and has shown that a significant amount of nitrate can reach shallow groundwater. The second focus of the study has been to change management practices to reduce the amount of nitrogen available to reach groundwater, along with continued monitoring. This has occurred since 1998. Results of the study are better management practices that significantly reduce the amount of nitrogen available to groundwater. This will help minimize the potential adverse impacts to groundwater quality from nitrates.

Chapter 7

Inventory of California's Groundwater Information

Chapter 7
Inventory of California's Groundwater Information

The groundwater information in this chapter summarizes the available information on statewide and regional groundwater issues. For more detailed information on specific groundwater basins see the supplement to this report that is available on the California Department of Water Resources (DWR) website, http://www.waterplan.water.ca.gov/groundwater/118index.htm. See Appendix A for information on accessing individual basin descriptions and the map delineating California's groundwater basins.

Statewide Groundwater Information

There is a large amount of data available for many of the State's most heavily developed groundwater basins. Conversely, there is relatively little data available on groundwater in the undeveloped areas. The information in this report is generally limited to a compilation of the information readily available to DWR staff and may not include the most up-to-date data generated by studies that have been completed recently by water management agencies. For this reason, the collection of additional, more recent data on groundwater basins should be continued and integrated into the basin descriptions. Statewide summaries are included below.

Groundwater Basins

There are currently 431 groundwater basins delineated, underlying about 40 percent of the surface area of the State. Of those, 24 basins are subdivided into a total of 108 subbasins, giving a total of 515 distinct groundwater systems described in this report (Figure 20). Basin delineation methods are described in Appendix G. Additionally, many of the subbasin boundaries were developed or modified with public input, but little physical data. These boundaries should not be considered as precisely defining a groundwater basin boundary; the determination of whether any particular area lies within a groundwater basin boundary should be determined only after detailed local study.

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated.

Groundwater Budgets

Rather than simply providing all groundwater budget data collected during this update, the budget information was classified into one of three categories indicating the relative level of detail of information available. These categories, types A, B, and C, are discussed in Box R, "Explanation of Groundwater Data Tables." A type A budget indicates that much of the information needed to characterize the groundwater budget for the basin or subbasin was available. DWR staff did not verify these type A budgets, so DWR cannot address the accuracy of the data provided by them. Type B indicates that enough data are available to estimate the groundwater extraction to meet local water use needs. This is useful in understanding the reliance of a particular area on groundwater. Type C indicates a low level of knowledge of any of the budget components for the area.

Figure 21 depicts where these type A, B, and C budgets occur. In general, there is a greater level of understanding (type A or B) in the more heavily developed areas in terms of groundwater use. These include the Central Valley and South Coast. The lowest level of knowledge of groundwater budget data is in the southeast desert area. A discussion of groundwater use in each region is included below.

Box Q How Does the Information in This Report Relate to the Recently Enacted Laws Senate Bill 221 and Senate Bill 610 (2002)?

Recently enacted legislation requires developers of certain new housing projects to demonstrate an available water supply for that development. If a part of that proposed water supply is groundwater, urban water suppliers must provide additional information on the availability of an adequate supply of groundwater to meet the projected demand and show that they have the legal right to extract that amount of groundwater. SB 610 (2002) amended the Water Code to require, among other things, the following information (Section 10631(b)(2)):

> *For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.*

The hydrogeologic information contained in the basin descriptions that supplement this update of Bulletin 118 includes only the information that was available in California Department of Water Resources (DWR) files through reference searches and through limited contact with local agencies. Local agencies may have conducted more recent studies that have generated additional information about water budgets and aquifer characteristics. Unless the agency notified DWR, or provided a copy of the recent reports to DWR staff, that recent information has not been included in the basin descriptions. Therefore, although SB 610 refers to groundwater basins identified as overdrafted in Bulletin 118, it would be prudent for local water suppliers to evaluate the potential for overdraft of any basin included as a part of a water supply assessment.

Persons interested in collecting groundwater information in accordance with the Water Code as amended by SB 221 and SB 610 may start with the information in Bulletin 118, but should follow up by consulting the references listed for each basin and contacting local water agencies to obtain any new information that is available. Otherwise, evaluation of available groundwater resources as mandated by SB 221 and SB 610 may not be using the most complete and recent information about water budgets and aquifer characteristics.

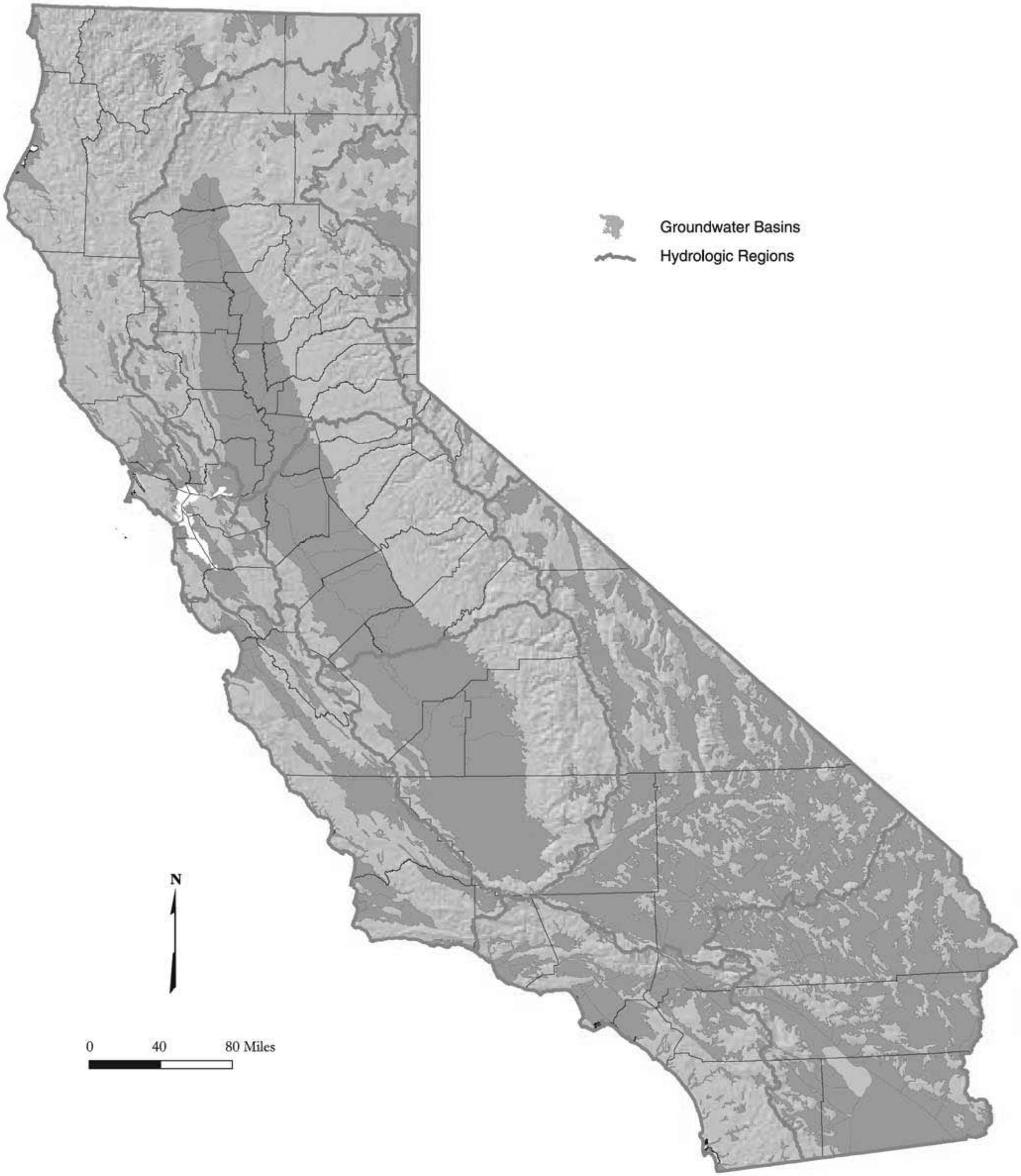

Figure 20 Groundwater basins and subbasins

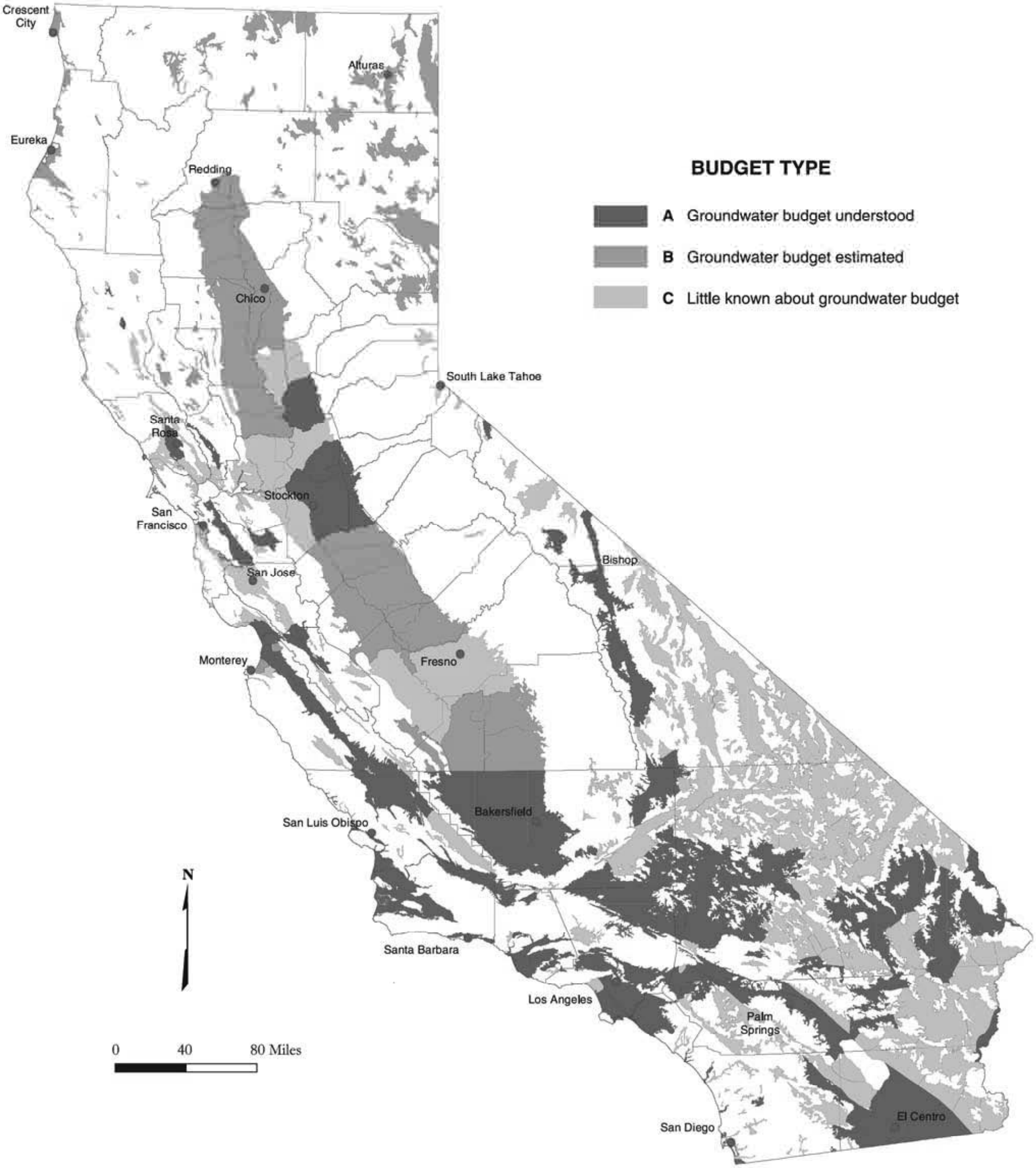

Figure 21 Basin and subbasin groundwater budget types

Box R Explanation of Groundwater Data Tables

A groundwater data table for each hydrologic region is included at the end of each hydrologic region section in Chapter 7. The tables include the following information:

Basin/Subbasin Number. The basin numbering format is x-xxx.xx. The first number in the sequence assigns the basin to one of the nine Regional Water Quality Control Board boundaries. The second number is the groundwater basin number. Any number following the decimal identifies that the groundwater basin has been further divided into subbasins. Reevaluation of available hydrogeologic information resulted in the deletion of some basins and subbasins identified in Bulletins 118-75 and 118-80. Because of this, there are some gaps in the sequence of basin numbers in this report. The methods used for developing the current groundwater basin maps are discussed in Appendix H. The names and numbers of the basins deleted, along with any comments related to their elimination are included in the appropriate region in Chapter 7. Previously unidentified groundwater basins or subbasins that were delineated during this update are assigned new identification numbers that sequentially follow the last number used in Bulletin 118-80 for groundwater basins or subbasins.

Basin or Subbasin Name. Basin names are based on published and unpublished reports, topographic maps, and local terminology. Names of more recently delineated basins or subbasins are based on the principal geographic feature, which in most cases corresponds to the name of a valley. In the case of a subbasin, its formal name should include the name of the basin (for example, Sacramento Valley Groundwater Basin, North American Subbasin). However, both locally and informally, the term subbasin is used interchangeably with basin (for example, North American Basin).

Area. The area for each basin or subbasin is presented in acres rounded to three significant figures (for example, 147,148 acres was rounded to 147,000 acres). The area describes only the upper surface or map view of a basin. The basin underlies the area and may extend beyond the surface expression (discussed in Chapter 6).

Groundwater Budget Type. The type of groundwater budget information available was classified as Type A, B, or C based on the following criteria:

Type A – indicates one of the following: (1) a groundwater budget exists for the basin or enough components from separate studies could be combined to give a general indication of the basin's groundwater budget, (2) a groundwater model exists for the basin that can be used to calculate a groundwater budget, or (3) actual groundwater extraction data exist for the basin.

Type B – indicates that a use-based estimate of groundwater extraction is calculated for the basin. The use-based estimate is determined by calculating the overall use from California Department of Water Resources land use and urban water use surveys. Known surface water supplies are then subtracted from the total demand leaving the rest of the use to be met by groundwater extraction.

Type C – indicates that there are not enough data to provide either an estimate of the basin's groundwater budget or groundwater extraction from the basin.

Well Yields. Maximum and average well yields in gallons per minute (gpm) are reported for municipal supply and agricultural wells where available. Most of the values reported are from initial tests reported during construction of the well, which may not be an accurate indication of the long-term production capacity of the wells.

Box R continued on next page

Box R Explanation of Groundwater Data Tables (continued)

Types of Monitoring. This includes monitoring of both groundwater levels and quality. "Levels" indicate the number of wells actively monitored without consideration of frequency. Most wells are monitored semi-annually, but many are monitored monthly. "Quality" indicates the number of wells monitored for various constituents; these could range from a grab sample taken for a field specific conductance measurement to a full analysis of organic and inorganic constituents. "Title 22" indicates the number of public water system wells that are actively sampled and monitored under the direction of California Department of Health Services (DHS) Title 22 Program.

Total Dissolved Solids. This category includes range and average values of total dissolved solids (TDS). This data primarily represents data from published reports. In some cases, a range of average TDS values is presented.

Active Monitoring

The summary of active monitoring includes wells that are monitored for groundwater elevation or groundwater quality within the delineated groundwater basins as of 1999. Groundwater elevation data collected by DWR and cooperators are available online at http://wdl.water.ca.gov. Most of the water quality data are for public supply wells and were provided by the California Department of Health Services (DHS). Other groundwater level and water quality monitoring activities were reported by local agencies during this update. The summary indicates that there are nearly 14,000 wells monitored for groundwater levels, 10,700[1] wells monitored under DHS water quality monitoring program, and 4,700 wells monitored for miscellaneous water quality by other agencies.

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[1] These numbers include the wells in basins and subbasins only; throughout the entire state, DHS has responsibility for more than 16,000 public supply wells.

Box S What Happens When an MCL Exceedance Occurs?

All suppliers of domestic water to the public are subject to regulations adopted by the U.S. Environmental Protection Agency under the Safe Drinking Water Act (42 U.S.C. 300f et seq.) as well as by the California Department of Health Services under the California Safe Drinking Water Plan Act (Health and Safety Code §§ 116270-116750).

These regulations include primary drinking water standards that establish maximum contaminant levels (MCLs) for inorganic and organic chemicals and radioactivity. MCLs are based on health protection, technical feasibility, and economic factors.

California requires public water systems to sample their drinking water sources, analyze for regulated contaminants, and determine compliance with the MCLs on a regular basis. Sampling frequency depends on the contaminant, type of water source, and previous sampling results; frequency can range from monthly to once every nine years, or none at all if sampling is waived because the source is not vulnerable to the contaminant.

Primary MCLs are enforceable standards. In California, compliance is usually determined at the wellhead or the surface water intake. To meet water quality standards and comply with regulations, a water system with a contaminant exceeding an MCL must notify the public and remove the source from service or initiate a process and schedule to install treatment for removing the contaminant.

Notification requirements reflect the severity of the associated health risks; immediate health concerns prompt immediate notice to consumers. Violations that do not pose a significant health concern may use a less immediate notification process. In addition to consumer notification, a water system is required by statute to notify the local governing body (for example, city council or county board of supervisors) whenever a drinking water well exceeds an MCL, even if the well is taken out of service.

Detections of regulated contaminants (and certain unregulated contaminants) must also be reported to consumers in the water system's annual Consumer Confidence Report.

Groundwater Quality

The summary of water quality relied heavily on data from the DHS Title 22 water quality monitoring program. The assessment consisted of querying the DHS database for active wells that have constituents exceeding the maximum contaminant level (MCL) for drinking water. Summaries of this assessment for each of the State's hydrologic regions (HRs) are discussed in this chapter.

DHS data are the most comprehensive statewide water quality data set available, but this data set should not be used as a sole indicator of the groundwater quality in California. Data from these wells are not necessarily representative of any given basin; it only represents the quality of groundwater where a public water supply is extracted.

The Natural Resources Defense Council (NRDC 2001) issued a report that concludes California's groundwater resources face a serious long-term threat from contamination. Despite heavy reliance on groundwater, no comprehensive statewide assessments of groundwater quality were available. In response to the NRDC report, the State Water Resources Control Board (SWRCB) is planning a comprehensive assessment of the State's groundwater quality. This program is discussed in Chapter 4, in the section titled "Groundwater Quality Monitoring Act of 2001 (AB 599)."

Regional Groundwater Use

The importance of groundwater as a resource varies regionally throughout the State. For planning purposes, DWR divides California into 10 hydrologic regions (HRs), which correspond to the State's major drainage areas. HR boundaries are shown in Figure 22. A review of average water year supplies from the California Water Plan (DWR 1998) shows the importance of groundwater as a local supply for agricultural and municipal use throughout the State and in each of California's 10 HRs (Table 12 and Figure 23).

Table 12 Annual agricultural and municipal water demands met by groundwater

Hydrologic region	Total Demand Volume (TAF)	Demand met by Groundwater (TAF)	Demand met by Groundwater (%)
North Coast	1063	263	25
San Francisco Bay	1353	68	5
Central Coast	1263	1045	83
South Coast	5124	1177	23
Sacramento River	8720	2672	31
San Joaquin River	7361	2195	30
Tulare Lake	10556	4340	41
North Lahontan	568	157	28
South Lahontan	480	239	50
Colorado River	4467	337	8

Source: DWR 1998

With more than 80 percent of demand met by groundwater, the Central Coast HR is heavily reliant on groundwater to meet its local needs. The Tulare Lake and South Lahontan HRs meet more than 40 percent of their local demand from groundwater. The South Coast, North Coast, North Lahontan, San Joaquin River, and Sacramento River HRs take between 20 and 40 percent of their supply from groundwater. Groundwater is a relatively minor source of supply in the San Francisco Bay and Colorado River HRs.

Of all the groundwater extracted annually in the state, an estimated 35 percent is produced from the Tulare Lake HR. More than 70 percent of groundwater extraction occurs in the Central Valley (Tulare Lake, San Joaquin River, and Sacramento River HRs combined). Nearly 20 percent is extracted in the highly urbanized South Coast and Central Coast HRs, while less than 10 percent is extracted in the remaining five HRs combined.

Figure 22 California's 10 hydrologic regions

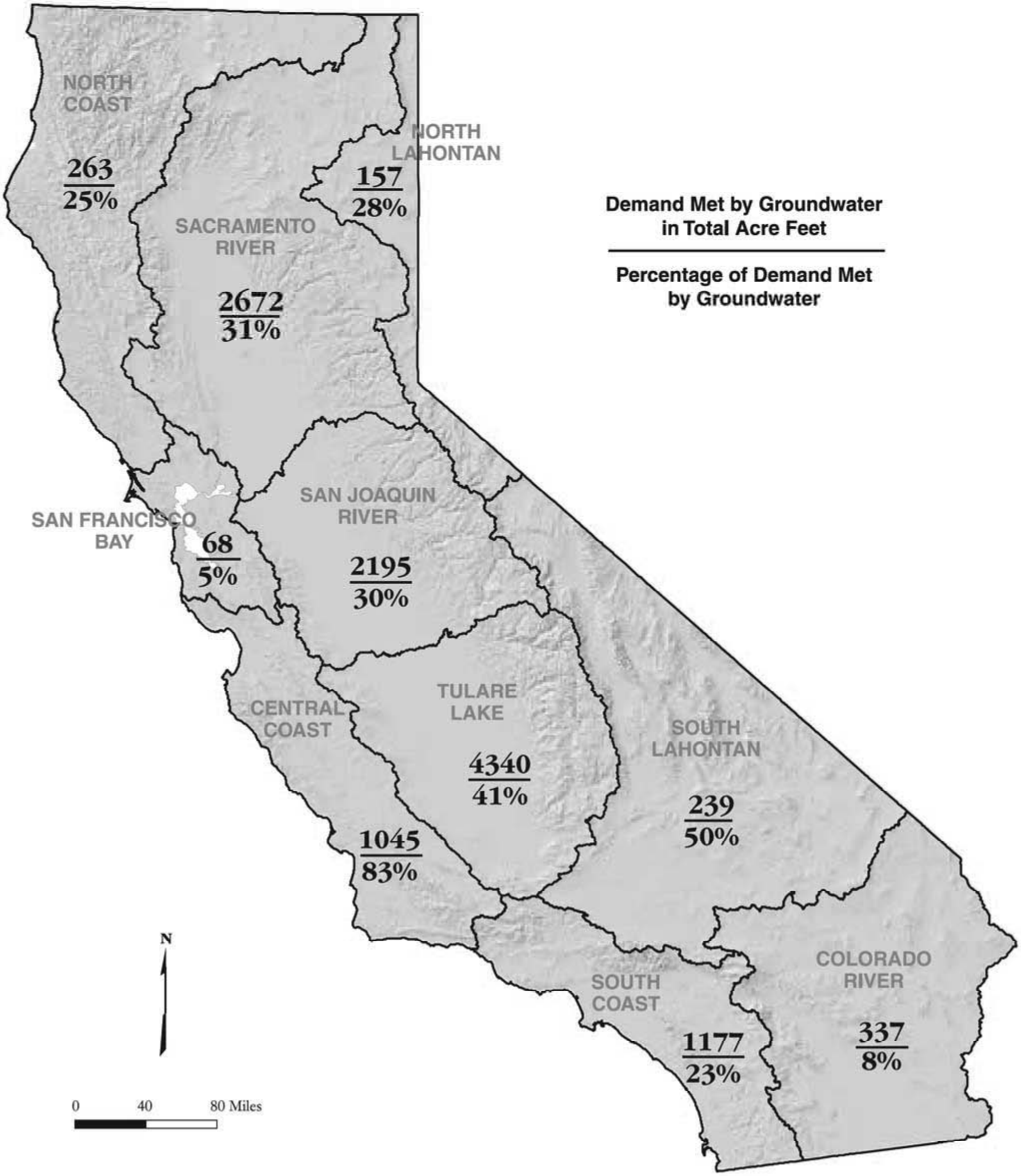

Figure 23 Agricultural and urban demand supplied by groundwater in each hydrologic region

The remainder of this chapter provides a summary of each of the 10 HRs. A basin location map for each HR is followed by a brief discussion of groundwater occurrence and groundwater conditions. A summary tabulation of groundwater information for each groundwater basin within the HR is provided. Greater detail for the data presented in these tables, including a bibliography, is provided in the individual basin/subbasin descriptions in the supplemental report (see Appendix A). Because the groundwater basin numbers are based on the boundaries of the State's nine Regional Water Quality Control Boards (RWQCB), Figure 24 shows the relationship between the Regional Board boundaries and DWR's HR boundaries.

The groundwater basin tabulations give an overview of available data. Where a basin is divided into subbasins, only the information for the subbasins is provided. The data for each subbasin generally come from different sources, so it is inappropriate to sum the data into a larger basin summary. An explanation of each of the data items presented in the summary table is provided in Box R.

Figure 24 Regional Water Quality Control Board regions and Department of Water Resources hydrologic regions

North Coast Hydrologic Region

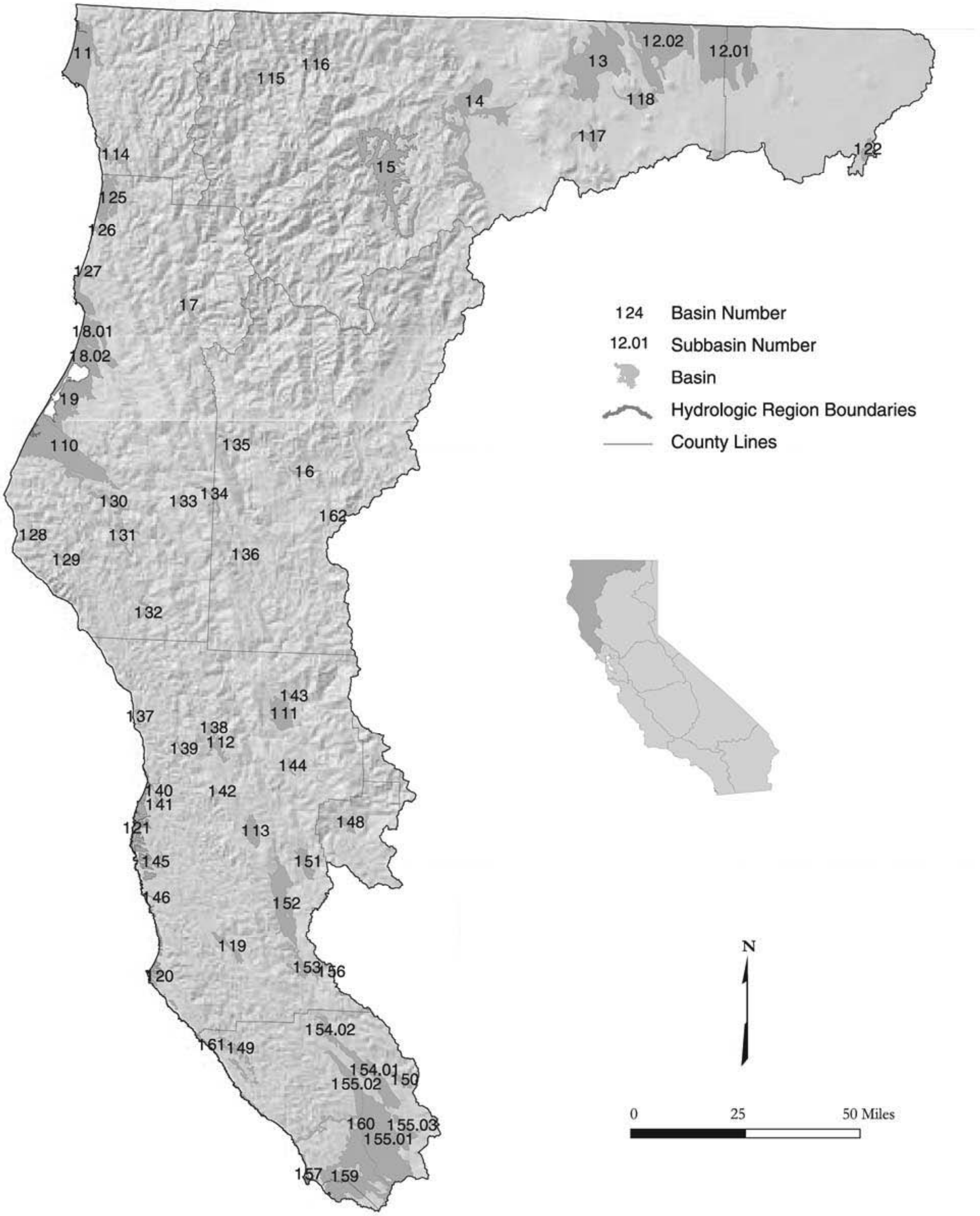

Figure 25 North Coast Hydrologic Region

Basins and Subbasins of the North Coast Hydrologic Region

Basin/subbasin	Basin name
1-1	Smith River Plain
1-2	Klamath River Valley
1-2.01	Tule Lake
1-2.02	Lower Klamath
1-3	Butte Valley
1-4	Shasta Valley
1-5	Scott River Valley
1-6	Hayfork Valley
1-7	Hoopa Valley
1-8	Mad River Valley
1-8.01	Mad River Lowland
1-8.02	Dows Prairie School Area
1-9	Eureka Plain
1-10	Eel River Valley
1-11	Covelo Round Valley
1-12	Laytonville Valley
1-13	Little Lake Valley
1-14	Lower Klamath River Valley
1-15	Happy Camp Town Area
1-16	Seiad Valley
1-17	Bray Town Area
1-18	Red Rock Valley
1-19	Anderson Valley
1-20	Garcia River Valley
1-21	Fort Bragg Terrace Area
1-22	Fairchild Swamp Valley
1-25	Prairie Creek Area
1-26	Redwood Creek Area
1-27	Big Lagoon Area
1-28	Mattole River Valley
1-29	Honeydew Town Area
1-30	Pepperwood Town Area
1-31	Weott Town Area
1-32	Garberville Town Area
1-33	Larabee Valley
1-34	Dinsmores Town Area
1-35	Hyampom Valley
1-36	Hettenshaw Valley
1-37	Cottoneva Creek Valley
1-38	Lower Laytonville Valley
1-39	Branscomb Town Area
1-40	Ten Mile River Valley
1-41	Little Valley
1-42	Sherwood Valley
1-43	Williams Valley
1-44	Eden Valley
1-45	Big River Valley
1-46	Navarro River Valley
1-48	Gravelley Valley
1-49	Annapolis Ohlson Ranch Formation Highlands
1-50	Knights Valley
1-51	Potter Valley
1-52	Ukiah Valley
1-53	Sanel Valley
1-54	Alexander Valley
1-54.01	Alexander Area
1-54.02	Cloverdale Area
1-55	Santa Rosa Valley
1-55.01	Santa Rosa Plain
1-55.02	Healdsburg Area
1-55.03	Rincon Valley
1-56	McDowell Valley
1-57	Bodega Bay Area
1-59	Wilson Grove Formation Highlands
1-60	Lower Russian River Valley
1-61	Fort Ross Terrace Deposits
1-62	Wilson Point Area

Description of the Region

The North Coast HR covers approximately 12.46 million acres (19,470 square miles) and includes all or portions of Modoc, Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Lake, and Sonoma counties (Figure 25). Small areas of Shasta, Tehama, Glenn, Colusa, and Marin counties are also within the region. Extending from the Oregon border south to Tomales Bay, the region includes portions of four geomorphic provinces. The northern Coast Range forms the portion of the region extending from the southern boundary north to the Mad River drainage and the fault contact with the metamorphic rocks of the Klamath Mountains, which continue north into Oregon. East of the Klamath terrane along the State border are the volcanic terranes of the Cascades and the Modoc Plateau. In the coastal mountains, most of the basins are along the narrow coastal strip between the Pacific Ocean and the rugged Coast Range and Klamath Mountains and along inland river valleys; alluviated basin areas are very sparse in the steep Klamath Mountains. In the volcanic terrane to the east, most of the basins are in block faulted valleys that once held Pleistocene-age lakes. The North Coast HR corresponds to the boundary of RWQCB 1. Significant geographic features include basin areas such as the Klamath River Basin, the Eureka/Arcata area, Hoopa Valley, Anderson Valley, and the Santa Rosa Plain. Other significant features include Mount Shasta, forming the southern border of Shasta Valley, and the rugged north coastal shoreline. The 1995 population of the entire region was about 606,000, with most being centered along the Pacific Coast and in the inland valleys north of the San Francisco Bay Area.

The northern mountainous portion of the region is rural and sparsely populated, primarily because of the rugged terrain. Most of the area is heavily forested. Some irrigated agriculture occurs in the narrow river valleys, but most occurs in the broader valleys on the Modoc Plateau where pasture, grain and alfalfa predominate. In the southern portion of the region, closer to urban centers, crops like wine grapes, nursery stock, orchards, and truck crops are common.

A majority of the surface water in the North Coast HR goes to environmental uses because of the “wild and scenic” designation of most of the region’s rivers. Average annual precipitation ranges from 100 inches in the Smith River drainage to 29 inches in the Santa Rosa area and about 10 inches in the Klamath drainage; as a result, drought is likely to affect the Klamath Basin more than other portions of the region. Communities that are not served by the area’s surface water projects also tend to experience shortages. Surface water development in the region includes the U.S. Bureau of Reclamation (USBR) Klamath Project, Humboldt Bay Municipal Water District’s Ruth Lake, and U.S. Army Corps of Engineer’s Russian River Project. An important factor concerning water demand in the Klamath Project area is water allocation for endangered fish species in the upper and lower basin. Surface water deliveries for agriculture in 2001, a severe drought year, were only about 20 percent of normal.

Groundwater Development

Groundwater development in the North Coast HR occurs along the coast, near the mouths of some of the region’s major rivers, on the adjacent narrow marine terraces, or in the inland river valleys and basins. Reliability of these supplies varies significantly from area to area. There are 63 groundwater basins/subbasins delineated in the region, two of which are shared with Oregon. These basins underlie approximately 1.022 million acres (1,600 square miles).

Along the coast, most groundwater is developed from shallow wells installed in the sand and gravel beds of several of the region’s rivers. Under California law, the water produced in these areas is considered surface water underflow. Water from Ranney collectors installed in the Klamath River, Rowdy Creek, the Smith

River, and the Mad River supply the towns of Klamath, Smith River and Crescent City in Del Norte County and most of the Humboldt Bay area in Humboldt County. Except on the Mad River, which has continuous supply via releases from Ruth Reservoir, these supplies are dependent on adequate precipitation and flows throughout the season. In drought years when streamflows are low, seawater intrusion can occur causing brackish or saline water to enter these systems. This has been a problem in the town of Klamath, which in 1995 had to obtain community water from a private well source. Toward the southern portion of the region, along the Mendocino coast, the Town of Mendocino typifies the problems related to groundwater development in the shallow marine terrace aquifers. Groundwater supply is limited by the aquifer storage capacity, and surveys done in the Town of Mendocino in the mid-1980s indicate that about 10 percent of wells go dry every year and up to 40 percent go dry during drought years.

Groundwater development in the inland coastal valleys north of the divide between the Russian and Eel Rivers is generally of limited extent. Most problems stemming from reliance on groundwater in these areas is a lack of alluvial aquifer storage capacity. Many groundwater wells rely on hydrologic connection to the rivers and streams of the valleys. The City of Rio Dell has experienced water supply problems in community wells and, as a result, recently developed plans to install a Ranney collector near the Eel River. South of the divide, in the Russian River drainage, a significant amount of groundwater development has occurred on the Santa Rosa Plain and surrounding areas. The groundwater supplies augment surface supplies from the Russian River Project.

In the north-central part of the North Coast HR, the major groundwater basins include the Klamath River Valley, Shasta Valley, Scott River Valley, and Butte Valley. The Klamath River Valley is shared with Oregon. Of these groundwater basins, Butte Valley has the most stable water supply conditions. The historical annual agricultural surface water supply has been about 20,000 acre-feet. As farming in the valley expanded from the early 1950s to the early 1990s, bringing nearly all the arable land in the valley into production, groundwater was developed to farm the additional acres. It has been estimated that current, fully developed demands are only about 80 percent of the available groundwater supply. By contrast, water supply issues in the other three basins are contingent upon pending management decisions regarding restoration of fish populations in the Klamath River and the Upper Klamath Basin system. The Endangered Species Act (ESA) fishery issues include lake level requirements for two sucker fish species and in-stream flow requirements for coho salmon and steelhead trout. Since about 1905, the Klamath Project has provided surface water to the agricultural community, which in turn has provided water to the wildlife refuges. Since the early 1990s, it has been recognized that surface water in the Klamath Project is over-allocated, but very little groundwater development had occurred. In 2001, which was a severe drought year, USBR delivered a total of about 75,000 acre-feet of water to agriculture in California, about 20 percent of normal. In the Klamath River Groundwater Basin this translated to a drought disaster, both for agriculture and the wildlife refuges. In addition, there were significant impacts for both coho salmon and sucker fisheries in the Klamath River watershed. As a result of the reduced surface water deliveries, significant groundwater development occurred, and groundwater extraction increased from an estimated 6,000 acre-feet in 1997 to roughly 60,000 acre-feet in 2001. Because of the complexity of the basin's water issues, a long-term Klamath Project Operation plan has not yet been finalized. Since 1995, USBR has issued an annual operation plan based on estimates of available supply. The Scott River Valley and Shasta Valley rely to a significant extent on surface water diversions. In most years, surface water supplies the majority of demand, and groundwater extraction supplements supply as needed depending on wet or dry conditions. Discussions are under way to develop strategies to conjunctively use surface water and groundwater to meet environmental, agricultural, and other demands.

Groundwater Quality

Groundwater quality characteristics and specific local impairments vary with regional setting within the North Coast HR. In general, seawater intrusion and nitrates in shallow aquifers are problems in the coastal groundwater basins; high total dissolved solids (TDS) content and general alkalinity are problems in the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese can be problems in the inland basins of Mendocino and Sonoma counties.

Water Quality in Public Supply Wells

From 1994 through 2000, 584 public supply water wells were sampled in 32 of the 63 basins and subbasins in the North Coast HR. Analyzed samples indicate that 553 wells, or 95%, met the state primary Maximum Contaminant Levels (MCL) for drinking water. Thirty-one wells, or 5%, sampled have constituents that exceed one or more MCL. Figure 26 shows the percentage of each contaminant group that exceeded MCLs in the 31 wells.

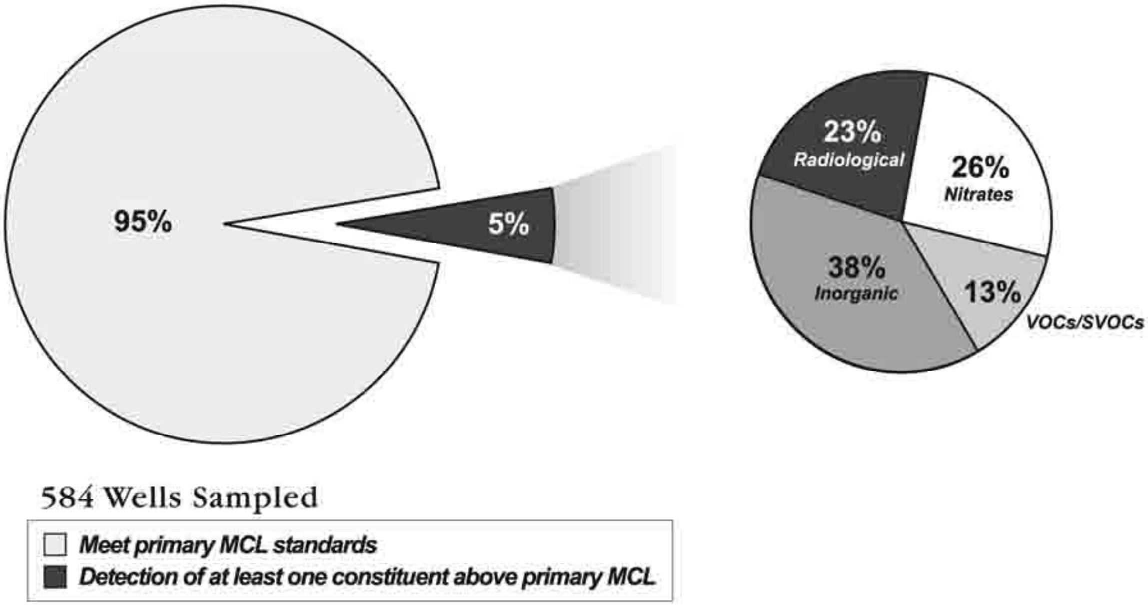

Figure 26 MCL exceedances in public supply wells in the North Coast Hydrologic Region

Table 13 lists the three most frequently occurring individual contaminants in each of the five contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 13 Most frequently occurring contaminants by contaminant group in the North Coast Hydrologic Region

Contaminant group wellsInorganics – Primary exceedance	Contaminant - # of wells Aluminum – 4	Contaminant - # of wells Arsenic – 4	Contaminant - # of 4 tied at 1
Inorganics – Secondary	Manganese – 150	Iron – 108	Copper – 2
Radiological	Radium 228 – 3	Combined RA226 + RA228 – 3	Radium 226 – 1
Nitrates	Nitrate(as NO_3) – 7	Nitrite(as N) – 1	
VOCs/SVOCs	TCE – 2	3 tied at 1 exceedance	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Since Bulletin 118-80 was published, RWQCB 2 boundary has been modified. This resulted in several basins being reassigned to RWQCB 1. These are listed in Table 14, along with other modifications to North Coast HR.

Table 14 Modifications since Bulletin 118-80 of groundwater basins in North Coast Hydrologic Region

Basin name	New number	Old number
McDowell Valley	1-56	2-12
Knights Valley	1-50	2-13
Potter Valley	1-51	2-14
Ukiah Valley	1-52	2-15
Sanel Valley	1-53	2-16
Alexander Valley	1-54	2-17
Santa Rosa Valley	1-55	2-18
Lower Russian River Valley	1-60	2-20
Bodega Bay Area	1-57	2-21
Modoc Plateau Recent Volcanic Area	deleted	1-23
Modoc Plateau Pleistocene Volcanic Area	deleted	1-24
Gualala River Valley	deleted	1-47
Wilson Grove Formation Highlands	1-59	2-25
Fort Ross Terrace Deposits	1-61	
Wilson Point Area	1-62	

Fort Ross Terrace Deposits (1-61) and Wilson Point Area (1-62) have been defined since B118-80 and are included in this update. Mad River Valley Groundwater Basin (1-8) has been subdivided into two subbasins. Sebastopol Merced Formation (2-25) merged into Basin 1-59 and was renamed Wilson Grove Formation Highlands.

There are a couple of deletions of groundwater basins from Bulletin 118-80. The Modoc Plateau Recent Volcanic Area (1-23) and the Modoc Plateau Pleistocene Volcanic Area (1-24) are volcanic aquifers and were not assigned basin numbers in this bulletin. These are considered to be groundwater source areas as discussed in Chapter 6. Gualala River Valley (1-47) was deleted because the State Water Resources Control Board determined the water being extracted in this area as surface water within a subterranean stream.

Table 15 North Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
1-1	SMITH RIVER PLAIN	40,450	B	500	50	7	10	33	164	32 - 496
1-2	KLAMATH RIVER VALLEY									
1-2.01	UPPER KLAMATH LAKE BASIN - Tule Lake	85,930	B	3,380	1,208	40	8	5	721	140 - 2,200
1-2.02	UPPER KLAMATH LAKE BASIN - Lower Klamath	73,330	B	2,600	1,550	4	-	-	-	-
1-3	BUTTE VALLEY	79,700	B	5,000	2,358	28	13	9	310	55 - 1,110
1-4	SHASTA VALLEY	52,640	B	1,200	273	9	15	24	-	-
1-5	SCOTT RIVER VALLEY	63,900	B	3,000	794	6	10	5	258	47 - 1,510
1-6	HAYFORK VALLEY	3,300	B	200	-	-	5	-	-	-
1-7	HOOPA VALLEY	3,900	B	300	-	-	4	-	125	95 - 159
1-8	MAD RIVER VALLEY									
1-8.01	MAD RIVER VALLEY LOWLAND	25,600	B	120	72	4	9	2	184	55 - 280
1-8.02	DOWS PRAIRIE SCHOOL AREA	14,000	B	-	-	-	3	-	-	-
1-9	EUREKA PLAIN	37,400	B	1,200	-	4	4	6	177	97 - 460
1-10	EEL RIVER VALLEY	73,700	B	1,200	-	8	11	29	237	110 - 340
1-11	COVELO ROUND VALLEY	16,400	C	850	193	9	5	29	239	116 - 381
1-12	LAYTONVILLE VALLEY	5,020	A	700	7	4	3	-	149	53 - 251
1-13	LITTLE LAKE VALLEY	10,000	A	1,000	45	7	7	-	340	97 - 1,710
1-14	LOWER KLAMATH RIVER VALLEY	7,030	B	-	-	-	-	-	-	43 - 150
1-15	HAPPY CAMP TOWN AREA	2,770	B	-	-	-	-	17	-	-
1-16	SEIAD VALLEY	2,250	B	-	-	-	2	2	-	-
1-17	BRAY TOWN AREA	8,030	B	-	-	-	-	-	-	-
1-18	RED ROCK VALLEY	9,000	B	-	-	-	-	-	-	-
1-19	ANDERSON VALLEY	4,970	C	300	30	7	5	7	-	80 - 400
1-20	GARCIA RIVER VALLEY	2,240	C	-	-	-	-	-	-	-
1-21	FORT BRAGG TERRACE AREA	24,100	C	75	14	-	-	51	185	26 - 650
1-22	FAIRCHILD SWAMP VALLEY	3,300	B	-	-	-	-	-	-	-
1-25	PRAIRIE CREEK AREA	20,000	B	-	-	-	-	1	106	-
1-26	REDWOOD CREEK AREA	2,000	B	-	-	1	0	4	-	102 - 332
1-27	BIG LAGOON AREA	13,400	B	-	-	1	0	31	174	-
1-28	MATTOLE RIVER VALLEY	3,150	B	-	-	-	-	2	-	-
1-29	HONEYDEW TOWN AREA	2,370	B	-	-	-	-	1	-	-
1-30	PEPPERWOOD TOWN AREA	6,290	B	-	-	-	-	1	-	-
1-31	WEOTT TOWN AREA	3,650	B	-	-	-	-	2	-	-
1-32	GARBERVILLE TOWN AREA	2,100	B	-	-	-	-	5	-	-
1-33	LARABEE VALLEY	970	B	-	-	-	-	-	-	-
1-34	DINSMORES TOWN AREA	2,300	B	-	-	-	-	3	-	-
1-35	HYAMPOM VALLEY	1,350	B	-	-	-	-	1	-	-
1-36	HETTENSHAW VALLEY	850	B	-	-	-	-	-	-	-
1-37	COTTONEVA CREEK VALLEY	760	C	-	-	-	-	-	118	118
1-38	LOWER LAYTONVILLE VALLEY	2,150	C	-	-	-	-	-	-	-
1-39	BRANSCOMB TOWN AREA	1,320	C	-	-	-	-	-	130	80 - 179
1-40	TEN MILE RIVER VALLEY	1,490	C	-	-	-	-	-	-	-
1-41	LITTLE VALLEY	810	C	-	-	-	-	-	-	-

Table 15 North Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
1-42	SHERWOOD VALLEY	1,150	C	-	-	-	-	-	-	-
1-43	WILLIAMS VALLEY	1,640	C	-	-	-	-	-	-	-
1-44	EDEN VALLEY	1,380	C	-	-	-	-	-	140	140
1-45	BIG RIVER VALLEY	1,690	C	-	-	-	-	2	-	-
1-46	NAVARRO RIVER VALLEY	770	C	-	-	-	-	-	-	-
1-48	GRAVELLEY VALLEY	3,000	C	-	-	-	-	3	-	-
1-49	ANAPOLIS OHLSON RANCH FOR. HIGHLANDS	8,650	C	36	-	-	0	1	260	260
1-50	KNIGHTS VALLEY	4,090	C	-	-	-	-	-	-	-
1-51	POTTER VALLEY	8,240	C	100	-	2	0	1	-	140 - 395
1-52	UKIAH VALLEY									
1-53	SANEL VALLEY	5,570	C	1,250	-	5	8	6	-	174 - 306
1-54	ALEXANDER VALLEY									
1-54.01	ALEXANDER AREA									
1-54.02	CLOVERDALE AREA	6,500	C	-	500	3	-	13	-	130 - 304
1-55	SANTA ROSA VALLEY									
1-55.01	SANTA ROSA PLAIN	80,000	A	1,500	-	43	-	155	-	-
1-55.02	HEALDSBURG AREA	15,400	C	500	-	8	-	28	-	90 - 500
1-55.03	RINCON VALLEY	5,600	C	-	-	2	-	12	-	-
1-56	McDOWELL VALLEY	1,500	C	1,200	-	-	-	-	145	143 - 146
1-57	BODEGA BAY AREA	2,680	A	150	-	-	-	6	-	-
1-59	WILSON GROVE FORMATION HIGHLANDS	81,500	C	-	-	14	-	68	-	-
1-60	LOWER RUSSIAN RIVER VALLEY	6,600	C	500 +	-	1	-	32	-	120 - 210
1-61	FORT ROSS TERRACE DEPOSITS	8,490	C	75	27	-	-	13	320	230 - 380
1-62	WILSON POINT AREA	700	B	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS = total dissolved solids

San Francisco Bay Hydrologic Region

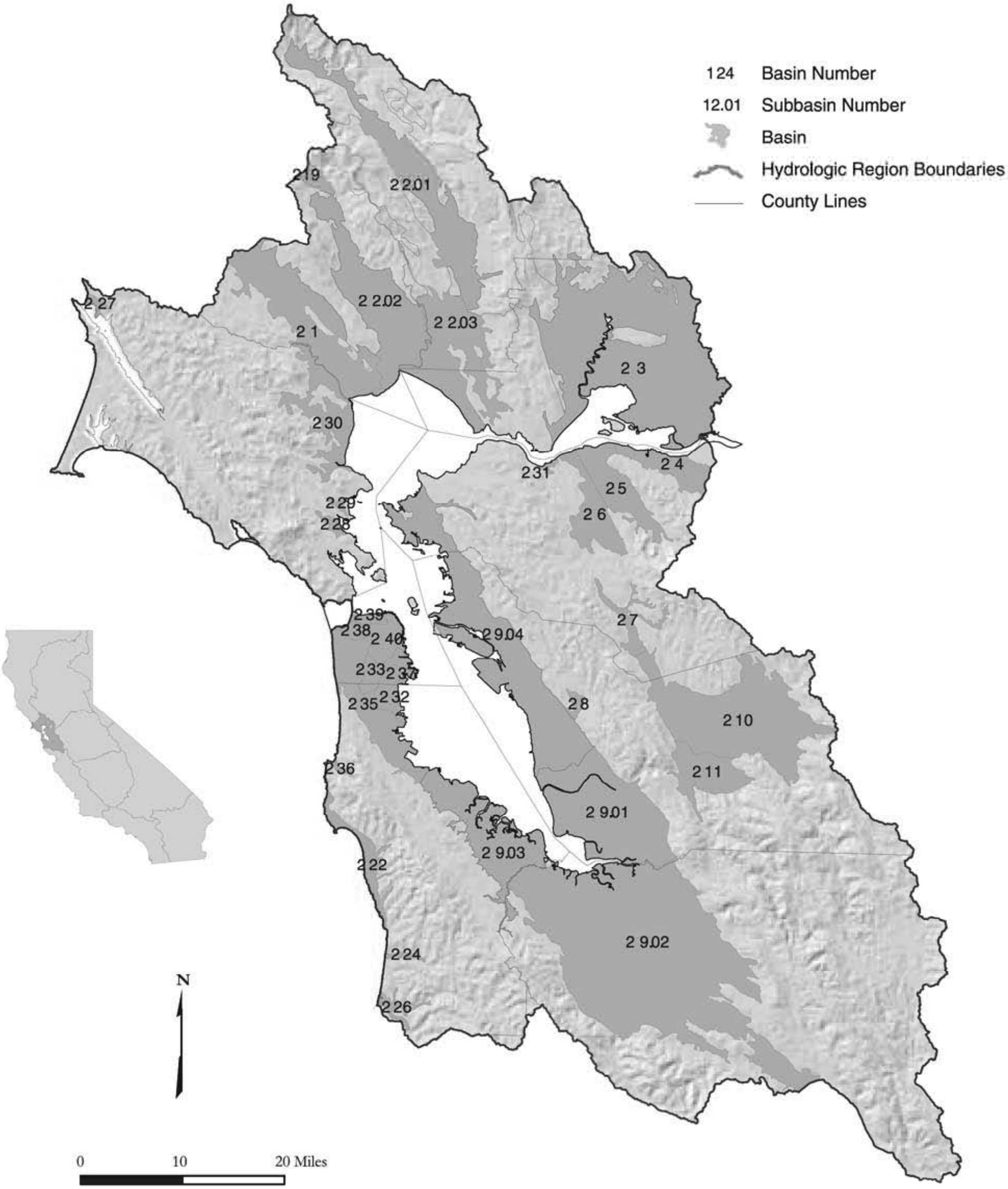

Figure 27 San Francisco Bay Hydrologic Region

Basins and Subbasins of the San Francisco Bay Hydrologic Region

Basin/subbasin	Basin name
2-1	Petaluma Valley
2-2	Napa-Sonoma Valley
2-2.01	Napa Valley
2-2.02	Sonoma Valley
2-2.03	Napa-Sonoma Lowlands
2-3	Suisun-Fairfield Valley
2-4	Pittsburg Plain
2-5	Clayton Valley
2-6	Ygnacio Valley
2-7	San Ramon Valley
2-8	Castro Valley
2-9	Santa Clara Valley
2-9.01	Niles Cone
2-9.02	Santa Clara
2-9.03	San Mateo Plain
2-9.04	East Bay Plain
2-10	Livermore Valley
2-11	Sunol Valley
2-19	Kenwood Valley
2-22	Half Moon Bay Terrace
2-24	San Gregorio Valley
2-26	Pescadero Valley
2-27	Sand Point Area
2-28	Ross Valley
2-29	San Rafael Valley
2-30	Novato Valley
2-31	Arroyo Del Hambre Valley
2-32	Visitacion Valley
2-33	Islais Valley
2-35	Merced Valley
2-36	San Pedro Valley
2-37	South San Francisco
2-38	Lobos
2-39	Marina
2-40	Downtown San Francisco

Description of the Region

The San Francisco Bay HR covers approximately 2.88 million acres (4,500 square miles) and includes all of San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties (Figure 27). The region corresponds to the boundary of RWQCB 2. Significant geographic features include the Santa Clara, Napa, Sonoma, Petaluma, Suisun-Fairfield, and Livermore valleys; the Marin and San Francisco peninsulas; San Francisco, Suisun, and San Pablo bays; and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Range. While being the smallest in size of the 10 HRs, the region has the second largest population in the State at about 5.8 million in 1995 (DWR 1998). Major population centers include the cities of San Francisco, San Jose and Oakland.

Groundwater Development

The region has 28 identified groundwater basins. Two of those, the Napa-Sonoma Valley and Santa Clara Valley groundwater basins, are further divided into three and four subbasins, respectively. The groundwater basins underlie approximately 896,000 acres (1,400 square miles) or about 30 percent of the entire HR.

Despite the tremendous urban development in the region, groundwater use accounts for only about 5 percent (68,000 acre-feet) of the region's estimated average water supply for agricultural and urban uses, and accounts for less than one percent of statewide groundwater uses.

In general, the freshwater-bearing aquifers are relatively thin in the smaller basins and moderately thick in the more heavily utilized basins. The more heavily utilized basins in this region include the Santa Clara Valley, Napa-Sonoma Valley, and Petaluma Valley groundwater basins. In these basins, the municipal and irrigation wells have average depths ranging from about 200 to 500 feet. Well yields in these basins range from less than 50 gallons per minute (gpm) to approximately 3,000 gpm. In the smaller basins, most municipal and irrigation wells have average well depths in the 100- to 200-foot range. Well yields in the smaller and less utilized basins are typically less than 500 gpm.

Land subsidence has been a significant problem in the Santa Clara Valley Groundwater Basin in the past. An extensive annual monitoring program has been set up within the basin to evaluate changes in an effort to maintain land subsidence at less than 0.01 feet per year (SCVWD 2001). Additionally, groundwater recharge projects have been implemented in the Santa Clara Valley to ensure that groundwater will continue to be a viable water supply in the future.

Groundwater Quality

In general, groundwater quality throughout most of the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high TDS, nitrate, boron, and organic compounds.

The areas of high TDS (and chloride) concentrations are typically found in the region's groundwater basins that are situated close to the San Francisco Bay, such as the northern Santa Clara, southern Sonoma, Petaluma, and Napa valleys. Elevated levels of nitrate have been detected in a large percentage of private wells tested within the Coyote Subbasin and Llagas Subbasin of the Gilroy-Hollister Valley Groundwater Basin (in the Central Coast HR) located to the south of the Santa Clara Valley (SCVWD 2001). The shallow aquifer zone within the Petaluma Valley also shows persistent nitrate contamination. Groundwater with high TDS, iron, and boron levels is present in the Calistoga area of Napa Valley, and elevated boron levels in other parts of Napa Valley make the water unfit for agricultural uses. Releases of fuel hydrocarbons from leaking underground storage tanks and spills/leaks of organic solvents at industrial sites have caused minor to significant groundwater impacts in many basins throughout the region. Methyl tertiary-butyl ether (MTBE) and chlorinated solvent releases to soil and groundwater continue to be problematic. Environmental oversight for many of these sites is performed either by local city and county enforcement agencies, the RWQCB, the Department of Toxic Substances Control, and/or the U.S. Environmental Protection Agency.

Water Quality in Public Supply Wells

From 1994 through 2000, 485 public supply water wells were sampled in 18 of the 33 basins and subbasins in the San Francisco Bay HR. Analyzed samples indicate that 410 wells, or 85 percent, met the state primary MCLs for drinking water standards. Seventy-five wells, or 15 percent, have constituents that exceed one or more MCL. Figure 28 shows the percentages of each contaminant group that exceeded MCLs in the 75 wells.

Table 16 lists the three most frequently occurring contaminants in each contaminant group and the number of wells in the HR that exceeded the MCL for those contaminants.

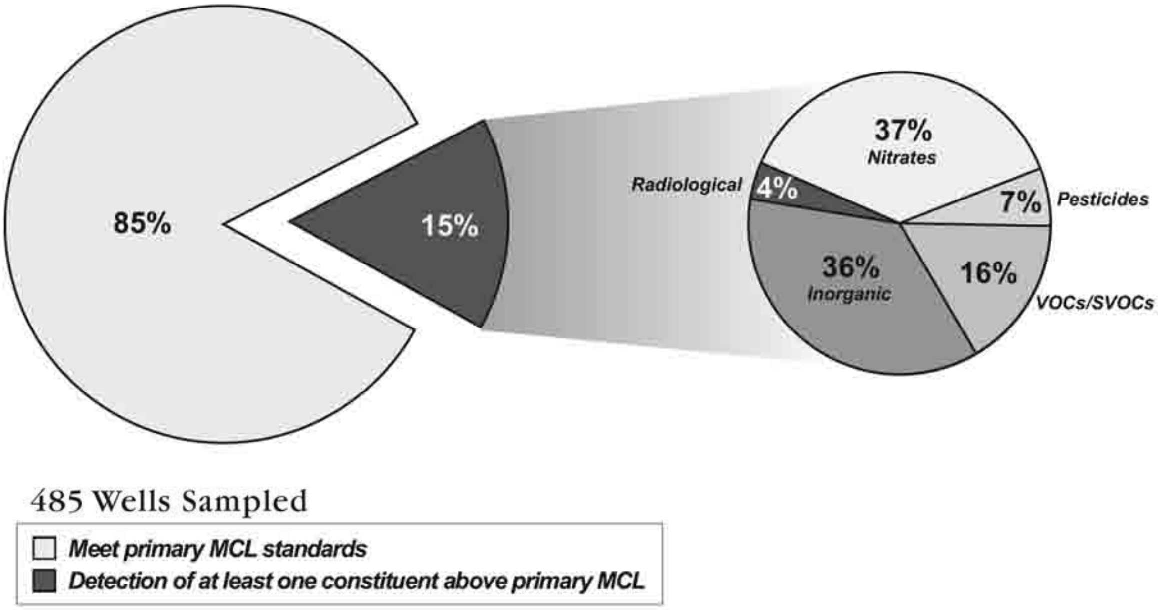

Figure 28 MCL exceedances in public supply wells in the San Francisco Bay Hydrologic Region

Table 16 Most frequently occurring contaminants by contaminant group in the San Francisco Bay Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics	Iron – 57	Manganese – 57	Fluoride – 7
Radiological	Gross Alpha – 2	Radium 226 – 1	
Nitrates	Nitrate (as NO_3) – 27	Nitrate + Nitrite – 3	Nitrite (as N) – 1
Pesticides	Di(2-Ethylhexyl)phthalate – 4	Heptachlor – 1	
VOCs/SVOCs	PCE – 4	Dichloromethane – 3	TCE– 2 Vinyl Chloride – 2

TCE = Trichloroethylene
PCE = Tetrachloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Coumpound

Changes from Bulletin 118-80

Since Bulletin 118-80 was published, RWQCB 2 boundary has been modified. This resulted in several basins being reassigned to RWQCB 1. These are listed in Table 17.

Table 17 Modifications since Bulletin 118-80 of groundwater basins in San Francisco Bay Hydrologic Region

Basin name	New number	Old number
McDowell Valley	1-56	2-12
Knights Valley	1-50	2-13
Potter Valley	1-51	2-14
Ukiah Valley	1-52	2-15
Sanel Valley	1-53	2-16
Alexander Valley	1-54	2-17
Santa Rosa Valley	1-55	2-18
Lower Russian River Valley	1-60	2-20
Bodega Bay Area	1-57	2-21

No additional basins were assigned to the San Francisco Bay HR in this revision. However, the Santa Clara Valley Groundwater Basin (2-9) has been subdivided into four subbasins instead of two, and the Napa-Sonoma Valley Groundwater Basin is now three subbasins instead of two.

There are several deletions of groundwater basins from Bulletin 118-80. The San Francisco Sand Dune Area (2-34) was deleted when the San Francisco groundwater basins were redefined in a USGS report in the early 1990s. The Napa-Sonoma Volcanic Highlands (2-23) is a volcanic aquifer and was not assigned a basin number in this bulletin. This is considered to be a groundwater source area as discussed in Chapter 6. Bulletin 118-80 identified seven groundwater basins that were stated to differ from 118-75: Sonoma County Basin, Napa County Basin, Santa Clara County Basin, San Mateo Basin, Alameda Bay Plain Basin, Niles Cone Basin, and Livermore Basin. They were created primarily by combining several smaller basins and subbasins within individual counties. This report does not consider these seven as basins. There is no change in numbering because the basins were never assigned a basin number.

Table 18 San Francisco Bay Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Active Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
2-1	PETALUMA VALLEY	46,100	C	100	-	16	7	24	347	58-650
2-2	NAPA-SONOMA VALLEY									
2-2.01	NAPA VALLEY	45,900	A	3,000	223	19	10	23	272	150-370
2-2.02	SONOMA VALLEY	44,700	C	1,140	516	18	9	35	321	100-550
2-2.03	NAPA-SONOMA LOWLANDS	40,500	C	300	98	0	6	9	185	50-300
2-3	SUISUN-FAIRFIELD VALLEY	133,600	C	500	200	21	17	35	410	160-740
2-4	PITTSBURG PLAIN	11,600	C	-	-	-	-	9	-	-
2-5	CLAYTON VALLEY	17,800	C	-	-	-	-	48	-	-
2-6	YGNACIO VALLEY	15,500	C	-	-	-	-	-	-	-
2-7	SAN RAMON VALLEY	7,060	C	-	-	-	-	-	-	-
2-8	CASTRO VALLEY	1,820	C	-	-	-	-	-	-	-
2-9	SANTA CLARA VALLEY									
2-9.01	NILES CONE	57,900	A	3,000	2,000	350	120	20	-	-
2-9.02	SANTA CLARA	190,000	C	-	-	-	10	234	408	200-931
2-9.03	SAN MATEO PLAIN	48,100	C	-	-	-	2	14	407	300-480
2-9.04	EAST BAY PLAIN	77,400	A	1,000	UNK	29	16	7	638	364-1,420
2-10	LIVERMORE VALLEY	69,500	A	-	-	-	-	36	-	-
2-11	SUNOL VALLEY	16,600	C	-	-	-	-	2	-	-
2-19	KENWOOD VALLEY	3,170	C	-	-	-	-	13	-	-
2-22	HALF MOON BAY TERRACE	9,150	C	-	-	5	-	9	-	-
2-24	SAN GREGORIO VALLEY	1,070	C	-	-	-	-	-	-	-
2-26	PESCADERO VALLEY	2,900	C	-	-	3	-	4	-	-
2-27	SAND POINT AREA	1,400	C	-	-	-	-	6	-	-
2-28	ROSS VALLEY	1,770	C	-	-	-	-	-	-	-
2-29	SAN RAFAEL VALLEY	880	C	-	-	-	-	-	-	-
2-30	NOVATO VALLEY	20,500	C	-	-	-	-	1	-	-
2-31	ARROYO DEL HAMBRE VALLEY	790	C	-	-	-	-	-	-	-
2-32	VISITACION VALLEY	880	C	-	-	-	-	-	-	-
2-33	ISLAIS VALLEY	1,550	C	-	-	-	-	-	-	-
2-35	MERCED VALLEY	10,400	C	-	-	-	-	10	-	-
2-36	SAN PEDRO VALLEY	880	C	-	-	-	-	-	-	-
2-37	SOUTH SAN FRANCISCO	2,170	C	-	-	-	-	-	-	-
2-38	LOBOS	2,400	A	-	-	-	-	-	-	-
2-39	MARINA	220	A	-	-	-	-	-	-	-
2-40	DOWNTOWN SAN FRANCISCO	7,600	C	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS - total dissolved solids

Central Coast Hydrologic Region

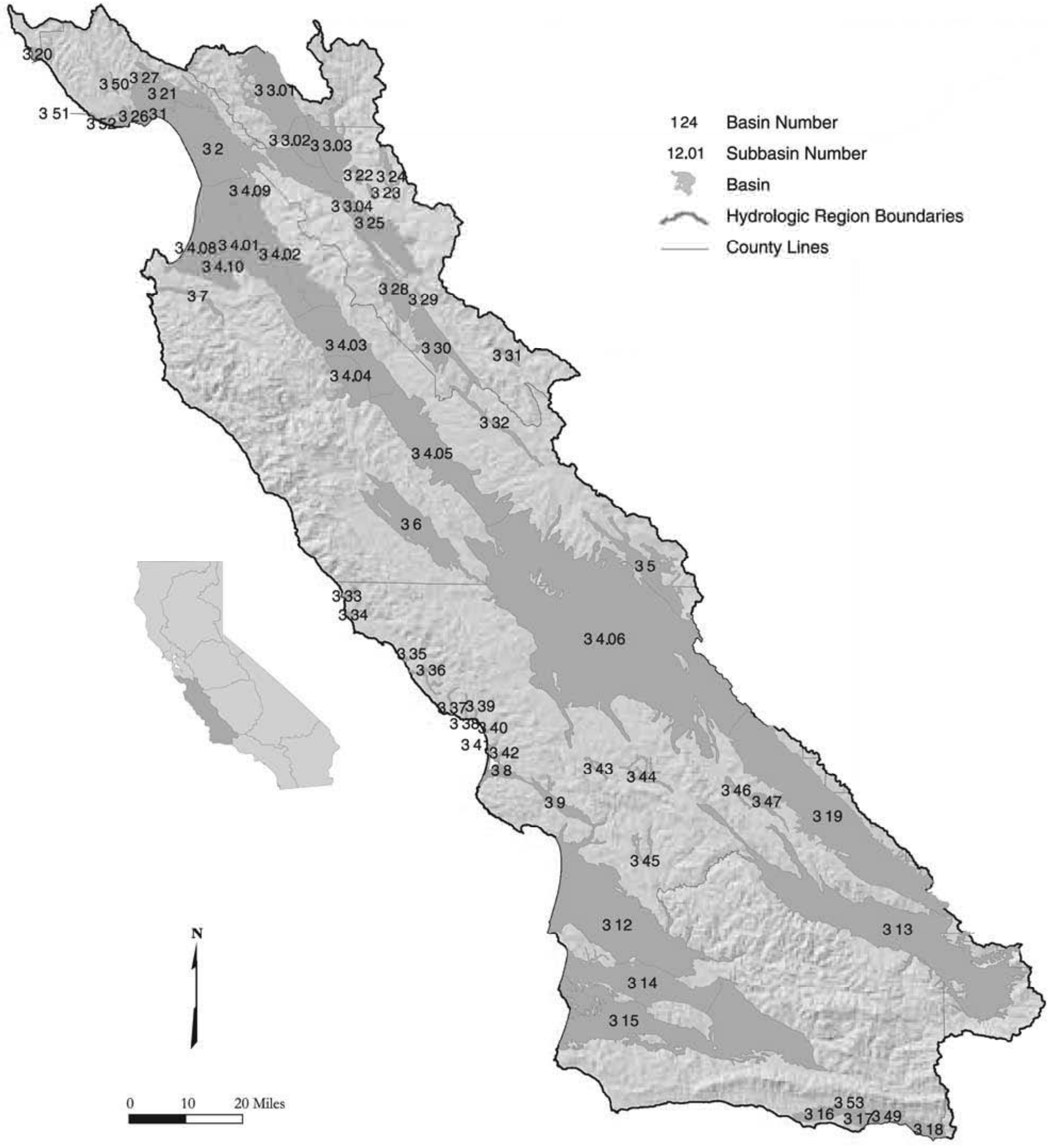

Figure 29 Central Coast Hydrologic Region

Basins and Subbasins of Central Coast Hydrologic Region

RegionBasin/ subbasin	Basin name
3-1	Soquel Valley
3-2	Pajaro Valley
3-3	Gilroy-Hollister Valley
3-3.01	Llagas Area
3-3.02	Bolsa Area
3-3.03	Hollister Area
3-3.04	San Juan Bautista Area
3-4	Salinas Valley
3-4.01	180/400 Foot Aquifer
3-4.02	East Side Aquifer
3-4.04	Forebay Aquifer
3-4.05	Upper Valley Aquifer
3-4.06	Paso Robles Area
3-4.08	Seaside Area
3-4.09	Langley Area
3-4.10	Corral de Tierra Area
3-5	Cholame Valley
3-6	Lockwood Valley
3-7	Carmel Valley
3-8	Los Osos Valley
3-9	San Luis Obispo Valley
3-12	Santa Maria River Valley
3-13	Cuyama Valley
3-14	San Antonio Creek Valley
3-15	Santa Ynez River Valley
3-16	Goleta
3-17	Santa Barbara
3-18	Carpinteria
3-19	Carrizo Plain
3-20	Ano Nuevo Area
3-21	Santa Cruz Purisima Formation
3-22	Santa Ana Valley
3-23	Upper Santa Ana Valley
3-24	Quien Sabe Valley
3-25	Tres Pinos Valley
3-26	West Santa Cruz Terrace
3-27	Scotts Valley
3-28	San Benito River Valley
3-29	Dry Lake Valley
3-30	Bitter Water Valley
3-31	Hernandez Valley
3-32	Peach Tree Valley
3-33	San Carpoforo Valley
3-34	Arroyo de la Cruz Valley
3-35	San Simeon Valley
3-36	Santa Rosa Valley
3-37	Villa Valley
3-38	Cayucos Valley
3-39	Old Valley
3-40	Toro Valley
3-41	Morro Valley
3-42	Chorro Valley
3-43	Rinconada Valley
3-44	Pozo Valley
3-45	Huasna Valley
3-46	Rafael Valley
3-47	Big Spring Area
3-49	Montecito
3-50	Felton Area
3-51	Majors Creek
3-52	Needle Rock Point
3-53	Foothill

Description of the Region

The Central Coast HR covers approximately 7.22 million acres (11,300 square miles) in central California (Figure 29). This HR includes all of Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara counties, most of San Benito County, and parts of San Mateo, Santa Clara, and Ventura counties. Significant geographic features include the Pajaro, Salinas, Carmel, Santa Maria, Santa Ynez, and Cuyama valleys; the coastal plain of Santa Barbara; and the Coast Range. Major drainages in the region include the Salinas, Cuyama, Santa Ynez, Santa Maria, San Antonio, San Lorenzo, San Benito, Pajaro, Nacimiento, Carmel, and Big Sur Rivers.

Population data from the 2000 Census suggest that about 1.4 million people or about 4 percent of the population of the State live in this HR. Major population centers include Santa Barbara, Santa Maria, San Luis Obispo, Gilroy, Hollister, Morgan Hill, Salinas, and Monterey.

The Central Coast HR has 50 delineated groundwater basins. Within this region, the Gilroy-Hollister Valley and Salinas Valley groundwater basins are divided into four and eight subbasins, respectively. Groundwater basins in this HR underlie about 2.390 million acres (3,740 square miles) or about one-third of the HR.

Groundwater Development

Locally, groundwater is an extremely important source of water supply. Within the region, groundwater accounted for 83 percent of the annual supply used for agricultural and urban purposes in 1995. For an average year, groundwater in the region accounts for about 8.4 percent of the statewide groundwater supply and about 1.3 percent of the total state water supply for agricultural and urban needs. In drought years, groundwater in this region is expected to account for about 7.2 percent of the statewide groundwater supply and about 1.9 percent of the total State water supply for agricultural and urban needs (DWR 1998).

Aquifers are varied and range from large extensive alluvial valleys with thick multilayered aquifers and aquitards to small inland valleys and coastal terraces. Several of the larger basins provide a dependable and drought-resistant water supply to coastal cities and farms.

Conjunctive use of surface water and groundwater is a long-standing practice in the region. Several reservoirs including Hernandez, Twitchell, Lake San Antonio, and Lake Nacimiento are operated primarily for the purpose of groundwater recharge. The concept is to maintain streamflow over a longer period than would occur without surface water storage and thus provide for increased recharge of groundwater. Seawater intrusion is a major problem throughout much of the region. In the Salinas Valley Groundwater Basin, seawater intrusion was first documented in the 1930s and has been observed more than 5 miles inland.

Groundwater Quality

Much of the groundwater in the region is characterized by calcium sulfate to calcium sodium bicarbonate sulfate water types because of marine sedimentary rock in the watersheds. Aquifers intruded by seawater are typically characterized by sodium chloride to calcium chloride, and have chloride concentrations greater than 500 mg/L. In several areas, groundwater exceeds the MCL for nitrate.

Water Quality in Public Supply Wells

From 1994 through 2000, 711 public supply water wells were sampled in 38 of the 60 basins and subbasins in the Central Coast HR. Analyzed samples indicate that 587 wells, or 83 percent, met the state primary MCLs for drinking water. One-hundred-twenty-four wells, or 17 percent, have constituents that exceed one or more MCL. Figure 30 shows the percentages of each contaminant group that exceeded MCLs in the 124 wells.

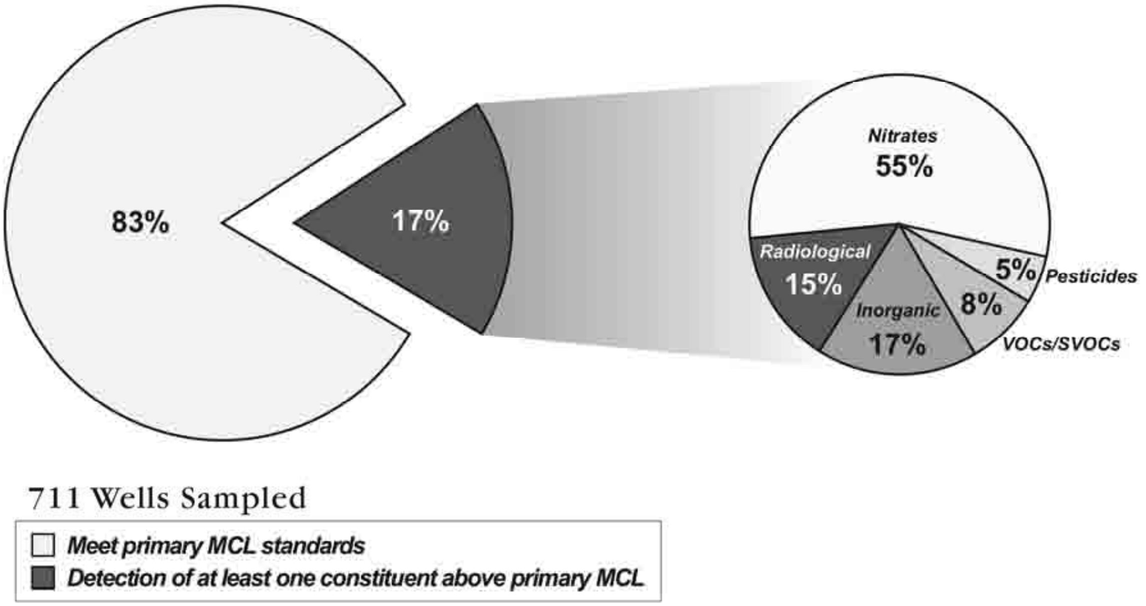

Figure 30 MCL exceedances in public supply wells in the Central Coast Hydrologic Region

Table 19 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 19 Most frequently occurring contaminants by contaminant group in the Central Coast Hydrologic Region

Contaminant group wells	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of
Inorganics – Primary	Antimony – 6	Aluminum – 4	Chromium (Total) – 4
Inorganics – Secondary	Iron – 145	Manganese – 135	TDS – 11
Radiological	Gross Alpha – 15	Radium 226 – 3	Uranium – 3
Nitrates	Nitrate (as NO_3) – 69	Nitrate + Nitrite – 24	
Pesticides	Heptachlor – 4	Di (2-Ethylhexyl) phthalate – 2	
VOCs/SVOCs	TCE – 3	3 are tied at 2 exceedances	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC= Semivolatile Organic Compound

Changes from Bulletin 118-80

Four new basins have been defined since Bulletin 118-80. They are Felton Area, Majors Creek, Needle Rock Point, and Foothill groundwater basins. Additionally, new subbasins have been broken out in both the Gilroy-Hollister Valley Groundwater Basin (3-3) and the Salinas Valley Groundwater Basin (3-4) (Table 20).

Table 20 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Central Coast Hydrologic Region

Subbasin name	New number	Old number
Llagas Area	3-3.01	3-3
Bolsa Area	3-3.02	3-3
Hollister Area	3-3.03	3-3
San Juan Bautista Area	3-3.04	3-3
180/400 Foot Aquifer	3-4.01	3-4
East Side Aquifer	3-4.02	3-4
Upper Forebay Aquifer	3-4.04	3-4
Upper Valley Aquifer	3-4.05	3-4
Pismo Creek Valley Basin	3-12	3-10
Arroyo Grande Creek Basin	3-12	3-11
Careaga Sand Highlands Basin	3-12 and 3-14	3-48
Felton Area	3-50	
Majors Creek	3-51	
Needle Rock Point	3-52	
Foothill	3-53	

Pismo Creek Valley Basin (3-10) and Arroyo Grande Creek Basin (3-11) have been merged into the Santa Maria River Valley Basin (3-12). Careaga Sand Highlands Basin (3-48) has been merged into the Santa Maria River Valley Basin (3-12) and San Antonio Creek Valley Basin (3-14).

Table 21 Central Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
3-1	SOQUEL VALLEY	2,500	C	1,421	665	6	6	16	482	270-990
3-2	PAJARO VALLEY	76,800	A	2,000	500	185	185	149	580-910	300-30,000
3-3	GILROY-HOLLISTER VALLEY									
3-3.01	LLAGAS AREA	55,600	C	-	-	-	-	95	-	-
3-3.02	BOLSA AREA	21,000	A	-	400	11	<11	3	-	400-1800
3-3.03	HOLLISTER AREA	32,700	A	-	400	42	<42	35	-	400-1600
3-3.04	SAN JUAN BAUTISTA AREA	74,300	A	-	400	37	<37	40	-	460-1700
3-4	SALINAS VALLEY									
3-4.01	180/400 FOOT AQUIFER	84,400	A	-	-	166	218	82	478	223-1,013
3-4.02	EAST SIDE AQUIFER	57,500	A	-	-	74	67	53	450	168-977
3-4.04	FOREBAY AQUIFER	94,100	A	-	-	89	91	35	624	300-1,100
3-4.05	UPPER VALLEY AQUIFER	98,200	A	4,000	-	36	37	17	443	140-3,700
3-4.06	PASO ROBLES AREA	597,000	A	3,300	-	183	-	58	614	165-3,868
3-4.08	SEASIDE AREA	25,900	B	3,500	1,000		7	24	400	200-900
3-4.09	LANGLEY AREA	15,400	B	1,570	450	-	-	52	-	52-348
3-4.10	CORRAL DE TIERRA AREA	22,300	C	948	450	-	3	26	-	355-679
3-5	CHOLAME VALLEY	39,800	C	3,000	1,000	1	-	1	-	-
3-6	LOCKWOOD VALLEY	59,900	C	1,500	100	-	-	9	-	-
3-7	CARMEL VALLEY	5,160	C	1,000	600	50	23	12	260-670	220-1,200
3-8	LOS OSOS VALLEY	6,990	A	700	230	-	-	10	354	78-33,700
3-9	SAN LUIS OBISPO VALLEY	12,700	A	600	300	-	-	11	583	278-1,949
3-12	SANTA MARIA RIVER VALLEY	184,000	A	2,500	1,000	286	10	108	598	139-1,200
3-13	CUYAMA VALLEY	147,000	A	4,400	1,100	17	2	8	-	206-3,905
3-14	SAN ANTONIO CREEK VALLEY	81,800	A	-	400	30	-	9	415	129-8,040
3-15	SANTA YNEZ RIVER VALLEY	204,000	A	1,300	750	163	21	76	507	400-700
3-16	GOLETA	9,210	A	800	500	49	11	17	755	617-929
3-17	SANTA BARBARA	6,160	A	625	560	75	36	5	-	217-385
3-18	CARPINTERIA	8,120	A	500	300	41	41	4	557	317-1,780
3-19	CARRIZO PLAIN	173,000	C	1,000	500	-	-	1	-	-
3-20	ANO NUEVO AREA	2,032	C	-	-	-	-	2	-	-
3-21	SANTA CRUZ PURISIMA FORMATION	40,200	C	200	20	-	-	39	440	380-560
3-22	SANTA ANA VALLEY	2,720	C	130	-	-	-	-	-	-
3-23	UPPER SANTA ANA VALLEY	1,430	C	-	-	-	-	-	-	-
3-24	QUIEN SABE VALLEY	4,710	C	122	122	-	-	-	-	-
3-25	TRES PINOS VALLEY	3,390	C	1,225	-	-	-	3	-	-
3-26	WEST SANTA CRUZ TERRACE	7,870	C	550	200	-	-	7	480	378-684
3-27	SCOTTS VALLEY	774	C	410	100-900	26	7	7	360	100-980
3-28	SAN BENITO RIVER VALLEY	24,200	C	2,000	-	-	-	3	-	-
3-29	DRY LAKE VALLEY	1,420	C	-	-	-	-	-	-	-
3-30	BITTER WATER VALLEY	32,200	C	-	-	-	-	-	-	-
3-31	HERNANDEZ VALLEY	2,860	C	160	58	-	-	-	-	-

Table 21 Central Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
3-32	PEACH TREE VALLEY	9,790	C	117	84	-	-	-	-	-
3-33	SAN CARPOFORO VALLEY	200	C	-	-	-	-	-	-	217-385
3-34	ARROYO DE LA CRUZ VALLEY	750	C	-	-	-	-	-	-	211-381
3-35	SAN SIMEON VALLEY	620	A	170	100	-	-	4	413	46-2,210
3-36	SANTA ROSA VALLEY	4,480	A	708	400	-	-	2	-	298-2,637
3-37	VILLA VALLEY	980	C	-	-	-	-	-	-	260-1,635
3-38	CAYUCOS VALLEY	530	C	166	100	-	-	-	-	815-916
3-39	OLD VALLEY	750	C	335	200	-	-	-	-	346-2,462
3-40	TORO VALLEY	721	C	500	0	-	-	-	-	458-732
3-41	MORRO VALLEY	1,200	C	442	300	-	-	6	1150	469-5,100
3-42	CHORRO VALLEY	3,200	C	700	200	-	-	6	656	60-3,606
3-43	RINCONADA VALLEY	2,580	C	0	0	-	-	-	-	-
3-44	POZO VALLEY	6,840	C	230	100	-	-	5	-	287-676
3-45	HUASNA VALLEY	4,700	C	0	0	-	-	-	-	-
3-46	RAFAEL VALLEY	2,990	C	0	0	-	-	-	-	-
3-47	BIG SPRING AREA	7,320	C	0	0	-	-	-	-	-
3-49	MONTECITO	6,270	A	1,000	750	88	2	4	700	600-1,100
3-50	FELTON AREA	1,160	C	825	244	6	-	2	-	69-400
3-51	MAJORS CREEK	364	C	50	38	-	-	-	-	-
3-52	NEEDLE ROCK POINT	480	C	450	320	-	-	-	-	-
3-53	FOOTHILL	3,120	A	-	-	-	8	7	828	554-1,118

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

South Coast Hydrologic Region

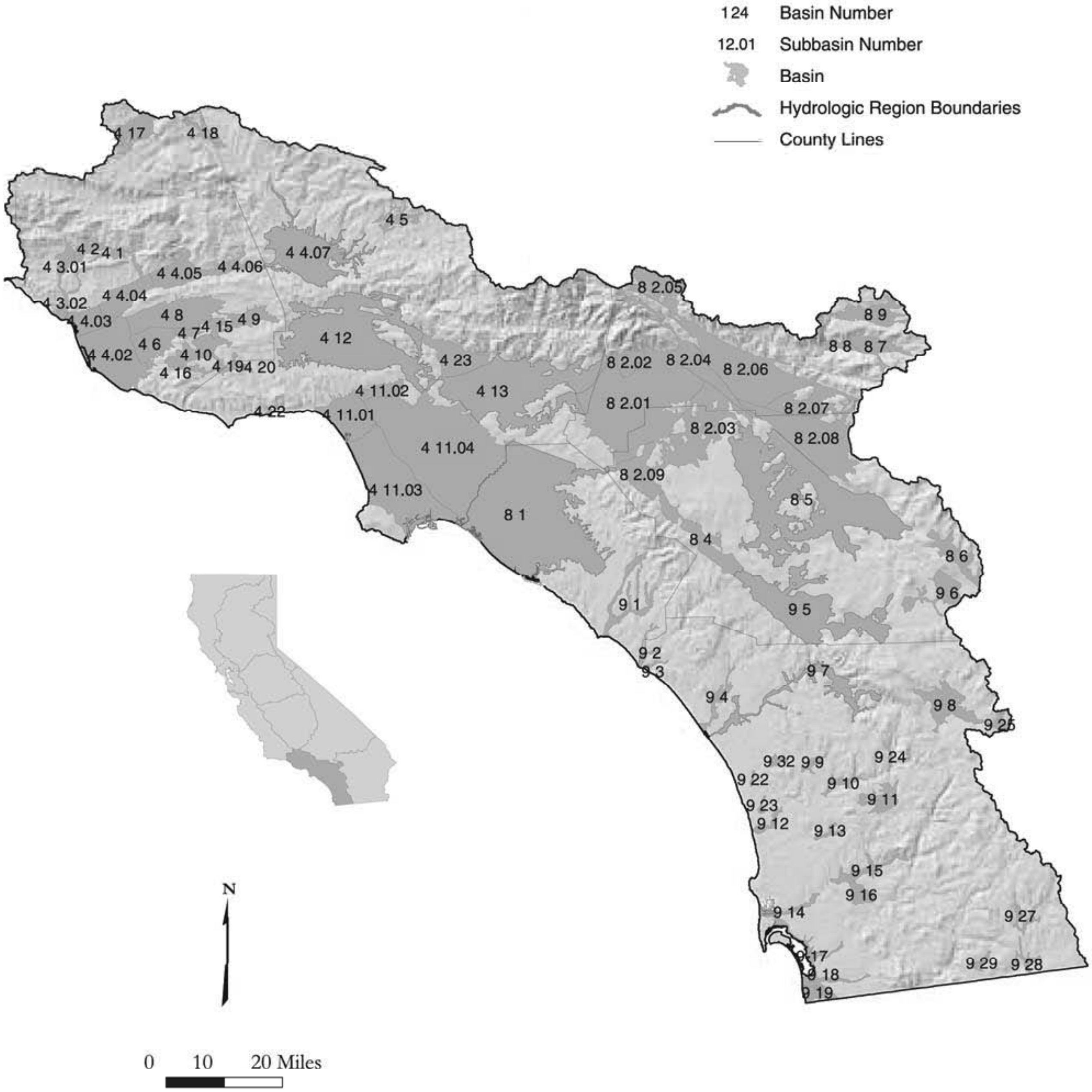

Figure 31 South Coast Hydrologic Region

Basins and Subbasins of the South Coast Hydrologic Region

Basin/subbasin	Basin name
4-1	Upper Ojai Valley
4-2	Ojai Valley
4-3	Ventura River Valley
4-3.01	Upper Ventura River
4-3.02	Lower Ventura River
4-4	Santa Clara River Valley
4-4.02	Oxnard
4-4.03	Mound
4-4.04	Santa Paula
4-4.05	Fillmore
4-4.06	Piru
4-4.07	Santa Clara River Valley East
4-5	Acton Valley
4-6	Pleasant Valley
4-7	Arroyo Santa Rosa Valley
4-8	Las Posas Valley
4-9	Simi Valley
4-10	Conejo Valley
4-11	Coastal Plain of Los Angeles
4-11.01	Santa Monica
4-11.02	Hollywood
4-11.03	West Coast
4-11.04	Central
4-12	San Fernando Valley
4-13	San Gabriel Valley
4-15	Tierre Rejada
4-16	Hidden Valley
4-17	Lockwood Valley
4-18	Hungry Valley
4-19	Thousand Oaks Area
4-20	Russell Valley
4-22	Malibu Valley
4-23	Raymond
8-1	Coastal Plain of Orange County
8-2	Upper Santa Ana Valley
8-2.01	Chino
8-2.02	Cucamonga
8-2.03	Riverside-Arlington
8-2.04	Rialto-Colton
8-2.05	Cajon
8-2.06	Bunker Hill
8-2.07	Yucaipa
8-2.08	San Timoteo
8-2.09	Temescal
8-4	Elsinore
8-5	San Jacinto
8-6	Hemet Lake Valley
8-7	Big Meadows Valley
8-8	Seven Oaks Valley
8-9	Bear Valley
9-1	San Juan Valley
9-2	San Mateo Valley
9-3	San Onofre Valley
9-4	Santa Margarita Valley
9-5	Temecula Valley
9-6	Coahuila Valley
9-7	San Luis Rey Valley
9-8	Warner Valley
9-9	Escondido Valley
9-10	San Pasqual Valley
9-11	Santa Maria Valley
9-12	San Dieguito Creek
9-13	Poway Valley
9-14	Mission Valley
9-15	San Diego River Valley
9-16	El Cajon Valley
9-17	Sweetwater Valley
9-18	Otay Valley
9-19	Tijuana Basin
9-22	Batiquitos Lagoon Valley
9-23	San Elijo Valley
9-24	Pamo Valley
9-25	Ranchita Town Area
9-27	Cottonwood Valley
9-28	Campo Valley
9-29	Potrero Valley
9-32	San Marcos Area

Description of the Region

The South Coast HR covers approximately 6.78 million acres (10,600 square miles) of the southern California watershed that drains to the Pacific Ocean (Figure 31). The HR is bounded on the west by the Pacific Ocean and the watershed divide near the Ventura-Santa Barbara County line. The northern boundary corresponds to the crest of the Transverse Ranges through the San Gabriel and San Bernardino mountains. The eastern boundary lies along the crest of the San Jacinto Mountains and low-lying hills of the Peninsular Range that form a drainage boundary with the Colorado River HR. The southern boundary is the international boundary with the Republic of Mexico. Significant geographic features include the coastal plain, the central Transverse Ranges, the Peninsular Ranges, and the San Fernando, San Gabriel, Santa Ana River, and Santa Clara River valleys.

The South Coast HR includes all of Orange County, most of San Diego and Los Angeles Counties, parts of Riverside, San Bernardino, and Ventura counties, and a small amount of Kern and Santa Barbara Counties. This HR is divided into Los Angeles, Santa Ana and San Diego subregions, RWQCBs 4, 8, and 9 respectively. Groundwater basins are numbered according to these subregions. Basin numbers in the Los Angeles subregion are preceded by a 4, in Santa Ana by an 8, and in San Diego by a 9. The Los Angeles subregion contains the Ventura, Santa Clara, Los Angeles, and San Gabriel River drainages, Santa Ana encompasses the Santa Ana River drainage, and San Diego includes the Santa Maria River, San Luis Rey River and the San Diego River and other drainage systems.

According to 2000 census data, about 17 million people live within the boundaries of the South Coast HR, approximately 50 percent of the population of California. Because this HR amounts to only about 7 percent of the surface area of the State, this has the highest population density of any HR in California (DWR 1998). Major population centers include the metropolitan areas surrounding Ventura, Los Angeles, San Diego, San Bernardino, and Riverside.

The South Coast HR has 56 delineated groundwater basins. Twenty-one basins are in subregion 4 (Los Angeles), eight basins in subregion 8 (Santa Ana), and 27 basins in subregion 9 (San Diego).

The Los Angeles subregion overlies 21 groundwater basins and encompasses most of Ventura and Los Angeles counties. Within this subregion, the Ventura River Valley, Santa Clara River Valley, and Coastal Plain of Los Angeles basins are divided into subbasins. The basins in the Los Angeles subregion underlie 1.01 million acres (1,580 square miles) or about 40 percent of the total surface area of the subregion.

The Santa Ana subregion overlies eight groundwater basins and encompasses most of Orange County and parts of Los Angeles, San Bernardino, and Riverside counties. The Upper Santa Ana Valley Groundwater Basin is divided into nine subbasins. Groundwater basins underlie 979,000 acres (1,520 square miles) or about 54 percent of the Santa Ana subregion.

The San Diego subregion overlies 27 groundwater basins, encompasses most of San Diego County, and includes parts of Orange and Riverside counties. Groundwater basins underlie about 277,000 acres (433 square miles) or about 11 percent of the surface of the San Diego subregion.

Overall, groundwater basins underlie about 2.27 million acres (3,530 square miles) or about 33 percent of the South Coast HR.

Groundwater Development

Groundwater has been used in the South Coast HR for well over 100 years. High demand and use of groundwater in Southern California has given rise to many disputes over management and pumping rights, with the resolution of these cases playing a large role in the establishment and clarification of water rights law in California. Raymond Groundwater Basin, located in this HR, was the first adjudicated basin in the State. Of the 16 adjudicated basins in California, 11 are in the South Coast HR. Groundwater provides about 23 percent of water demand in normal years and about 29 percent in drought years (DWR 1998).

Groundwater is found in unconfined alluvial aquifers in most of the basins of the San Diego subregion and the inland basins of the Santa Ana and Los Angeles subregions. In some larger basins, typified by those underlying the coastal plain, groundwater occurs in multiple aquifers separated by aquitards that create confined groundwater conditions. Basins range in depth from tens or hundreds of feet in smaller basins, to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this HR depending on aquifer characteristics and well location, size, and use. Some aquifers are capable of yielding thousands of gallons per minute to municipal wells.

Conjunctive Use

Conjunctive use of surface water and groundwater is a long-standing practice in the region. At present, much of the potable water used in Southern California is imported from the Colorado River and from sources in the eastern Sierra and Northern California. Several reservoirs are operated primarily for the purpose of storing surface water for domestic and irrigation use, but groundwater basins are also recharged from the outflow of some reservoirs. The concept is to maintain streamflow over a longer period of time than would occur without regulated flow and thus provide for increased recharge of groundwater basins. Most of the larger basins in this HR are highly managed, with many conjunctive use projects being developed to optimize water supply.

Coastal basins in this HR are prone to intrusion of seawater. Seawater intrusion barriers are maintained along the Los Angeles and Orange County sections of the coastal plain. In Orange County, recycled water is injected into the ground to form a mound of groundwater between the coast and the main groundwater basin. In Los Angeles County, imported and recycled water is injected to maintain a seawater intrusion barrier.

Groundwater Quality

Groundwater in basins of the Los Angeles subregion is mainly calcium sulfate and calcium bicarbonate in character. Nitrate content is elevated in some parts of the subregion. Volatile organic compounds (VOCs) have created groundwater impairments in some of the industrialized portions of the region. The San Gabriel Valley and San Fernando Valley groundwater basins both have multiple sites of contamination from VOCs. The main constituents in the contamination plumes are trichloroethylene (TCE) and tetrachloroethylene (PCE). Some of the locations have been declared federal Superfund sites. Contamination plumes containing high concentrations of TCE and PCE also occur in the Bunker Hill Subbasin of the Upper Santa Ana Valley Groundwater Basin. Some of these plumes are also designated as Superfund sites. Perchlorate is emerging as an important contaminant in several areas in the South Coast HR.

Groundwater in basins of the Santa Ana subregion is primarily calcium and sodium bicarbonate in character. Local impairments from excess nitrate or VOCs have been recognized. Groundwater and surface water in the Chino Subbasin of the Santa Ana River Valley Groundwater Basin have elevated nitrate concentrations, partly derived from a large dairy industry in that area. In Orange County, water from the Santa Ana River provides a large part of the groundwater replenishment. Wetlands maintained along the Santa Ana River near the boundary of the Upper Santa Ana River and Orange County Groundwater Basins provide effective removal of nitrate from surface water, while maintaining critical habitat for endangered species.

Groundwater in basins of the San Diego subregion has mainly calcium and sodium cations and bicarbonate and sulfate anions. Local impairments by nitrate, sulfate, and TDS are found. Camp Pendleton Marine Base, in the northwestern part of this subregion, is on the EPA National Priorities List for soil and groundwater contamination by many constituents.

Water Quality in Public Supply Wells

From 1994 through 2000, 2,342 public supply water wells were sampled in 47 of the 73 basins and subbasins in the South Coast HR. Analyzed samples indicate that 1,360 wells, or 58 percent, met the state primary MCLs for drinking water. Nine-hundred-eighty-two wells, or 42 percent, have constituents that exceed one or more MCL. Figure 32 shows the percentages of each contaminant group that exceeded MCLs in the 982 wells.

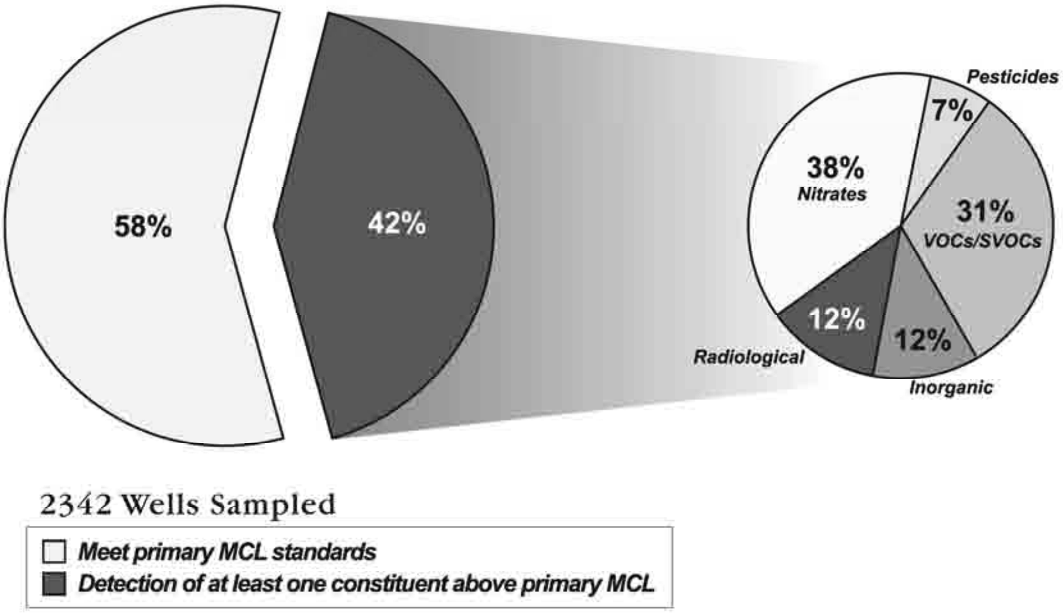

Figure 32 MCL exceedances in public supply wells in the South Coast Hydrologic Region

Table 22 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Changes from Bulletin 118-80

Several modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report (Table 23). The Cajalco Valley (8-3), Jamul Valley (9-20), Las Pulgas Valley (9-21), Pine Valley (9-26), and Tecate Valley (9-30) Groundwater Basins have been deleted in this report because they have thin deposits of alluvium and well completion reports indicate that groundwater production is from underlying fractured bedrock. The Conejo Tierra Rejada Volcanic (4-21) is a volcanic aquifer and was not assigned a basin number in this bulletin. This is considered to be groundwater source area as discussed in Chapter 6.

Table 22 Most frequently occurring contaminants by contaminant group in the South Coast Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 56	Thallium – 13	Aluminum – 12
Inorganics – Secondary	Iron – 337	Manganese – 335	TDS – 36
Radiological	Gross Alpha – 104	Uranium – 40	Radium 226 – 9 Radium 228 – 9
Nitrates	Nitrate (as NO_3) – 364	Nitrate + Nitrite – 179	Nitrate Nitrogen (NO_3-N) – 14
Pesticides	DBCP – 61	Di(2-Ethylhexyl)phthalate –5	Heptachlor – 2 EDB – 2
VOCs/SVOCs	TCE – 196	PCE – 152	1,2 Dichloroethane – 89

DBCP = Dibromochloropropane
EDB = Ethylene Dibromide
VOCs = Volatile Organic Compounds
SVOCs = Semivolatile Organic Compounds

The Ventura River Valley (4-3), Santa Clara River Valley (4-4), Coastal Plain of Los Angeles (4-11), and Upper Santa Ana Valley (8-2) Groundwater Basins have been divided into subbasins in this report. The extent of the San Jacinto Groundwater Basin (8-5) has been decreased because completion of Diamond Valley Reservoir has inundated the valley. Paloma Valley has been removed because well logs indicate groundwater production is solely from fractured bedrock. The Raymond Groundwater Basin (4-23) is presented as an individual basin instead of being incorporated into the San Gabriel Valley Groundwater Basin (4-13) because it is bounded by physical barriers and has been managed as a separate and individual groundwater basin for many decades. In Bulletin 118-75, groundwater basins in two different subregions were designated the Upper Santa Ana Valley Groundwater Basin (4-14 and 8-2). To alleviate this confusion, basin 4-14 has been divided, with parts of the basin incorporated into the neighboring San Gabriel Valley Groundwater Basin (4-13) and the Chino subbasin of the Upper Santa Ana Valley Groundwater Basin (8-2.01). The San Marcos Area Groundwater Basin (9-32) in central San Diego County is presented as a new basin in this report.

Table 23 Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Coast Hydrologic Region

Basin/subbasin name	Number	Old number
Upper Ventura River	4-3.01	4-3
Lower Ventura River	4-3.02	4-3
Oxnard	4-4.02	4-4
Mound	4-4.03	4-4
Santa Paula	4-4.04	4-4
Fillmore	4-4.05	4-4
Piru	4-4.06	4-4
Santa Clara River Valley East	4-4.07	4-4
Santa Monica	4-11.01	4-11
Hollywood	4-11.02	4-11
West Coast	4-11.03	4-11
Central	4-11.04	4-11
Upper Santa Ana Valley	Incorporated into 8-2.01 and 4-13	4-14
Conejo-Tierra Rejada Volcanic	deleted	4-21
Raymond	4-23	4-13
Chino	8-2.01	8-2
Cucamonga	8-2.02	8-2
Riverside-Arlington	8-2.03	8-2
Rialto-Colton	8-2.04	8-2
Cajon	8-2.05	8-2
Bunker Hill	8-2.06	8-2
Yucaipa	8-2.07	8-2
San Timoteo	8-2.08	8-2
Temescal	8-2.09	8-2
Cajalco Valley	deleted	8-3
Tijuana Basin	9-19	
Jamul Valley	deleted	9-20
Las Pulgas Valley	deleted	9-21
Batiquitos Lagoon Valley	9-22	
San Elijo Valley	9-23	
Pamo Valley	9-24	
Ranchita Town Area	9-25	
Pine Valley	deleted	9-26
Cottonwood Valley	9-27	
Campo Valley	9-28	
Potrero Valley	9-29	
Tecate Valley	deleted	9-30
San Marcos Area	9-32	Not previously identified

Table 24 South Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm) Maximum	Well Yields (gpm) Average	Active Monitoring Levels	Active Monitoring Quality	Active Monitoring Title 22	TDS (mg/L) Average	TDS (mg/L) Range
4-1	UPPER OJAI VALLEY	3,800	A	200	50	4	-	1	707	438-1,249
4-2	OJAI VALLEY	6,830	A	600	383	24	-	22	640	450-1,140
4-3	VENTURA RIVER VALLEY									
4-3.01	UPPER VENTURA RIVER	7,410	C	-	600	17	-	18	706	500-1,240
4-3.02	LOWER VENTURA RIVER	5,300	A	-	20	-	-	2	-	760-3,000
4-4	SANTA CLARA RIVER VALLEY									
4-4.02	OXNARD	58,000	A	1,600	-	127	127	69	1,102	160-1,800
4-4.03	MOUND	14,800	A	-	700	11	11	4	1,644	1,498-1,908
4-4.04	SANTA PAULA	22,800	A	-	700	60	50	10	1,198	470-3,010
4-4.05	FILLMORE	20,800	A	2,100	700	23	-	10	1,100	800-2,400
4-4.06	PIRU	8,900	A	-	800	19	-	3	1,300	608-2,400
4-4.07	SANTA CLARA RIVER VALLEY EAST	66,200	C	-	-	-	-	62	-	-
4-5	ACTON VALLEY	8,270	A	1,000	140	-	-	7	-	-
4-6	PLEASANT VALLEY	21,600	A	-	1,000	9	-	12	1,110	597-3,490
4-7	ARROYO SANTA ROSA VALLEY	3,740	A	1,200	950	6	-	7	1,006	670-1,200
4-8	LAS POSAS VALLEY	42,200	A	750	-	-	-	24	742	338-1,700
4-9	SIMI VALLEY	12,100	A	-	394	13	-	1	-	1,580
4-10	CONEJO VALLEY	28,900	A	1,000	100	-	-	3	631	335-2,064
4-11	COASTAL PLAIN OF LOS ANGELES									
4-11.01	SANTA MONICA	32,100	C	4,700	-	-	-	12	916	729-1,156
4-11.02	HOLLYWOOD	10,500	A	-	-	5	5	1	-	526
4-11.03	WEST COAST	91,300	A	1,300	-	67	58	33	456	-
4-11.04	CENTRAL	177,000	A	11,000	1,730	302	64	294	453	200-2,500
4-12	SAN FERNANDO VALLEY	145,000	A	3,240	1,220	1398	2385	126	499	176-1,16
4-13	SAN GABRIEL VALLEY	154,000	A	4,850	1,000	67	296	259	367	90-4,288
4-15	TIERRA REJADA	4,390	A	1,200	172	4	1	-	-	619-930
4-16	HIDDEN VALLEY	2,210	C	-	-	-	-	1	453	289-743
4-17	LOCKWOOD VALLEY	21,800	A	350	25	-	-	1	-	-
4-18	HUNGRY VALLEY	5,310	C	-	28	-	-	-	<350	-
4-19	THOUSAND OAKS AREA	3,110	C	-	39	2	-	-	1,410	1,200-2,300
4-20	RUSSELL VALLEY	3,100	A	-	25	-	-	-	-	-
4-22	MALIBU VALLEY	613	C	1,060	1,030	-	-	-	-	-
4-23	RAYMOND	26,200	A	3,620	1,880	88	-	70	346	138-780
8-1	COASTAL PLAIN OF ORANGE COUNTY	224,000	A	4,500	2,500	521	411	240	475	232-661
8-2	UPPER SANTA ANA VALLEY									
8-2.01	CHINO	154,000	A	1,500	1,000	12	8	187	484	200-600
8-2.02	CUCAMONGA	9,530	C	4,400	2,115	1	1	21	-	-
8-2.03	RIVERSIDE-ARLINGTON	58,600	A	-	-	11	3	43	-	370-756
8-2.04	RIALTO-COLTON	30,100	A	5,000	545	50	5	41	337	
8-2.05	CAJON	23,200	C	200	60	-	-	5	-	-
8-2.06	BUNKER HILL	89,600	A	5,000	1,245	398	169	204	-	150-550
8-2.07	YUCAIPA	25,300	A	2,800	206	19	3	45	334	-

Table 24 South Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Active Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
8-2.08	SAN TIMOTEO	73,100	A	-	-	67	12	36	-	-
8-2.09	TEMESCAL	23,500	C	-	-	2	2	20	753	373-950
8-4	ELSINORE	25,700	C	5,400	-	1	1	18	-	
8-5	SAN JACINTO	188,000	C	-	-	150	115	56	463	160-12,000
8-6	HEMET LAKE VALLEY	16,700	C	820	196	-	-	9	-	-
8-7	BIG MEADOWS VALLEY	14,200	C	120	34	-	-	8	-	-
8-8	SEVEN OAKS VALLEY	4,080	C	-	-	-	-	1	-	-
8-9	BEAR VALLEY	19,600	A	1,000	500	57	57	52	-	-
9-1	SAN JUAN VALLEY	16,700	C	1,000	-	-	-	8	760	430-12,880
9-2	SAN MATEO VALLEY	2,990	A	-	-	-	-	5	586	490-770
9-3	SAN ONOFRE VALLEY	1,250	A	-	-	-	-	2	-	600-1,500
9-4	SANTA MARGARITA VALLEY	626	A	1,980	-	4	-	-	-	337-9,030
9-5	TEMECULA VALLEY	87,800	C	1,750	-	140	4	67	476	220-1,500
9-6	COAHUILA VALLEY	18,200	C	500	-	2	-	1	-	304-969
9-7	SAN LUIS REY VALLEY	37,000	C	2,000	500	-	-	28	1,258	530-7,060
9-8	WARNER VALLEY	24,000	C	1,800	800	-	-	4	-	263
9-9	ESCONDIDO VALLEY	2,890	C	190	50	-	-	1	-	250-5,000
9-10	SAN PASQUAL VALLEY	4,540	C	1,700	1,000	-	-	2	-	500-1,550
9-11	SANTA MARIA VALLEY	12,300	A	500	36	3	-	2	1,000	324-1,680
9-12	SAN DIEGUITO CREEK	3,560	A	1,800	700	-	-	-	-	2,000
9-13	POWAY VALLEY	2,470	C	200	100	-	-	1	-	610-1,500
9-14	MISSION VALLEY	7,350	C	-	1,000	-	-	-	-	-
9-15	SAN DIEGO RIVER VALLEY	9,890	C	2,000	-	-	-	5	-	260-2,870
9-16	EL CAJON VALLEY	7,160	C	300	50	1	-	2,340		
9-17	SWEETWATER VALLEY	5,920	C	1,500	300	7	7	9	2,114	300-50,000
9-18	OTAY VALLEY	6,830	C	1,000	185	-	-	-	-	500->2,000
9-19	TIJUANA BASIN	7,410	A	2,000	350	-	-	-	-	380-3,620
9-22	BATIQUITOS LAGOON VALLEY	741	C	-	-	-	-	-	1,280	788-2,362
9-23	SAN ELIJO VALLEY	883	C	1,800	-	-	-	-	-	1,170-5,090
9-24	PAMO VALLEY	1,500	C	-	-	-	-	-	369	279-455
9-25	RANCHITA TOWN AREA	3,130	C	125	22	-	-	-	-	283-305
9-27	COTTONWOOD VALLEY	3,850	C	-	-	-	-	1	-	-
9-28	CAMPO VALLEY	3,550	C	-	<40	-	-	4	-	800
9-29	POTRERO VALLEY	2,020	C	-	-	-	-	4	-	-
9-32	SAN MARCOS VALLEY	2,130	C	60	-	-	-	-	-	500-700

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Sacramento River Hydrologic Region

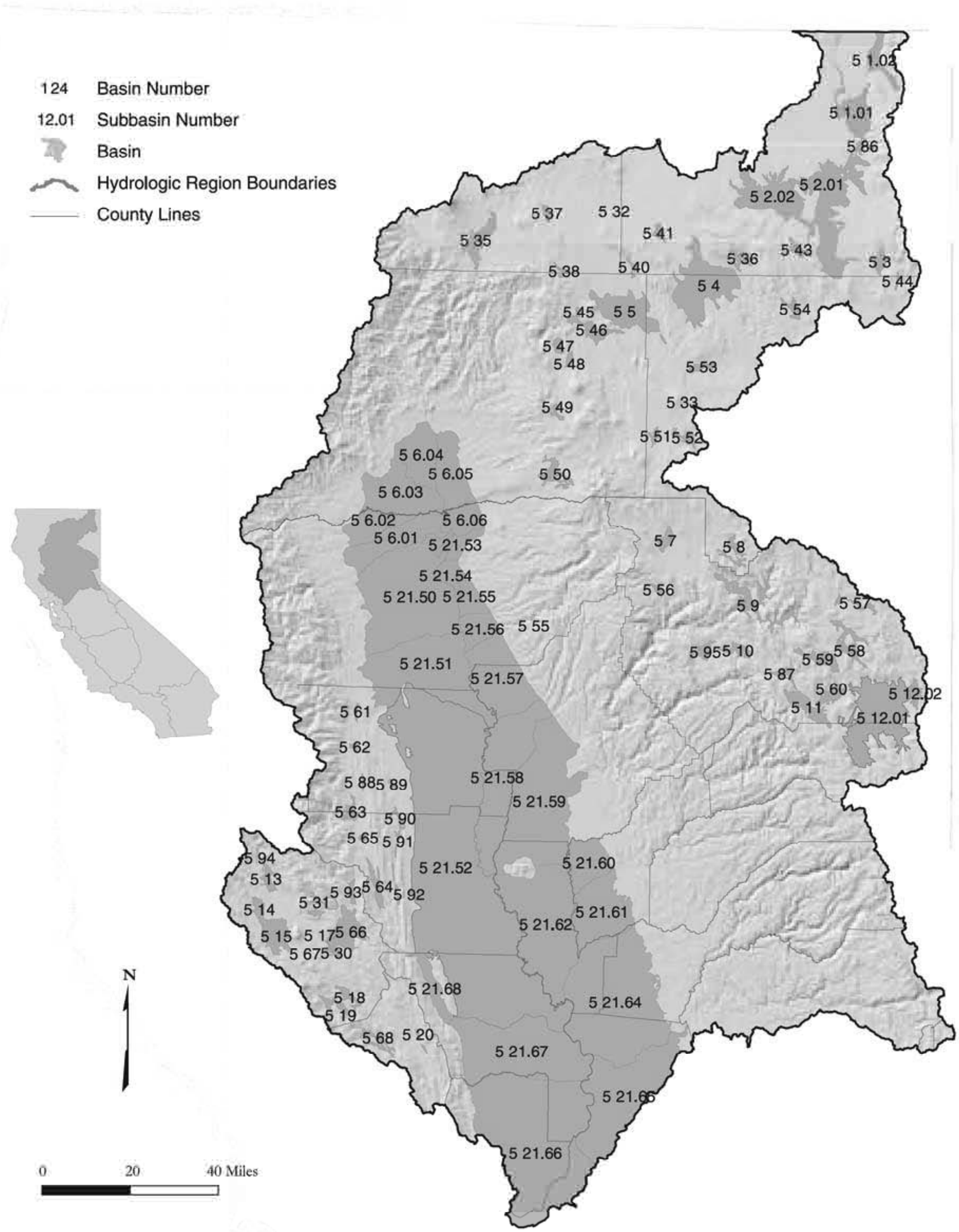

Figure 33 Sacramento River Hydrologic Region

Basins and Subbasins of the Sacramento River Hydrologic Region

Basin/subbasins	Basin name
5-1	Goose Lake Valley
5-1.01	Lower Goose Lake Valley
5-1.02	Fandango Valley
5-2	Alturas Area
5-2.01	South Fork Pitt River
5-2.02	Warm Springs Valley
5-3	Jess Valley
5-4	Big Valley
5-5	Fall River Valley
5-6	Redding Area
5-6.01	Bowman
5-6.02	Rosewood
5-6.03	Anderson
5-6.04	Enterprise
5-6.05	Millville
5-6.06	South Battle Creek
5-7	Lake Almanor Valley
5-8	Mountain Meadows Valley
5-9	Indian Valley
5-10	American Valley
5-11	Mohawk Valley
5-12	Sierra Valley
5-12.01	Sierra Valley
5-12.02	Chilcoot
5-13	Upper Lake Valley
5-14	Scotts Valley
5-15	Big Valley
5-16	High Valley
5-17	Burns Valley
5-18	Coyote Valley
5-19	Collayomi Valley
5-20	Berryessa Valley
5-21	Sacramento Valley
5-21.50	Red Bluff
5-21.51	Corning
5-21.52	Colusa
5-21.53	Bend
5-21.54	Antelope
5-21.55	Dye Creek
5-21.56	Los Molinos
5-21.57	Vina
5-21.58	West Butte
5-21.59	East Butte
5-21.60	North Yuba
5-21.61	South Yuba
5-21.62	Sutter
5-21.64	North American
5-21.65	South American
5-21.66	Solano
5-21.67	Yolo
5-21.68	Capay Valley
5-30	Lower Lake Valley
5-31	Long Valley
5-35	Mccloud Area
5-36	Round Valley
5-37	Toad Well Area
5-38	Pondosa Town Area
5-40	Hot Springs Valley
5-41	Egg Lake Valley
5-43	Rock Prairie Valley
5-44	Long Valley
5-45	Cayton Valley
5-46	Lake Britton Area
5-47	Goose Valley
5-48	Burney Creek Valley
5-49	Dry Burney Creek Valley
5-50	North Fork Battle Creek
5-51	Butte Creek Valley
5-52	Gray Valley
5-53	Dixie Valley
5-54	Ash Valley
5-56	Yellow Creek Valley
5-57	Last Chance Creek Valley
5-58	Clover Valley
5-59	Grizzly Valley
5-60	Humbug Valley
5-61	Chrome Town Area
5-62	Elk Creek Area
5-63	Stonyford Town Area
5-64	Bear Valley
5-65	Little Indian Valley
5-66	Clear Lake Cache Formation
5-68	Pope Valley
5-86	Joseph Creek
5-87	Middle Fork Feather River
5-88	Stony Gorge Reservoir
5-89	Squaw Flat
5-90	Funks Creek
5-91	Antelope Creek
5-92	Blanchard Valley
5-93	North Fork Cache Creek
5-94	Middle Creek
5-95	Meadow Valley

Description of the Region

The Sacramento River HR covers approximately 17.4 million acres (27,200 square miles). The region includes all or large portions of Modoc, Siskiyou, Lassen, Shasta, Tehama, Glenn, Plumas, Butte, Colusa, Sutter, Yuba, Sierra, Nevada, Placer, Sacramento, El Dorado, Yolo, Solano, Lake, and Napa counties (Figure 33). Small areas of Alpine and Amador counties are also within the region. Geographically, the region extends south from the Modoc Plateau and Cascade Range at the Oregon border, to the Sacramento-San Joaquin Delta. The Sacramento Valley, which forms the core of the region, is bounded to the east by the crest of the Sierra Nevada and southern Cascades and to the west by the crest of the Coast Range and Klamath Mountains. Other significant features include Mount Shasta and Lassen Peak in the southern Cascades, Sutter Buttes in the south central portion of the valley, and the Sacramento River, which is the longest river system in the State of California with major tributaries the Pit, Feather, Yuba, Bear and American rivers. The region corresponds approximately to the northern half of RWQCB 5. The Sacramento metropolitan area and surrounding communities form the major population center of the region. With the exception of Redding, cities and towns to the north, while steadily increasing in size, are more rural than urban in nature, being based in major agricultural areas. The 1995 population of the entire region was 2.372 million.

The climate in the northern, high desert plateau area of the region is characterized by cold snowy winters with only moderate precipitation and hot dry summers. This area depends on adequate snowpack to provide runoff for summer supply. Annual precipitation ranges from 10 to 20 inches. Other mountainous areas in the northern and eastern portions of the region have cold wet winters with large amounts of snow, which typically provide abundant runoff for summer supplies. Annual precipitation ranges from 40 to more than 80 inches. Summers are generally mild in these areas. The Coast Range and southern Klamath Mountains receive copious amounts of precipitation, but most of the runoff flows to the coast in the North Coastal drainage. Sacramento Valley comprises the remainder of the region. At a much lower elevation than the rest of the region, the valley has mild winters with moderate precipitation. Annual precipitation varies from about 35 inches in Redding to about 18 inches in Sacramento. Summers in the valley are hot and dry.

Most of the mountainous portions of the region are heavily forested and sparsely populated. Three major national forests (Mendocino, Trinity, and Shasta) make up the majority of lands in the Coast Range, southern Klamath Mountains, and the southern Cascades; these forests and the region's rivers and lakes provide abundant recreational opportunities. In the few mountain valleys with arable land, alfalfa, grain and pasture are the predominant crops. In the foothill areas of the region, particularly adjacent to urban centers, suburban to rural housing development is occurring along major highway corridors. This development is leading to urban sprawl and is replacing the former agricultural production on those lands. In the Sacramento Valley, agriculture is the largest industry. Truck, field, orchard, and rice crops are grown on approximately 2.1 million acres. Rice represents about 23 percent of the total irrigated acreage.

The Sacramento River HR is the main water supply for much of California's urban and agricultural areas. Annual runoff in the HR averages about 22.4 maf, which is nearly one-third of the State's total natural runoff. Major water supplies in the region are provided through surface storage reservoirs. The two largest surface water projects in the region are USBR's Shasta Lake (Central Valley Project) on the upper Sacramento River and Lake Oroville (DWR's State Water Project) on the Feather River. In all, there are more than 40 major surface water reservoirs in the region. Municipal, industrial, and agricultural supplies to the region are about 8 maf, with groundwater providing about 2.5 maf of that total. Much of the remainder of the runoff goes to dedicated natural flows, which support various environmental requirements, including in-stream fishery flows and flushing flows in the Delta.

Groundwater Development

Groundwater provides about 31 percent of the water supply for urban and agricultural uses in the region, and has been developed in both the alluvial basins and the hard rock uplands and mountains. There are 88 basins/ subbasins delineated in the region. These basins underlie 5.053 million acres (7,900 square miles), about 29 percent of the entire region. The reliability of the groundwater supply varies greatly. The Sacramento Valley is recognized as one of the foremost groundwater basins in the State, and wells developed in the sediments of the valley provide excellent supply to irrigation, municipal, and domestic uses. Many of the mountain valleys of the region also provide significant groundwater supplies to multiple uses.

Geologically, the Sacramento Valley is a large trough filled with sediments having variable permeabilities; as a result, wells developed in areas with coarser aquifer materials will produce larger amounts of water than wells developed in fine aquifer materials. In general, well yields are good and range from one-hundred to several thousand gallons per minute. Because surface water supplies have been so abundant in the valley, groundwater development for agriculture primarily supplement the surface supply. With the changing environmental laws and requirements, this balance is shifting to a greater reliance on groundwater, and conjunctive use of both supplies is occurring to a greater extent throughout the valley, particularly in drought years. Groundwater provides all or a portion of municipal supply in many valley towns and cities. Redding, Anderson, Chico, Marysville, Sacramento, Olivehurst, Wheatland, Willows, and Williams rely to differing degrees on groundwater. Red Bluff, Corning, Woodland, Davis, and Dixon are completely dependent on groundwater. Domestic use of groundwater varies, but in general, rural unincorporated areas rely completely on groundwater.

In the mountain valleys and basins with arable land, groundwater has been developed to supplement surface water supplies. Most of the rivers and streams of the area have adjudicated water rights that go back to the early 1900s, and diversion of surface water has historically supported agriculture. Droughts and increased competition for supply have led to significant development of groundwater for irrigation. In some basins, the fractured volcanic rock underlying the alluvial fill is the major aquifer for the area. In the rural mountain areas of the region, domestic supplies come almost entirely from groundwater. Although a few mountain communities are supplied in part by surface water, most rely on groundwater. These groundwater supplies are generally quite reliable in areas that have sufficient aquifer storage or where surface water replenishes supply throughout the year. In areas that depend on sustained runoff, water levels can be significantly depleted in drought years and many old, shallow wells can be dewatered. During 2001, an extreme drought year on the Modoc Plateau, many well owners experienced problems with water supply.

Groundwater development in the fractured rocks of the foothills of the southern Cascades and Sierra Nevada is fraught with uncertainty. Groundwater supplies from fractured rock sources are highly variable in terms of water quantity and water quality and are an uncertain source for large-scale residential development. Originally, foothill development relied on water supply from springs and river diversions with flumes and ditches for conveyance that date back to gold mining era operations. Current development is primarily based on individual private wells, and as pressures for larger scale development increase, questions about the reliability of supply need to be addressed. Many existing foothill communities have considerable experience with dry or drought year shortages. In Butte County residents in Cohasset, Forest Ranch, and Magalia have had to rely on water brought up the ridges in tanker trucks. The suggested answer has been the development of regional water supply projects. Unfortunately, the area's development pattern of small, geographically dispersed population centers does not lend itself to the kind of financial base necessary to support such projects.

Groundwater Quality

Groundwater quality in the Sacramento River HR is generally excellent. However, there are areas with local groundwater problems. Natural water quality impairments occur at the north end of the Sacramento Valley in the Redding subbasin, and along the margins of the valley and around the Sutter Buttes, where Cretaceous-age marine sedimentary rocks containing brackish to saline water are near the surface. Water from the older underlying sediments mixes with the fresh water in the younger alluvial aquifer and degrades the quality. Wells constructed in these areas typically have high TDS. Other local natural impairments are moderate levels of hydrogen sulfide in groundwater in the volcanic and geothermal areas in the western portion of the region. In the Sierra foothills, there is potential for encountering uranium and radon-bearing rock or sulfide mineral deposits containing heavy metals. Human-induced impairments are generally associated with individual septic system development in shallow unconfined portions of aquifers or in fractured hard rock areas where insufficient soil depths are available to properly leach effluent before it reaches the local groundwater supply.

Water Quality in Public Supply Wells

From 1994 through 2000, 1,356 public supply water wells were sampled in 51 of the 88 basins and subbasins in the Sacramento River HR. Samples analyzed indicate that 1,282 wells, or 95 percent, met the state primary MCLs for drinking water. Seventy-four wells, or 5 percent, have constituents that exceed one or more MCL. Figure 34 shows the percentages of each contaminant group that exceeded MCLs in the 74 wells.

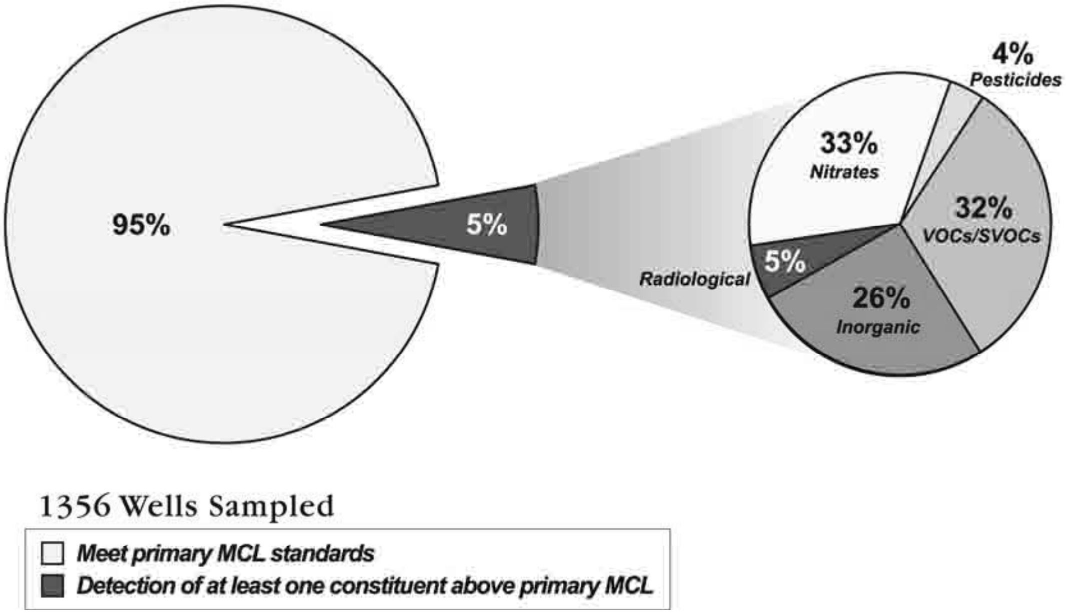

Figure 34 MCL exceedances in public supply wells in the Sacramento River Hydrologic Region

Table 25 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 25 Most frequently occurring contaminants by contaminant group in the Sacramento River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Cadmium – 4	Chromium (Total) – 3	3 tied at 2
Inorganics – Secondary	Manganese – 221	Iron – 166	Specific Conductance – 3
Radiological	Gross Alpha – 4		
Nitrates	Nitrate (as NO_3) – 22	Nitrate + Nitrite – 5	Nitrate Nitrogen (NO_3-N) – 2
Pesticides	Di(2-Ethylhexyl)phthalate – 4		
VOCs/SVOCs	PCE – 11	TCE – 7	Benzene – 4

PCE = Tetrachloroethylene
TCE = Trichloroethylene
VOC = Volatile Organic Compounds
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Some modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report. These are listed in Table 26.

Table 26 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Sacramento River Hydrologic Region

Basin name	New number	Old number
Fandango Valley	5-1.02	5-39
Bucher Swamp Valley	deleted	5-42
Modoc Plateau Recent Volcanic Areas	deleted	5-32
Modoc Plateau Pleistocene Volcanic Areas	deleted	5-33
Mount Shasta Area	deleted	5-34
Sacramento Valley Eastside Tuscan Formation Highlands	deleted	5-55
Clear Lake Pleistocene Volcanics	deleted	5-67

No additional basins were assigned to the Sacramento River HR in this revision. However, four basins have been divided into subbasins. Goose Lake Valley Groundwater Basin (5-1) has been subdivided into two subbasins, Fandango Valley (5-39) was modified to be a subbasin of Goose Lake Valley. Redding Area Groundwater Basin has been subdivided into six subbasins, Sierra Valley Groundwater Basin has been subdivided into two subbasins, and the Sacramento Valley Groundwater Basin has been subdivided into 18 subbasins.

There are several deletions of groundwater basins from Bulletin 118-80. Bucher Swamp Valley Basin (5-42) was deleted due to a thin veneer of alluvium over rock. Modoc Plateau Recent Volcanic Areas (5-32), Modoc Plateau Pleistocene Volcanic Areas (5-33), Mount Shasta Area (5-34), Sacramento Valley Eastside Tuscan Formation Highlands (5-55), and Clear Lake Pleistocene Volcanics (5-67) are volcanic aquifers and were not assigned basin numbers in this bulletin. These are considered to be groundwater source areas as discussed in Chapter 6.

Table 27 Sacramento River Hydrologic Region groundwater data

Basin/Subbasin		Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
					Maximum	Average	Levels	Quality	Title 22	Average	Range
5-1		GOOSE LAKE VALLEY									
	5-1.01	LOWER GOOSE LAKE	36,000	B	-	400	9	9	-	183	68 - 528
	5-1.02	FANDANGO VALLEY	18,500	B	2,000	-	3	-	-	-	-
5-2		ALTURAS AREA								357	180 - 800
	5-2.01	SOUTH FORK PITT RIVER	114,000	B	5,000	1,075	9	-	8	-	-
	5-2.02	WARM SPRINGS VALLEY	68,000	B	400	314	3	-	11	-	-
5-3		JESS VALLEY	6,700	B		3,000	-	-	-	-	-
5-4		BIG VALLEY	92,000	B	4,000	880	19	9	10	260	141 - 633
5-5		FALL RIVER VALLEY	54,800	B	1,500	266	16	7	3	174	115 - 232
5-6		REDDING AREA									
	5-6.01	BOWMAN	85,330	B	2,000	589	8	2	13	-	70 - 247
	5-6.02	ROSEWOOD	45,320	B	-	-	4	-	-	-	118 - 218
	5-6.03	ANDERSON	98,500	B	1,800	46	11	10	69	194	109-320
	5-6.04	ENTERPRISE	60,900	B	700	266	11	3	43	-	160 - 210
	5-6.05	MILLVILLE	67,900	B	500	254	6	5	4	140	-
	5-6.06	SOUTH BATTLE CREEK	32,300	B	-	-	0	0	0	360	-
5-7		LAKE ALMANOR VALLEY	7,150	B	-	-	10	4	4	105	53 - 260
5-8		MOUNTAIN MEADOWS VALLEY	8,150	B	-	-	-	-	-	-	-
5-9		INDIAN VALLEY	29,400	B	-	-	-	4	9	-	-
5-10		AMERICAN VALLEY	6,800	B	40	40		4	11	-	-
5-11		MOHAWK VALLEY	19,000	B	-	500	1	2	15	248	210 - 285
5-12		SIERRA VALLEY									
	5-12.01	SIERRA VALLEY	117,700	B	1,500	640	34	15	9	312	110 - 1,620
	5-12.02	CHILCOOT	7,550	B	-	-	15	-	8	-	-
5-13		UPPER LAKE VALLEY	7,260	B	900	302	12	3	6	-	-
5-14		SCOTTS VALLEY	7,320	B	1,200	171	9	1	9	158	140 - 175
5-15		BIG VALLEY	24,210	B	1,470	475	49	11	7	535	270 - 790
5-16		HIGH VALLEY	2,360	B	100	37	5	2	-	598	480 - 745
5-17		BURNS VALLEY	2,900	B	-	30	1	5	-	335	280 - 455
5-18		COYOTE VALLEY	6,530	B	800	446	6	3	3	288	175 - 390
5-19		COLLAYOMI VALLEY	6,500	B	1,000	121	10	4	3	202	150 - 255
5-20		BERRYESSA VALLEY	1,400	C	-	-	0	-	0	-	-
5-21		SACRAMENTO VALLEY									
	5-21.50	RED BLUFF	266,750	B	1,200	363	30	10	56	207	120 - 500
	5-21.51	CORNING	205,640	B	3,500	977	29	7	30	286	130 - 490
	5-21.52	COLUSA	918,380	B	5,600	984	98	30	134	391	120 - 1,220
	5-21.53	BEND	20,770	B	-	275	0	3	9		334-360
	5-21.54	ANTELOPE	18,710	B	800	575	4	5	22	296	-
	5-21.55	DYE CREEK	27,730	B	3,300	890	8	1	3	240	159 - 396
	5-21.56	LOS MOLINOS	33,170	B	1,000	500	3	3	9	217	
	5-21.57	VINA	125,640	B	3,850	1,212	23	5	69	285	48 - 543
	5-21.58	WEST BUTTE	181,600	B	4,000	1,833	32	8	36	293	130 - 676

Table 27 Sacramento River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-21.59	EAST BUTTE	265,390	B	4,500	1,019	43	4	44	235	122 - 570
5-21.60	NORTH YUBA	100,400	C	4,000	-	21	-	32	-	-
5-21.61	SOUTH YUBA	107,000	C	4,000	1,650	56	-	6	-	-
5-21.62	SUTTER	234,000	C	-	-	34	-	115	-	-
5-21.64	NORTH AMERICAN	351,000	A	-	800	121	-	339	300	150 - 1,000
5-21.65	SOUTH AMERICAN	248,000	C	-	-	105	-	247	221	24-581
5-21.66	SOLANO	425,000	C	-	-	123	23	136	427	150 - 880
5-21.67	YOLO	226,000	B	4,000+	1,000	127	20	185	880	480 - 2,060
5-21.68	CAPAY VALLEY	25,000	C	-	-	11	-	3	-	-
5-30	LOWER LAKE VALLEY	2,400	B	100	37		3	5	568	290 - 1,230
5-31	LONG VALLEY	2,600	B	100	63	-	-	-	-	-
5-35	MCCLOUD AREA	21,320	B	-	380	-	-	1	-	-
5-36	ROUND VALLEY	7,270	B	2,000	800	2				148 - 633
5-37	TOAD WELL AREA	3,360	B	-	-	-	-	-	-	-
5-38	PONDOSA TOWN AREA	2,080	B	-	-	-	-	-	-	-
5-40	HOT SPRINGS VALLEY	2,400	B	-	-	-	-	-	-	-
5-41	EGG LAKE VALLEY	4,100	B	-	20	-	-	-	-	-
5-43	ROCK PRAIRIE VALLEY	5,740	B	-	-	-	-	-	-	-
5-44	LONG VALLEY	1,090	B	-	-	-	-	-	-	-
5-45	CAYTON VALLEY	1,300	B	-	400	-	-	-	-	-
5-46	LAKE BRITTON AREA	14,060	B	-	-	-	-	2	-	-
5-47	GOOSE VALLEY	4,210	B	-	-	-	-	-	-	-
5-48	BURNEY CREEK VALLEY	2,350	B	-	-	-	-	2	-	-
5-49	DRY BURNEY CREEK VALLEY	3,070	B	-	-	-	-	-	-	-
5-50	NORTH FORK BATTLE CREEK VALLEY	12,760	B	-	-	-	-	3	-	-
5-51	BUTTE CREEK VALLEY	3,230	B	-	-	-	-	-	-	-
5-52	GRAYS VALLEY	5,440	B	-	-	-	-	-	-	-
5-53	DIXIE VALLEY	4,870	B	-	-	-	-	-	-	-
5-54	ASH VALLEY	6,010	B	3,000	2,200	-	-	-	-	-
5-56	YELLOW CREEK VALLEY	2,310	B	-	-	-	-	-	-	-
5-57	LAST CHANCE CREEK VALLEY	4,660	B	-	-	-	-	-	-	-
5-58	CLOVER VALLEY	16,780	B	-	-	-	-	-	-	-
5-59	GRIZZLY VALLEY	13,400	B	-	-	-	-	1	-	-
5-60	HUMBUG VALLEY	9,980	B	-	-	-	-	8	-	-
5-61	CHROME TOWN AREA	1,410	B	-	-	-	-	-	-	-
5-62	ELK CREEK AREA	1,440	B	-	-	-	-	-	-	-
5-63	STONYFORD TOWN AREA	6,440	B	-	-	-	-	-	-	-
5-64	BEAR VALLEY	9,100	B	-	-	-	-	-	-	-
5-65	LITTLE INDIAN VALLEY	1,270	B	-	-	-	-	-	-	-
5-66	CLEAR LAKE CACHE FORMATION	30,000	B	245	52		-	4	-	-
5-68	POPE VALLEY	7,180	C	-	-	-	-	1	-	-
5-86	JOSEPH CREEK	4,450	B	-	-	-	-	-	-	-

Table 27 Sacramento River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-87	MIDDLE FORK FEATHER RIVER	4,340	B	-	-	-	-	2	-	-
5-88	STONY GORGE RESERVOIR	1,070	B	-	-	-	-	-	-	-
5-89	SQUAW FLAT	1,300	C	-	-	-	-	-	-	-
5-90	FUNKS CREEK	3,000	C	-	-	-	-	-	-	-
5-91	ANTELOPE CREEK	2,040	B	-	-	-	-	-	-	-
5-92	BLANCHARD VALLEY	2,200	B	-	-	-	-	-	-	-
5-93	NORTH FORK CACHE CREEK	3,470	C	-	-	-	-	-	-	-
5-94	MIDDLE CREEK	700	B	-	75	-	-	1	-	-
5-95	MEADOW VALLEY	5,730	B	-	-	-	-	1	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

San Joaquin River Hydrologic Region

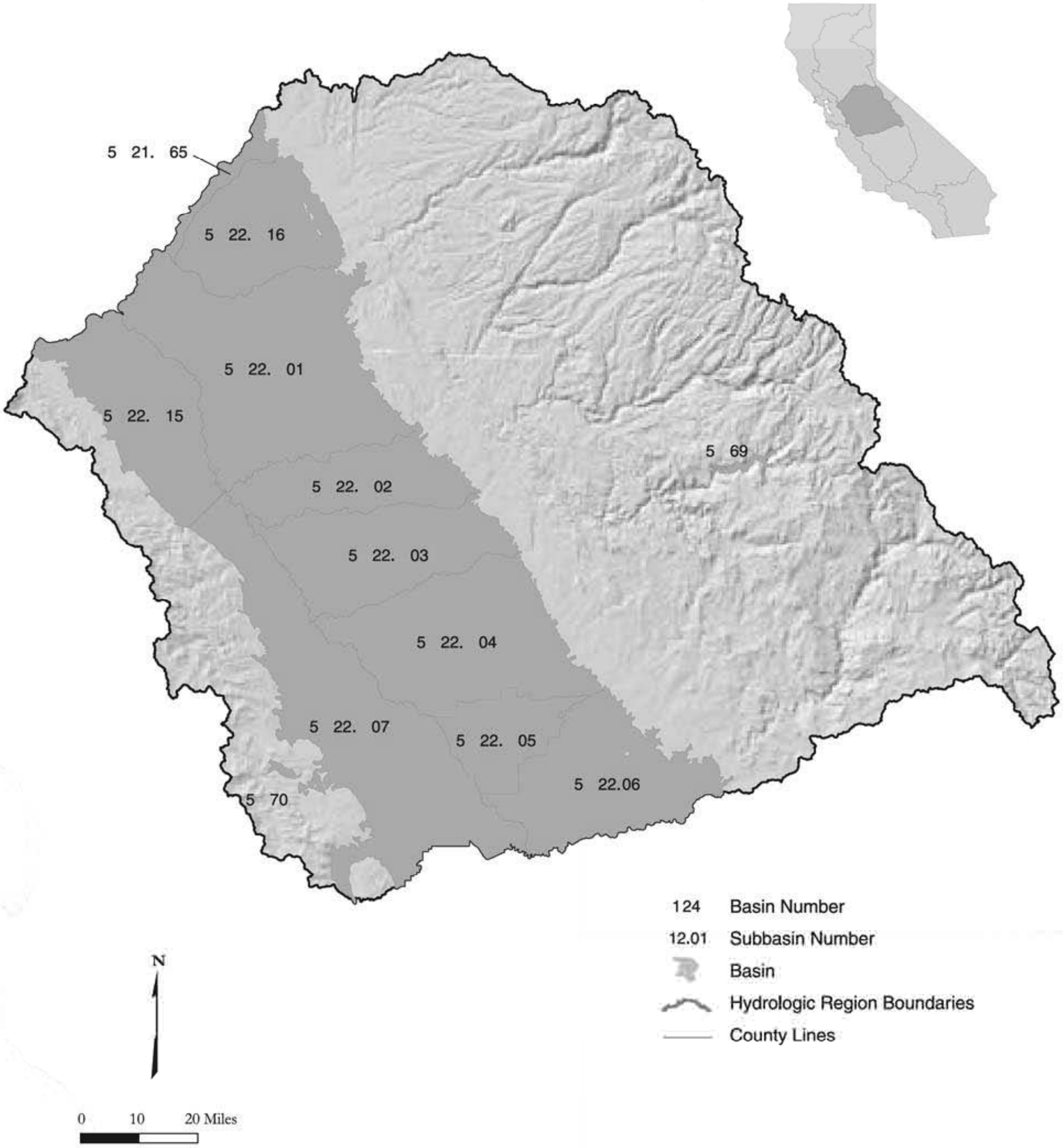

Figure 35 San Joaquin River Hydrologic Region

Basins and Subbasins of the San Joaquin River Hydrologic Region

Basin/subbasin	Basin name
5-22	San Joaquin Valley
5-22.01	Eastern San Joaquin
5-22.02	Modesto
5-22.03	Turlock
5-22.04	Merced
5-22.05	Chowchilla
5-22.06	Madera
5-22.07	Delta-Mendota
5-22.15	Tracy
5-22.16	Cosumnes
5-69	Yosemite Valley
5-70	Los Banos Creek Valley

Description of the Region

The San Joaquin River HR covers approximately 9.7 million acres (15,200 square miles) and includes all of Calaveras, Tuolumne, Mariposa, Madera, San Joaquin, and Stanislaus counties, most of Merced and Amador counties, and parts of Alpine, Fresno, Alameda, Contra Costa, Sacramento, El Dorado, and San Benito counties (Figure 35). The region corresponds to a portion near the middle of RWQCB 5. Significant geographic features include the northern half of the San Joaquin Valley, the southern part of the Sacramento-San Joaquin Delta, the Sierra Nevada and Diablo Range. The region is home to about 1.6 million people (DWR 1998). Major population centers include Merced, Modesto, and Stockton. The Merced area is entirely dependent on groundwater for its supply, as will be the new University of California at Merced campus.

Groundwater Development

The region contains two entire groundwater basins and part of the San Joaquin Valley Groundwater Basin, which continues south into the Tulare Lake HR. The San Joaquin Valley Groundwater Basin is divided into nine subbasins in this region. The basins underlie 3.73 million acres (5,830 square miles) or about 38 percent of the entire HR area.

The region is heavily groundwater reliant. Within the region groundwater accounts for about 30 percent of the annual supply used for agricultural and urban purposes. Groundwater use in the region accounts for about 18 percent of statewide groundwater use for agricultural and urban needs. Groundwater use in the region accounts for 5 percent of the State's overall supply from all sources for agricultural and urban uses (DWR 1998).

The aquifers are generally quite thick in the San Joaquin Valley subbasins, with groundwater wells commonly extending to depths of up to 800 feet. Aquifers include unconsolidated alluvium and consolidated rocks with unconfined and confined groundwater conditions. Typical well yields in the San Joaquin Valley range from 300 to 2,000 gpm with yields of 5,000 gpm possible. The region's only significant basin located outside of San Joaquin Valley is Yosemite Valley. Yosemite Valley Basin supplies water to Yosemite National Park and has substantial well yields.

Conjunctive Use

Since near the beginning of the region's agricultural development, groundwater has been used conjunctively with surface water to meet water needs. Groundwater was and is used when and where surface water is unable to fully meet demands either in time or area. For several decades, this situation was more of an incidental conjunctive use than a formal one. Historical groundwater use has resulted in some land subsidence in the southwest portion of the region.

Groundwater Quality

In general, groundwater quality throughout the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are TDS, nitrate, boron, chloride, and organic compounds. The Yosemite Valley Groundwater Basin has exceptionally high quality groundwater.

Areas of high TDS content are primarily along the west side of the San Joaquin Valley and in the trough of the valley. The high TDS content of west-side groundwater is due to recharge of streamflow originating from marine sediments in the Coast Range. High TDS content in the trough of the valley is the result of concentration of salts due to evaporation and poor drainage. Nitrates may occur naturally or as a result of disposal of human and animal waste products and fertilizer. Boron and chloride are likely a result of concentration from evaporation near the valley trough. Organic contaminants can be broken into two categories, agricultural and industrial. Agricultural pesticides and herbicides have been detected in groundwater throughout the region, but primarily along the east side of the San Joaquin Valley where soil permeability is higher and depth to groundwater is shallower. The most notable agricultural contaminant is dibromochloropropane (DBCP), a now-banned soil fumigant and known carcinogen once used extensively on grapes and cotton. Industrial organic contaminants include TCE, dichloroethylene (DCE), and other solvents. They are found in groundwater near airports, industrial areas, and landfills.

Water Quality in Public Supply Wells

From 1994 through 2000, 689 public supply water wells were sampled in 10 of the 11 basins and subbasins in the San Joaquin River HR. Samples analyzed indicate that 523 wells, or 76 percent, met the state primary MCLs for drinking water. One-hundred-sixty-six wells, or 24 percent, have constituents that exceed one or more MCL. Figure 36 shows the percentages of each contaminant group that exceeded MCLs in the 166 wells.

Table 28 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Changes from Bulletin 118-80

The subbasins of the San Joaquin Valley, which were delineated as part of the 118-80 update, are given their first numeric designation in this report. Additionally, the Cosumnes Subbasin has been added to the subbasins within the San Joaquin River HR. It is worth noting that the southern portion of the South American Subbasin of the Sacramento Valley Groundwater Basin is also included as part of this HR. The subbasin names and numbers within the region are listed in Table 29.

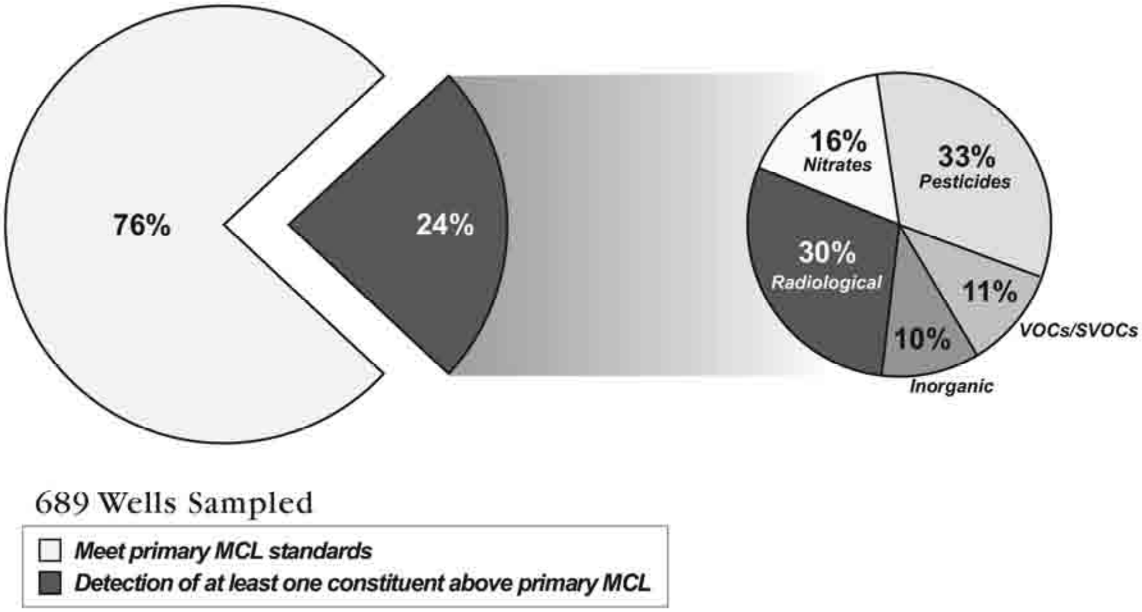

Figure 36 MCL exceedances in public supply wells in the San Joaquin River Hydrologic Region

Table 28 Most frequently occurring contaminants by contaminant group in the San Joaquin River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Aluminum – 4	Arsenic – 4	4 tied at 2 exceedances
Inorganics – Secondary	Manganese – 123	Iron – 102	TDS – 9
Radiological	Uranium – 33	Gross Alpha – 26	Radium 228 – 6
Nitrates	Nitrate (as NO_3) – 23	Nitrate + Nitrite – 6	Nitrate Nitrogen (NO_3-N) – 3
Pesticides	DBCP – 44	Di(2-Ethylhexyl)phthalate – 11	EDB – 6
VOCs	PCE – 8	Dichloromethane – 3	TCE – 3

DBCP = Dibromochloropropane
EDB = Ethylenedibromide
PCE = Tetrachloroethylene
TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Table 29 Modifications since Bulletin 118-80 of groundwater basins and subbasins in San Joaquin Hydrologic Region

Subbasin name	New number	Old number
Eastern San Joaquin	5-22.01	5-22
Modesto	5-22.02	5-22
Turlock	5-22.03	5-22
Merced	5-22.04	5-22
Chowchilla	5-22.05	5-22
Madera	5-22.06	5-22
Delta-Mendota	5-22.07	5-22
Tracy	5-22.15	5-22
Cosumnes	5-22.16	5-22

Table 30 San Joaquin River Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-22	SAN JOAQUIN VALLEY									
5-22.01	EASTERN SAN JOAQUIN	707,000	A	1,500	-	345	69	540	310	30 - 1,632
5-22.02	MODESTO	247,000	B	4,500	1000-2000	230	15	209	60-500	200-8300
5-22.03	TURLOCK	347,000	B	4,500	1000-2000	307	0	163	200-500	100-8300
5-22.04	MERCED	491,000	B	4,450	1500-1900	378	0	142	200-400	100-3600
5-22.05	CHOWCHILLA	159,000	B	4,750	750-2000	203	0	28	200-500	120-6400
5-22.06	MADERA	394,000	B	4,750	750-2000	378	0	127	200-400	100-6400
5-22.07	DELTA-MENDOTA	747,000	B	5,000	800-2000	816	0	120	770	210-86,000
5-22.15	TRACY	345,000	C	3,000	500-3,000	18	14	183	1,190	210-7,800
5-22.16	COSUMNES	281,000	A	1,500	-	75	13	72	218	140-438
5-69	YOSEMITE VALLEY	7,500	C	1,200	900	0	0	3	54	43-73
5-70	LOS BANOS CREEK VALLEY	4,840	C	-	-	0	0	0	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Tulare Lake Hydrologic Region

Figure 37 Tulare Lake Hydrologic Region

Basins and Subbasins of Tulare Lake Hydrologic Region

Basin/subbasin	Basin name
5-22	San Joaquin Valley
5-22.08	Kings
5-22.09	Westside
5-22.10	Pleasant Valley
5-22.11	Kaweah
5-22.12	Tulare Lake
5-22.13	Tule
5-22.14	Kern County
5-23	Panoche Valley
5-25	Kern River Valley
5-26	Walker Basin Creek Valley
5-27	Cummings Valley
5-28	Tehachapi Valley West
5-29	Castaic Lake Valley
5-71	Vallecitos Creek Valley
5-80	Brite Valley
5-82	Cuddy Canyon Valley
5-83	Cuddy Ranch Area
5-84	Cuddy Valley
5-85	Mil Potrero Area

Description of the Region

The Tulare Lake HR covers approximately 10.9 million acres (17,000 square miles) and includes all of Kings and Tulare counties and most of Fresno and Kern counties (Figure 37). The region corresponds to approximately the southern one-third of RWQCB 5. Significant geographic features include the southern half of the San Joaquin Valley, the Temblor Range to the west, the Tehachapi Mountains to the south, and the southern Sierra Nevada to the east. The region is home to more than 1.7 million people as of 1995 (DWR, 1998). Major population centers include Fresno, Bakersfield, and Visalia. The cities of Fresno and Visalia are entirely dependent on groundwater for their supply, with Fresno being the second largest city in the United States reliant solely on groundwater.

Groundwater Development

The region has 12 distinct groundwater basins and 7 subbasins of the San Joaquin Valley Groundwater Basin, which crosses north into the San Joaquin River HR. These basins underlie approximately 5.33 million acres (8,330 square miles) or 49 percent of the entire HR area.

Groundwater has historically been important to both urban and agricultural uses, accounting for 41 percent of the region's total annual supply and 35 percent of all groundwater use in the State. Groundwater use in the region represents about 10 percent of the State's overall supply for agricultural and urban uses (DWR 1998).

The aquifers are generally quite thick in the San Joaquin Valley subbasins with groundwater wells commonly exceeding 1,000 feet in depth. The maximum thickness of freshwater-bearing deposits (4,400 feet) occurs at the southern end of the San Joaquin Valley. Typical well yields in the San Joaquin Valley range from 300 gpm to 2,000 gpm with yields of 4,000 gpm possible. The smaller basins in the mountains surrounding the San Joaquin Valley have thinner aquifers and generally lower well yields averaging less than 500 gpm.

The cities of Fresno, Bakersfield, and Visalia have groundwater recharge programs to ensure that groundwater will continue to be a viable water supply in the future. Extensive groundwater recharge programs are also in place in the south valley where water districts have recharged several million acre-feet for future use and transfer through water banking programs.

The extensive use of groundwater in the San Joaquin Valley has historically caused subsidence of the land surface primarily along the west side and south end of the valley.

Groundwater Quality

In general, groundwater quality throughout the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high TDS, nitrate, arsenic, and organic compounds.

The areas of high TDS content are primarily along the west side of the San Joaquin Valley and in the trough of the valley. High TDS content of west-side water is due to recharge of stream flow originating from marine sediments in the Coast Range. High TDS content in the trough of the valley is the result of concentration of salts because of evaporation and poor drainage. In the central and west-side portions of the valley, where the Corcoran Clay confining layer exists, water quality is generally better beneath the clay than above it. Nitrates may occur naturally or as a result of disposal of human and animal waste products and fertilizer. Areas of high nitrate concentrations are known to exist near the town of Shafter and other isolated areas in the San Joaquin Valley. High levels of arsenic occur locally and appear to be associated with lakebed areas. Elevated arsenic levels have been reported in the Tulare Lake, Kern Lake and Buena Vista Lake bed areas. Organic contaminants can be broken into two categories, agricultural and industrial. Agricultural pesticides and herbicides have been detected throughout the valley, but primarily along the east side where soil permeability is higher and depth to groundwater is shallower. The most notable agricultural contaminant is DBCP, a now-banned soil fumigant and known carcinogen once used extensively on grapes. Industrial organic contaminants include TCE, DCE, and other solvents. They are found in groundwater near airports, industrial areas, and landfills.

Water Quality in Public Supply Wells

From 1994 through 2000, 1,476 public supply water wells were sampled in 14 of the 19 groundwater basins and subbasins in the Tulare Lake HR. Evaluation of analyzed samples shows that 1,049 of the wells, or 71 percent, met the state primary MCLs for drinking water. Four-hundred-twenty-seven wells, or 29 percent, exceeded one or more MCL. Figure 38 shows the percentages of each contaminant group that exceeded MCLs in the 427 wells.

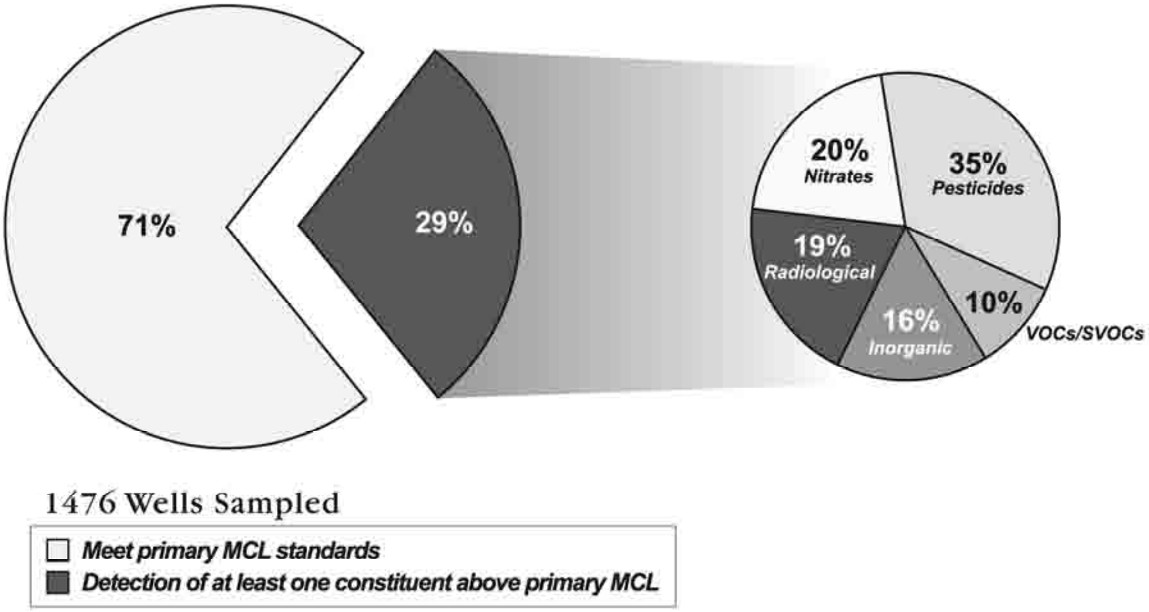

Figure 38 MCL exceedances by contaminant group in public supply wells in the Tulare Lake Hydrologic Region

Table 31 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 31 Most frequently occurring contaminants by contaminant group in the Tulare Lake Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics - Primary	Fluoride – 32	Arsenic – 16	Aluminum – 13
Inorganics - Secondary	Iron – 155	Manganese – 82	TDS – 9
Radiological	Gross Alpha – 74	Uranium – 24	Radium 228 – 8
Nitrates	Nitrate(as NO_3) – 83	Nitrate + Nitrite – 14	Nitrite(as N) – 3
Pesticides	DBCP – 130	EDB – 24	Di(2-Ethylhexyl)phthalate – 7
VOCs/SVOCs	TCE – 17	PCE – 16	Benzene – 6 MTBE – 6

DBCP = Dibromochloropropane
EDB = Ethylenedibromide
TCE = Trichloroethylene
PCE = Tetrachloroehylene
VOC = Volatile organic compound
SVOC = Semivolatile organic compound

Changes from Bulletin 118-80

There are no newly defined basins since Bulletin 118-80. However, the subbasins of the San Joaquin Valley, which were delineated as part of the 118-80 update, are given their first numeric designation in this report (Table 32).

Table 32 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Tulare Lake Hydrologic Region

Subbasin name	New number	Old number
Kings	5-22.08	5-22
Westside	5-22.09	5-22
Pleasant Valley	5-22.10	5-22
Kaweah	5-22.11	5-22
Tulare Lake	5-22.12	5-22
Tule	5-22.13	5-22
Kern County	5-22.14	5-22
Squaw Valley	deleted	5-24
Cedar Grove Area	deleted	5-72
Three Rivers Area	deleted	5-73
Springville Area	deleted	5-74
Templeton Mountain Area	deleted	5-75
Manache Meadow Area	deleted	5-76
Sacator Canyon Valley	deleted	5-77
Rockhouse Meadows Valley	deleted	5-78
Inns Valley	deleted	5-79
Bear Valley	deleted	5-81

Several basins have been deleted from the Bulletin 118-80 report. In Squaw Valley (5-24) all 118 wells are completed in hard rock. Cedar Grove Area (5-72) is a narrow river valley in Kings Canyon National Park with no wells. Three Rivers Area (5-73) has a thin alluvial terrace deposit but 128 of 130 wells are completed in hard rock. Springville Area (5-74) is this strip of alluvium adjacent to Tule River and all wells are completed in hard rock. Templeton Mountain Area (5-75), Manache Meadow Area (5-76), and Sacator Canyon Valley (5-77) are all at the crest of mountains with no wells. Rockhouse Meadows Valley (5-78) is in wilderness with no wells. Inns Valley (5-79) and Bear Valley (5-81) both have all wells completed in hard rock.

Table 33 Tulare Lake Hydrologic Region groundwater data

				Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Maximum	Average	Levels	Quality	Title 22	Average	Range
5-22	SAN JOAQUIN VALLEY									
5-22.08	KINGS	976,000	C	3,000	500-1,500	909	-	722	200-700	40-2000
5-22.09	WESTSIDE	640,000	C	2,000	1,100	960	-	50	520	220-35,000
5-22.10	PLEASANT VALLEY	146,000	B	3,300	-	151	-	2	1,500	1000-3000
5-22.11	KAWEAH	446,000	B	2,500	1,000-2,000	568	-	270	189	35-580
5-22.12	TULARE LAKE	524,000	B	3,000	300-1,000	241	-	86	200-600	200-40,000
5-22.13	TULE	467,000	B	3,000	-	459	-	150	256	200-30,000
5-22.14	KERN COUNTY	1,950,000	A	4,000	1,200-1,500	2,258	249	476	400-450	150-5000
5-23	PANOCHE VALLEY	33,100	C	-	-	48	-	-	1,300	394-3530
5-25	KERN RIVER VALLEY	74,000	C	3,650	350	-	-	92	378	253-480
5-26	WALKER BASIN CREEK VALLEY	7,670	C	650	-	-	-	1	-	-
5-27	CUMMINGS VALLEY	10,000	A	150	56	51	-	15	344	-
5-28	TEHACHAPI VALLEY WEST	14,800	A	1,500	454	64	-	19	315	280-365
5-29	CASTAC LAKE VALLEY	3,600	C	400	375	-	-	3	583	570-605
5-71	VALLECITOS CREEK VALLEY	15,100	C	-	-	-	-	0	-	-
5-80	BRITE VALLEY	3,170	A	500	50	-	-	-	-	-
5-82	CUDDY CANYON VALLEY	3,300	C	500	400	-	-	3	693	695
5-83	CUDDY RANCH AREA	4,200	C	300	180	-	-	4	550	480-645
5-84	CUDDY VALLEY	3,500	A	160	135	3	-	3	407	325-645
5-85	MIL POTRERO AREA	2,300	C	3,200	240	7	-	7	460	372-657

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

North Lahontan Hydrologic Region

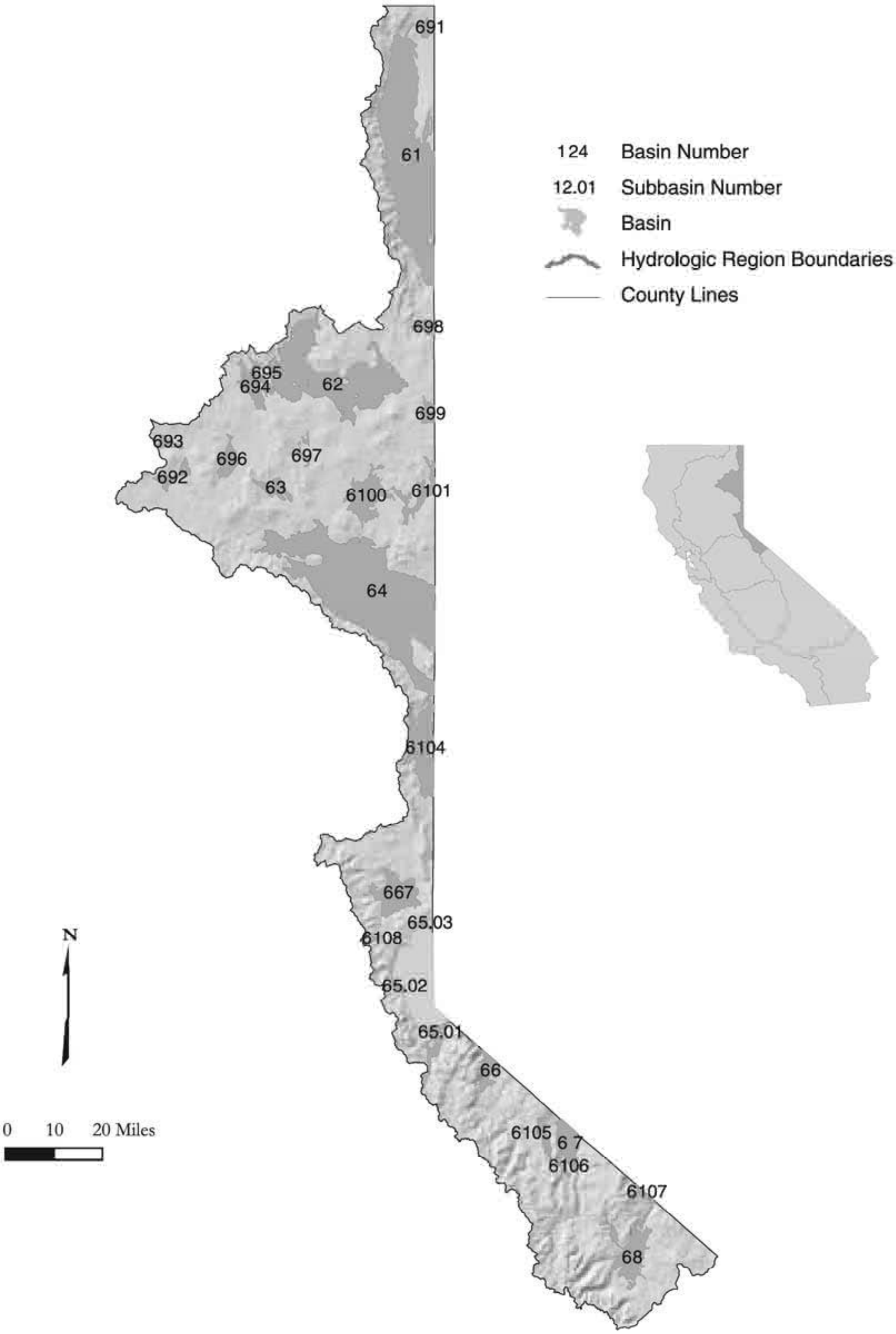

Figure 39 North Lahontan Hydrologic Region

Basins and Subbasins of the North Lahontan Hydrologic Region

Basin/subbasin	Basin name
6-1	Surprise Valley
6-2	Madeline Plains
6-3	Willow Creek Valley
6-4	Honey Lake Valley
6-5	Tahoe Valley
6-5.01	Tahoe Valley South
6-5.02	Tahoe Valley West
6-5.03	Tahoe Valley North
6-6	Carson Valley
6-7	Antelope Valley
6-8	Bridgeport Valley
6-67	Martis (Truckee) Valley
6-91	Cow Head Lake Valley
6-92	Pine Creek Valley
6-93	Harvey Valley
6-94	Grasshopper Valley
6-95	Dry Valley
6-96	Eagle Lake Area
6-97	Horse Lake Valley
6-98	Tuledad Canyon
6-99	Painters Flat
6-100	Secret Valley
6-101	Bull Flat
6-104	Long Valley
6-105	Slinkard Valley
6-106	Little Antelope Valley
6-107	Sweetwater Flat
6-108	Olympic Valley

Description of the Region

The North Lahonton HR covers approximately 3.91 million acres (6,110 square miles) and includes portions of Modoc, Lassen, Sierra, Nevada, Placer, El Dorado, Alpine, Mono, and Tuolumne counties (Figure 39). Reaching south from the Oregon border almost to Mono Lake on the east side of the Sierra, this region encompasses portions of two geomorphic provinces. From Long Valley north, most of the groundwater basins of the region were formed by basin and range block faulting near the western extent of the province. South from Long Valley, most of the basins are in the alpine valleys of the Sierra Nevada or are at the foot of the Sierra along the California-Nevada border where streams and rivers draining the eastern Sierran slopes terminate in desert sinks or lakes. The region corresponds to approximately the northern half of RWQCB 6. Significant geographic features include the Sierra Nevada, the volcanic terrane of the Modoc Plateau, Honey Lake Valley, and Lake Tahoe. The latter two areas are the major population centers in the region. The 1995 population of the entire region was about 84,000 people (DWR, 1998).

The northern portion of the region is rural and sparsely populated. Cattle ranching and associated hay cropping are the predominant land uses in addition to some pasture irrigation. Less than 4 percent of the entire region is irrigated. About 75 percent of the irrigated lands are in Modoc and Lassen counties, and most of the remainder is in Alpine and Mono counties. Much of the southern portion of the region is federally owned and managed as national forest lands where tourism and recreation constitute much of the economic base.

Much of the North Lahontan HR is chronically short of water due to the arid, high desert climate, which predominates in the region. Throughout the northern portion of the region where annual precipitation can be as low as 4 inches, runoff is typically scant and streamflows decrease rapidly during the irrigation season as the snowpack in the higher elevations melts. In the southern portion of the region, annual precipitation ranges from more than 70 inches (mostly snow in the higher elevations of the mountains) to as little as 8 inches in the low elevation valleys. In wet years, surface water can meet much of the agricultural demand, but in dry years, most of the region relies heavily on groundwater to meet water supply needs.

Groundwater Development

There are 24 groundwater basins in the region, one of which is divided into three subbasins. Thirteen of these basins are shared with Nevada and one with Oregon. These basins underlie approximately 1.03 million acres (1,610 square miles) or about 26 percent of the entire region. Although the groundwater basins were delineated based on mapped alluvial fill, much of the groundwater produced in many of them actually comes from underlying fractured rock aquifers. This is particularly true in the volcanic areas of Modoc and Lassen counties where, in many basins, volcanic flows are interstratified with lake sediments and alluvium. Wells constructed in the volcanics commonly produce large amounts of groundwater, whereas wells constructed in fine-grained lake deposits produce less. Because the thickness and lateral extent the of the hard rocks outside of the defined basin are generally not known, actual groundwater in storage in these areas is unknown.

Locally, groundwater is an important resource accounting for about 28 percent of the annual supply for agricultural and urban uses. Groundwater use in the region represents less than 1 percent of the State's overall supply for agricultural and urban uses (DWR 1998).

In the northern portion of the region, a sizable quantity of groundwater (nearly 130,000 acre-feet) is extracted annually for agricultural and municipal purposes. Groundwater extracted from the Honey Lake Valley Basin accounts for 41,900 acre-feet of the agricultural supply and 12,000 acre-feet of the municipal supply (based on normalized data from 1990). An additional 3,100 acre-feet is extracted to meet the demands of the Honey Lake Wildlife Area, which provides habitat for several threatened species (Bald Eagle, Sandhill Crane, Bank Swallow, and Peregrine Falcon).

Well yields in the Honey Lake Valley Basin are greatest in alluvial and volcanic deposits. Wells drawing from these deposits may have yields that vary from 10 gpm to more than 2,000 gpm, but drawdown in these cases is generally high. Eight wells in the Honey Lake Wildlife Area have an average yield of between 1,260 and 2,100 gpm. Depths of completed wells in the region range from 20 to 720 feet.

The Honey Lake Valley Basin is very close to exceeding prudent perennial yield, and future development could come at the expense of water for agriculture. A 1987 agreement between DWR, the state of Nevada, and the U.S. Geological Survey resulted in a study of the groundwater flow system in eastern Honey Lake Valley. Upon conclusion of the study in September 1990, a Nevada state engineer ruled that only about 13,000 acre-feet could be safely transferred from the basin.

No major changes in water use are anticipated in the near future in the northern portion of the region. Irrigated agriculture is already constrained by economically available water supplies. A small amount of agricultural expansion is expected but only in areas that can support minor additional groundwater development. Likewise, the modest need for additional municipal and irrigation supplies can be met by minor expansion of present surface systems or by increased use of groundwater.

The principal drainages in the southern portion of the region are the Truckee, Walker and Carson rivers. Water rights in these drainages historically have been heavily contested, and allocations are limited by interstate agreements with Nevada, in-stream environmental requirements, and miscellaneous private rights holders. In the Lake Tahoe Basin, further development is strictly limited because of concerns regarding water quality in the lake. Surface water storage developed in the region's drainages provides urban and agricultural supply to the Reno/Sparks area and to the many smaller communities in the eastern Sierra and at the foot of the mountain slopes. Most communities rely on a combination of surface water and groundwater supply.

In the upper Truckee drainage, the primary groundwater basins underlie the areas around Lake Tahoe and Martis Valley, where the Town of Truckee is located. Both areas use surface water and groundwater for urban and surrounding rural domestic supplies.

Little is known about the small groundwater basins developed along the foot of the eastern Sierra. Most communities overlying these basins are along the streams and rivers flowing down the mountains, and groundwater is extracted from the underlying alluvium. Groundwater augments surface supplies for agricultural purposes and supports municipal and rural domestic supplies.

Groundwater Quality

In basins in the northern portion of the region, groundwater quality ranges widely from excellent to poor. Wells that obtain their water supply from lake deposits can have high concentrations of boron, arsenic, fluoride, nitrate, and TDS. TDS content generally increases toward the central portions of these basins where concentrations have accumulated over time. The groundwater quality along the margins of most of these basins tends to be of much better quality. There is a potential for future groundwater pollution occurring in urban/suburban areas where single-family septic systems have been installed, especially in hard rock areas. Groundwater quality in the alpine basins is good to excellent; but, as in any area where single-family septic systems have been installed, there is potential for degradation of groundwater quality.

Water Quality in Public Supply Wells

From 1994 through 2000, 169 public supply water wells were sampled in 8 of the 26 basins and subbasins in the North Lahontan HR. Evaluation of the analyzed samples indicates that 147 wells, or 87 percent, met the state primary MCLs for drinking water. Twenty-two wells, or 13 percent, have constituents that exceed one or more MCL. Figure 40 shows the percentages of each contaminant group that exceeded MCLs in the 22 wells.

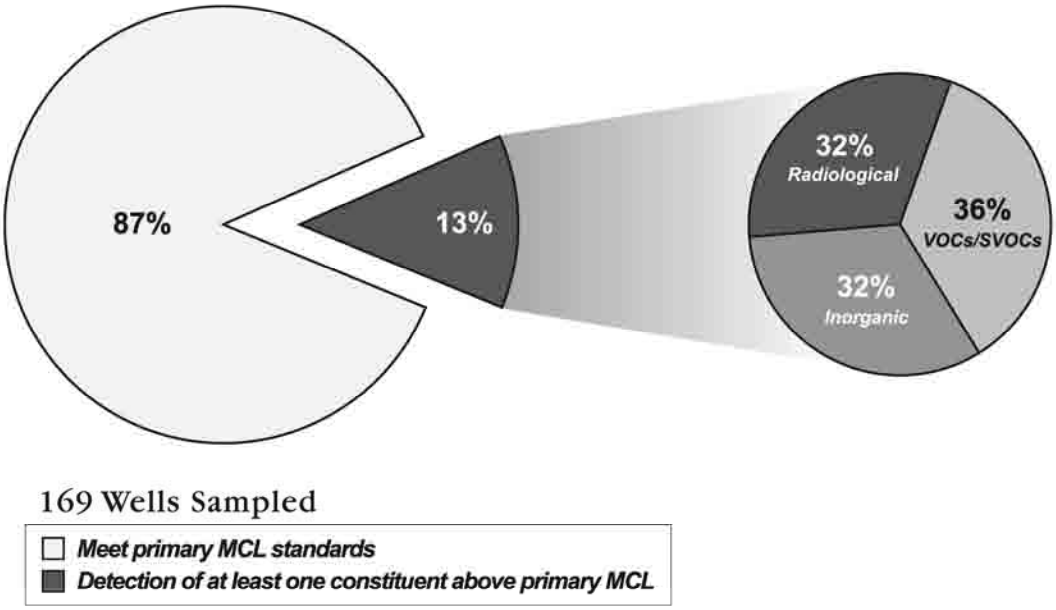

Figure 40 MCL exceedances in public supply wells in the North Lahontan Hydrologic Region

Table 34 lists the three most frequently occurring contaminants in each contaminant group and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 34 Most frequently occurring contaminants by contaminant group in the North Lahontan Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 3	Thallium – 3	3 tied at 1 exceedance
Inorganics – Secondary	Iron – 14	Manganese – 13	TDS – 1
Radiological	Gross Alpha – 7	Uranium – 5	Radium 226 – 1
VOCs/SVOCs	1,2 Dichloroethane – 8	TCE – 2	MTBE – 1

TCE = Trichloroethylene
MTBE = Methyltertiarybutylether
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

There are no newly defined basins since Bulletin 118-80. The only delineated areas removed from the list of region basins are the Recent and Pleistocene volcanic areas of the Modoc Plateau, previously numbered 6-102 and 6-103, respectively.

Table 35 North Lahontan Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
6-1	SURPRISE VALLEY	228,000	B	2,500	1,383	16	11	4	224	87 - 1,800
6-2	MADELINE PLAINS	156,150	B	-	450	2	6	-	402	81 - 1,790
6-3	WILLOW CREEK VALLEY	11,700	B	-	-	7	4	-	401	90 - 1,200
6-4	HONEY LAKE VALLEY	311,150	B	2,500	784	39	24	49	518	89 - 2,500
6-5	TAHOE VALLEY									
6-5.01	TAHOE SOUTH	14,800	C	4,000	-	6	-	54	-	59 - 206
6-5.02	TAHOE WEST	6,000	C	-	-	-	9	3	103	68 - 128
6-5.03	TAHOE VALLEY NORTH	2,000	C	900	-	-	-	-	141	-
6-6	CARSON VALLEY	10,700	C	-	-	-	-	-	-	-
6-7	ANTELOPE VALLEY	20,100	A	-	-	-	-	12	-	-
6-8	BRIDGEPORT VALLEY	32,500	C	-	-	-	-	6	-	-
6-67	MARTIS VALLEY	35,600	C	-	-	-	-	-	-	-
6-91	COW HEAD LAKE VALLEY	5,600	B	-	-	-	-	-	-	-
6-92	PINE CREEK VALLEY	9,530	B	-	-	-	-	1	-	-
6-93	HARVEY VALLEY	4,500	B	-	-	-	-	-	-	-
6-94	GRASSHOPPER VALLEY	17,670	B	-	-	-	-	-	-	-
6-95	DRY VALLEY	6,500	B	-	-	-	-	-	-	-
6-96	EAGLE LAKE AREA	-	B	-	-	-	4	4	-	-
6-97	HORSE LAKE VALLEY	3,800	B	-	-	-	-	-	-	-
6-98	TULEDAD CANYON	5,200	B	-	-	-	-	-	-	-
6-99	PAINTERS FLAT	6,400	B	-	-	-	-	-	-	-
6-100	SECRET VALLEY	33,680	B	-	-	2	2	-	-	125 - 3,200
6-101	BULL FLAT	18,100	B	-	-	-	-	-	-	-
6-104	LONG VALLEY	46,840	B	-	-	31	4		302	127 - 570
6-105	SLINKARD VALLEY	4,500	C	-	-	-	-	-	-	-
6-106	LITTLE ANTELOPE VALLEY	2,500	C	-	-	-	-	-	-	-
6-107	SWEETWATER FLAT	4,700	C	-	-	-	-	-	-	-
6-108	OLYMPIC VALLEY	700	C	600	330	-	-	2	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

South Lahontan Hydrologic Region

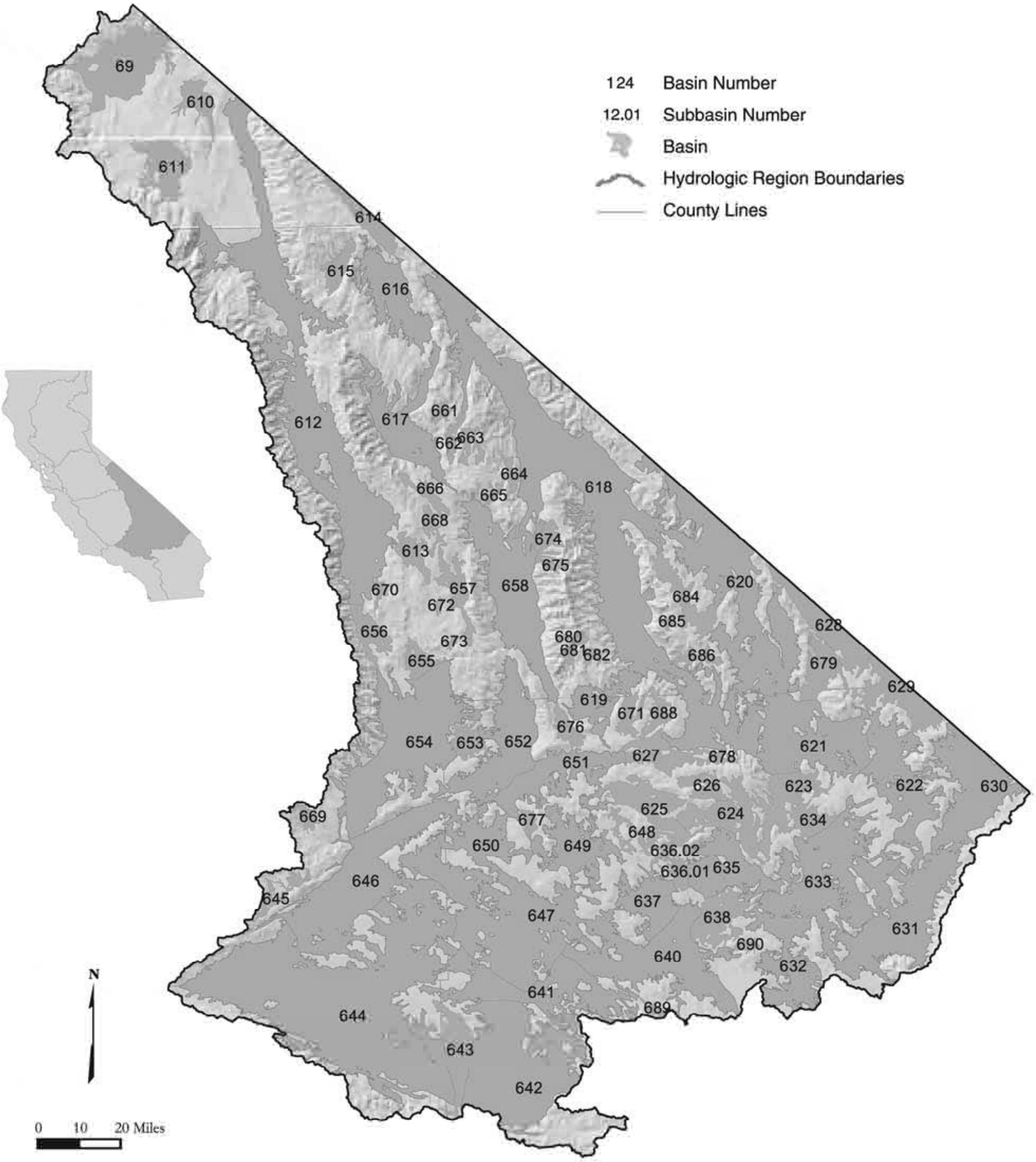

Figure 41 South Lahontan Hydrologic Region

Basins and Subbasins of the South Lahontan Hydrologic Region

Basin/subbasin	Basin name
6-9	Mono Valley
6-10	Adobe Lake Valley
6-11	Long Valley
6-12	Owens Valley
6-13	Black Springs Valley
6-14	Fish Lake Valley
6-15	Deep Springs Valley
6-16	Eureka Valley
6-17	Saline Valley
6-18	Death Valley
6-19	Wingate Valley
6-20	Middle Amargosa Valley
6-21	Lower Kingston Valley
6-22	Upper Kingston Valley
6-23	Riggs Valley
6-24	Red Pass Valley
6-25	Bicycle Valley
6-26	Avawatz Valley
6-27	Leach Valley
6-28	Pahrump Valley
6-29	Mesquite Valley
6-30	Ivanpah Valley
6-31	Kelso Valley
6-32	Broadwell Valley
6-33	Soda Lake Valley
6-34	Silver Lake Valley
6-35	Cronise Valley
6-36	Langford Valley
6-36.01	Langford Well Lake
6-36.02	Irwin
6-37	Coyote Lake Valley
6-38	Caves Canyon Valley
6-40	Lower Mojave River Valley
6-41	Middle Mojave River Valley
6-42	Upper Mojave River Valley
6-43	El Mirage Valley
6-44	Antelope Valley
6-45	Tehachapi Valley East
6-46	Fremont Valley
6-47	Harper Valley
6-48	Goldstone Valley
6-49	Superior Valley
6-50	Cuddeback Valley
6-51	Pilot Knob Valley
6-52	Searles Valley
6-53	Salt Wells Valley
6-54	Indian Wells Valley
6-55	Coso Valley
6-56	Rose Valley
6-57	Darwin Valley
6-58	Panamint Valley
6-61	Cameo Area
6-62	Race Track Valley
6-63	Hidden Valley
6-64	Marble Canyon Area
6-65	Cottonwood Spring Area
6-66	Lee Flat
6-68	Santa Rosa Flat
6-69	Kelso Lander Valley
6-70	Cactus Flat
6-71	Lost Lake Valley
6-72	Coles Flat
6-73	Wild Horse Mesa Area
6-74	Harrisburg Flats
6-75	Wildrose Canyon
6-76	Brown Mountain Valley
6-77	Grass Valley
6-78	Denning Spring Valley
6-79	California Valley
6-80	Middle Park Canyon
6-81	Butte Valley
6-82	Spring Canyon Valley
6-84	Greenwater Valley
6-85	Gold Valley
6-86	Rhodes Hill Area
6-88	Owl Lake Valley
6-89	Kane Wash Area
6-90	Cady Fault Area

Description of the Region

The South Lahontan HR covers approximately 21.2 million acres (33,100 square miles) in eastern California. This region includes about 21 percent of the surface area of California and both the highest (Mount Whitney) and lowest (Death Valley) surface elevations of the contiguous United States. The HR is bounded on the west by the crest of the Sierra Nevada and on the north by the watershed divide between Mono Lake and East Walker River drainages; on the east by Nevada and the south by the crest of the San Gabriel and San Bernardino mountains and the divide between watersheds draining south toward the Colorado River and those draining northward. This HR includes the Owens, Mojave, and Amargosa River systems, the Mono Lake drainage system, and many other internally drained basins. Average annual precipitation is about 7.9 inches, and runoff is about 1.3 maf per year (DWR 1994).

The South Lahontan HR includes Inyo County, much of Mono and San Bernardino counties, and parts of Kern and Los Angeles counties (Figure 41). National forests, national and state parks, military bases and other public lands comprise most of the land in this region. The Los Angeles Department of Water and Power is also a major landowner in the northern part of the HR and controls rights to much of the water draining the eastern Sierra Nevada.

According to 2000 census data, the South Lahontan HR is home to about 530,000 people, or 1.6 percent of the state's population. The major population centers are in the southern part of the HR and include Palmdale, Lancaster, Victorville, Apple Valley, and Hesperia.

Groundwater Development

In this report, 76 groundwater basins are delineated in the South Lahontan HR, and the Langford Valley Groundwater Basin (6-36) is divided into two subbasins. The groundwater basins underlie about 11.60 million acres (18,100 square miles) or about 55 percent of the HR.

Most of the groundwater production is concentrated, along with the population, in basins in the southern part of this region. Groundwater provides 41 percent of water supply for agriculture and urban uses (DWR 1998). Much of this HR is public land with very low population density, within these areas there has been little groundwater development and little is known about the basins.

In most smaller basins, groundwater is found in unconfined alluvial aquifers; however, in some of the larger basins, or near dry lakes, aquifers may be separated by aquitards that cause confined groundwater conditions. Depths of the basins range from tens or hundreds of feet in smaller basins to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this region depending on aquifer characteristics and well location, size, and use.

Conjunctive use of surface water and groundwater is practiced in the more heavily pumped basins. Some water used in the southern part of the HR is imported from Northern California by the State Water Project. Some of this imported water is used to recharge groundwater in the Mojave River Valley basins (6-40, 6-41, and 6-42). Surface water and groundwater are exported from the South Lahontan HR to the South Coast HR by the Los Angeles Department of Water and Power.

Groundwater Quality

The chemical character of the groundwater varies throughout the region, but most often is calcium or sodium bicarbonate. Near and beneath dry lakes, sodium chloride and sodium sulfate-chloride water is common. In general, groundwater near the edges of valleys contains lower TDS content than water beneath the central part of the valleys or near dry lakes.

Drinking water standards are most often exceeded for TDS, fluoride, and boron content. The EPA lists 13 sites of contamination in this HR. Of these, three military installations in the Antelope Valley and Mojave River Valley groundwater basins are federal Superfund sites because of VOCs and other hazardous contaminants.

Water Quality in Public Supply Wells

From 1994 through 2000, 605 public supply water wells were sampled in 19 of the 77 basins and subbasins in the South Lahontan HR. Analyzed samples indicate that 506 wells, or 84 percent, met the state primary MCLs for drinking water. Ninety-nine wells, or 16 percent, have constituents that exceed one or more MCL. Figure 42 shows the percentages of each contaminant group that exceeded MCLs in the 99 wells.

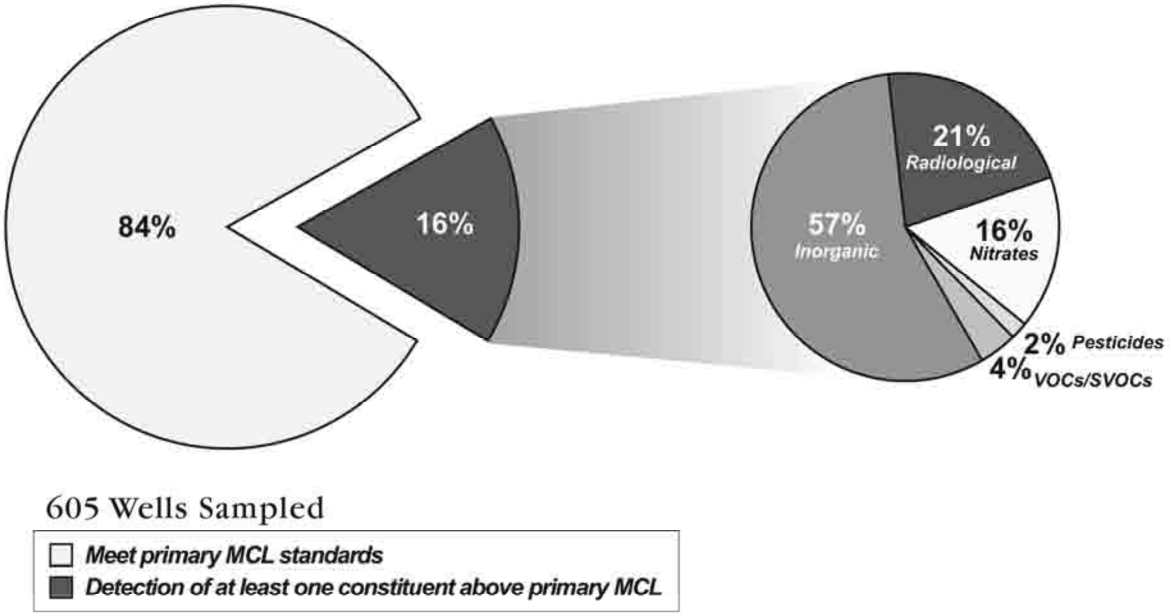

Figure 42 MCL exceedances in public supply wells in the South Lahontan Hydrologic Region

Table 36 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 36 Most frequently occurring contaminants by contaminant group in the South Lahontan Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 30	Arsenic – 19	Antimony – 5
Inorganics – Secondary	Iron – 82	Manganese – 36	Specific Conductance – 5 TDS – 5
Radiological	Gross Alpha – 18	Uranium – 7	Radium 228 – 2
Dissolved Nitrogen	Nitrate (as NO_3) – 12	Nitrate + Nitrite–6	Nitrite (as N) – 4
Pesticides	Di(2-Ethylhexyl)phthalate) – 2		
VOCs/SVOCs	MTBE – 2	TCE – 2	Carbon Tetrachloride – 2

TCE = Trichloroethylene
MTBE = Methyltertiarybutylether
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Several modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report (Table 37). Langford Valley Groundwater Basin (6-36) has been divided into two subbasins. Granite Mountain Area (6-59) and Fish Slough Valley (6-60) groundwater basins have been deleted because no information was found concerning wells or groundwater in these basins or because well completion reports indicate that groundwater production is derived from fractured rocks beneath the basin. Furnace Creek Area Groundwater Basin (6-83) has been incorporated into Death Valley Groundwater Basin (6-18), and Butterbread Canyon Valley Groundwater Basin (6-87) has been incorporated into Lost Lake Valley Groundwater Basin (6-71).

Table 37 Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Lahontan Hydrologic Region

Basin/subbasin name	New number	Old number
Langford Well Lake	6-36.01	6-36
Irwin	6-36.02	6-36
Troy Valley	Incorporated into 6-40 and 7-14.	6-39
Granite Mountain Area	Deleted	6-59
Fish Slough Valley	Deleted	6-60
Furnace Creek Area	Deleted – incorporated into 6-18	6-83
Butterbread Canyon Valley	Deleted – incorporated into 6-71	6-87

Troy Valley Groundwater Basin (6-39) has been split at the Pisgah fault, which is a groundwater barrier, and has been incorporated into Lower Mojave River Valley (6-40) and Lavic Valley (7-14) groundwater basins. This change incorporates part of the South Lahontan HR into a basin in the Colorado River HR[1]. The Middle Mojave River Valley Groundwater Basin (6-41) has changed boundaries along the north (Harper Valley; 6-47) and east sides (Lower Mojave River Valley; 6-40). The new boundaries are along the Camp Rock-Harper Lake fault zone, Waterman fault, and Helendale fault. Groundwater level elevations indicate that these faults are likely strong barriers to groundwater movement.

The boundary between the Upper Mojave River Valley Groundwater Basin (6-42) and the Lucerne Valley Groundwater Basin (7-19) was changed from the regional surface divide to the southern part of the Helendale fault, which is a groundwater barrier. This change incorporates part of the Colorado Desert HR into a basin in the South Lahontan HR[2].

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[1] The boundaries of the hydrologic regions are defined by surface drainage patterns. In this case, faults impede groundwater flow causing it to flow beneath the surface drainage divide into the adjacent hydrologic region.

[2] See previous note.

Table 38 South Lahontan Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
6-09	MONO VALLEY	173,000	A	800	480	-	-	-	-	2060
6-10	ADOBE LAKE VALLEY	39,800	C	-	-	-	-	-	-	-
6-11	LONG VALLEY	71,800	A	250	90	20	-	5	-	-
6-12	OWENS VALLEY	661,000	A	8,100	1,870	700	7	89	-	300-450,000
6-13	BLACK SPRINGS VALLEY	30,800	C	-	-	-	-	-	-	-
6-14	FISH LAKE VALLEY	48,100	C	-	-	-	-	-	-	-
6-15	DEEP SPRINGS VALLEY	29,900	C	700	390	-	-	-	-	-
6-16	EUREKA VALLEY	129,000	C	-	-	-	-	1	-	-
6-17	SALINE VALLEY	146,000	C	-	-	-	-	-	-	-
6-18	DEATH VALLEY	921,000	C	-	-	28	-	6	-	-
6-19	WINGATE VALLEY	71,400	C	-	-		-		-	-
6-20	MIDDLE AMARGOSA VALLEY	390,000	C	3,000	2,500	2	-	4	-	-
6-21	LOWER KINGSTON VALLEY	240,000	C	-	-	-	-	-	-	-
6-22	UPPER KINGSTON VALLEY	177,000	C	24	-	-	-	5	-	-
6-23	RIGGS VALLEY	87,700	C	-	-	-	-	-	-	-
6-24	RED PASS VALLEY	96,500	C	-	-	-	-	-	-	-
6-25	BICYCLE VALLEY	89,600	C	710	-	-	12	6	618	508-810
6-26	AVAWATZ VALLEY	27,700	C	-	-	-	-	-	-	-
6-27	LEACH VALLEY	61,300	C	-	-	-	-	-	-	-
6-28	PAHRUMP VALLEY	93,100	C	300	150	-	-	-	-	-
6-29	MESQUITE VALLEY	88,400	C	1,500	1,020	-	-	-	-	-
6-30	IVANPAH VALLEY	199,000	C	600	400	-	-	9	-	-
6-31	KELSO VALLEY	255,000	C	370	290	-	-		-	-
6-32	BROADWELL VALLEY	92,100	C	-	-	-	-	1	-	-
6-33	SODA LAKE VALLEY	381,000	C	2,100	1,100	-	-	3	-	-
6-34	SILVER LAKE VALLEY	35,300	C	-	-	-	-		-	-
6-35	CRONISE VALLEY	127,000	C	600	340	-	-	-	-	-
6-36	LANGFORD VALLEY									
6-36.01	LANGFORD WELL LAKE	19,300	C	1,700	410	11	7	3	498	440-568
6-36.02	IRWIN	10,500	C	550	-	40	-	3	528	496-598
6-37	COYOTE LAKE VALLEY	88,200	A	1,740	660	5	-	-	-	300-1000
6-38	CAVES CANYON VALLEY	73,100	A	300	-	4	1	4	-	300-1000
6-40	LOWER MOJAVE RIVER VALLEY	286,000	A	2,700	770	70	21	52	300	-
6-41	MIDDLE MOJAVE RIVER VALLEY	211,000	A	4,000	1,000	74	3	14	500	-
6-42	UPPER MOJAVE RIVER VALLEY	413,000	A	5,500	1,030	120	22	153	500	1105
6-43	EL MIRAGE VALLEY	75,900	A	1,000	230	50	3	21	-	-
6-44	ANTELOPE VALLEY	1,110,000	A	7,500	286	262	10	248	300	200-800
6-45	TEHACHAPI VALLEY EAST	24,000	C	150	31	31	-	9	361	298-405
6-46	FREMONT VALLEY	2,370,000	C	4,000	500	23	-	13	596	350-100,000
6-47	HARPER VALLEY	410,000	A	3,000	725	11	3	19	-	179-2391
6-48	GOLDSTONE VALLEY	28,100	C	-	-	-	-	-	-	-
6-49	SUPERIOR VALLEY	120,000	C	450	100	-	-	-	-	-

Table 38 South Lahontan Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
6-50	CUDDEBACK VALLEY	94,900	C	500	300	-	-	-	-	-
6-51	PILOT KNOB VALLEY	139,000	C	-	-	-	-	1	-	-
6-52	SEARLES VALLEY	197,000	C	1,000	300	-	-	-	-	-
6-53	SALT WELLS VALLEY	29,500	C	-	-	-	-	-	-	-
6-54	INDIAN WELLS VALLEY	382,000	A	3,800	815	116	20	63	312	110-1620
6-55	COSO VALLEY	25,600	C	-	-	-	-	-	-	-
6-56	ROSE VALLEY	42,500	C	-	-	-	-	1	-	-
6-57	DARWIN VALLEY	44,200	C	130	43	-	-	-	-	-
6-58	PANAMINT VALLEY	259,000	C	35	30	-	-	-	-	-
6-61	CAMEO AREA	9,310	C	-	-	-	-	-	-	-
6-62	RACE TRACK VALLEY	14,100	C	-	-	-	-	-	-	-
6-63	HIDDEN VALLEY	18,000	C	-	-	-	-	-	-	-
6-64	MARBLE CANYON AREA	10,400	C	-	-	-	-	-	-	-
6-65	COTTONWOOD SPRING AREA	3,900	C	-	-	-	-	-	-	-
6-66	LEE FLAT	20,300	C	-	-	-	-	-	-	-
6-68	SANTA ROSA FLAT	312	C	-	-	-	-	-	-	-
6-69	KELSO LANDER VALLEY	11,200	C	-	-	-	-	-	-	-
6-70	CACTUS FLAT	7,030	C	-	-	-	-	-	-	-
6-71	LOST LAKE VALLEY	23,300	C	-	-	-	-	-	-	-
6-72	COLES FLAT	2,950	C	-	-	-	-	-	-	-
6-73	WILD HORSE MESA AREA	3,320	C	-	-	-	-	-	-	-
6-74	HARRISBURG FLATS	24,900	C	-	-	-	-	1	-	-
6-75	WILDROSE CANYON	5,160	C	-	-	-	-	-	-	-
6-76	BROWN MOUNTAIN VALLEY	21,700	C	-	-	-	-	-	-	-
6-77	GRASS VALLEY	9,980	C	-	-	-	-	-	-	-
6-78	DENNING SPRING VALLEY	7,240	C	-	-	-	-	-	-	-
6-79	CALIFORNIA VALLEY	58,300	C	-	-	-	-	-	-	-
6-80	MIDDLE PARK CANYON	1,740	C	-	-	-	-	-	-	-
6-81	BUTTE VALLEY	8,810	C	-	-	-	-	-	-	-
6-82	ANVIL SPRING CANYON VALLEY	4,810	C	-	-	-	-	-	-	-
6-84	GREENWATER VALLEY	59,900	C	-	-	-	-	-	-	-
6-85	GOLD VALLEY	3,220	C	-	-	-	-	-	-	-
6-86	RHODES HILL AREA	15,600	C	-	-	-	-	-	-	-
6-88	OWL LAKE VALLEY	22,300	C	-	-	-	-	-	-	-
6-89	KANE WASH AREA	5,960	C	60	-	-	-	-	-	-
6-90	CADY FAULT AREA	7,960	C	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Colorado River Hydrologic Region

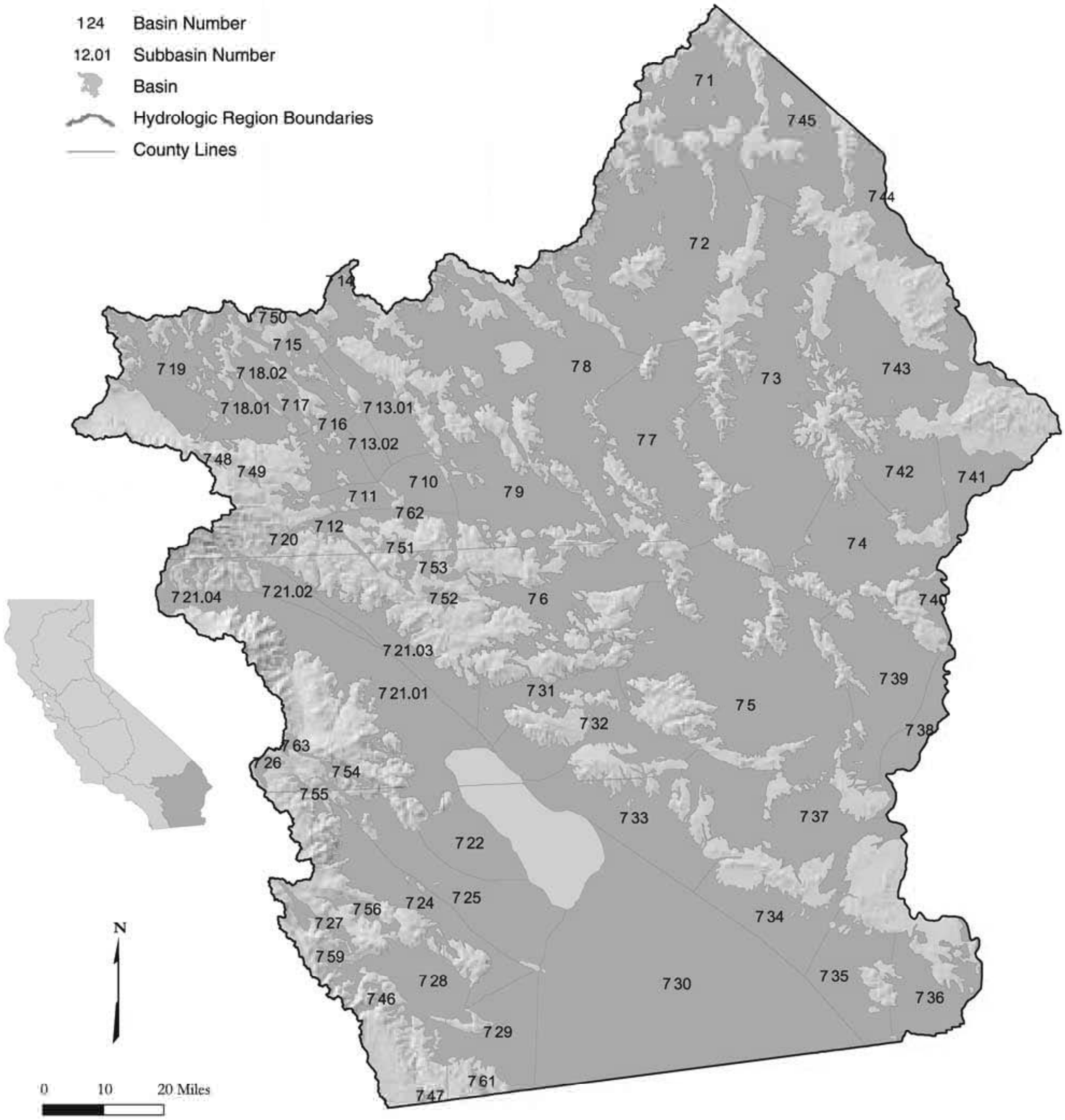

Figure 43 Colorado River Hydrologic Region

Basins and Subbasins of Colorado River Hydrologic Region

Basin/subbasin	Basin name
7-1	Lanfair Valley
7-2	Fenner Valley
7-3	Ward Valley
7-4	Rice Valley
7-5	Chuckwalla Valley
7-6	Pinto Valley
7-7	Cadiz Valley
7-8	Bristol Valley
7-9	Dale Valley
7-10	Twentynine Palms Valley
7-11	Copper Mountain Valley
7-12	Warren Valley
7-13	Deadman Valley
7-13.01	Deadman Lake
7-13.02	Surprise Spring
7-14	Lavic Valley
7-15	Bessemer Valley
7-16	Ames Valley
7-17	Means Valley
7-18	Johnson Valley Area
7-18.01	Soggy Lake
7-18.02	Upper Johnson Valley
7-19	Lucerne Valley
7-20	Morongo Valley
7-21	Coachella Valley
7-21.01	Indio
7-21.02	Mission Creek
7-21.03	Desert Hot Springs
7-21.04	San Gorgonio Pass
7-22	West Salton Sea
7-24	Borrego Valley
7-25	Ocotillo-Clark Valley
7-26	Terwilliger Valley
7-27	San Felipe Valley
7-28	Vallecito-Carrizo Valley
7-29	Coyote Wells Valley
7-30	Imperial Valley
7-31	Orocopia Valley
7-32	Chocolate Valley
7-33	East Salton Sea
7-34	Amos Valley
7-35	Ogilby Valley
7-36	Yuma Valley
7-37	Arroyo Seco Valley
7-38	Palo Verde Valley
7-39	Palo Verde Mesa
7-40	Quien Sabe Point Valley
7-41	Calzona Valley
7-42	Vidal Valley
7-43	Chemehuevi Valley
7-44	Needles Valley
7-45	Piute Valley
7-46	Canebrake Valley
7-47	Jacumba Valley
7-48	Helendale Fault Valley
7-49	Pipes Canyon Fault Valley
7-50	Iron Ridge Area
7-51	Lost Horse Valley
7-52	Pleasant Valley
7-53	Hexie Mountain Area
7-54	Buck Ridge Fault Valley
7-55	Collins Valley
7-56	Yaqui Well Area
7-59	Mason Valley
7-61	Davies Valley
7-62	Joshua Tree
7-63	Vandeventer Flat

Description of the Region

The Colorado River HR covers approximately 13 million acres (20,000 square miles) in southeastern California. It is bounded on the east by Nevada and Arizona, the south by the Republic of Mexico, the west by the Laguna, San Jacinto, and San Bernardino mountains, and the north by the New York, Providence, Granite, Old Dad, Bristol, Rodman, and Ord Mountain ranges. An average annual precipitation of 5.5 inches and average annual runoff of only 200,000 acre-feet makes this the most arid HR of California (DWR 1994). Surface runoff drains to many closed basins or to the Colorado River.

This HR includes all of Imperial, most of Riverside, much of San Bernardino, and part of San Diego counties (Figure 43). Many of the alluvial valleys in the region are underlain by groundwater aquifers that are the sole source of water for local communities.

About 533,000 people live within the Colorado River HR (DWR, 1998). The largest population centers are Palm Springs, Palm Desert, Indio, Coachella, and El Centro.

Groundwater Development

The earliest groundwater development in California may have been prehistoric water wells dug by the Cahuilla Indians in Coachella Valley of the Colorado River HR. In this report, 64 groundwater basins/subbasins are delineated in this HR. The Deadman Valley, Johnson Valley Area, and Coachella Valley groundwater basins have been divided into subbasins. Groundwater basins underlie about 8.68 million acres or about 26 percent of this HR.

In the Colorado River HR, groundwater provides about 8 percent of the water supply in normal years for agricultural and urban uses (DWR 1998). In most smaller basins, groundwater is found in unconfined alluvial aquifers. In some of the larger basins, particularly near dry lakes, aquifers may be separated by aquitards that create confined groundwater conditions. Depths of basins range from tens or hundreds of feet in smaller basins and along arms of ephemeral rivers to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this region depending on aquifer characteristics and well location, size, and use. Some aquifers are capable of yielding thousands of gallons per minute to municipal wells.

Conjunctive use of surface water and groundwater is a long-standing practice in the region. Water is imported from the Colorado River for irrigation in Imperial, Coachella, and Palo Verde Valleys and from groundwater recharge in Coachella Valley. Water imported from Northern California is used to replenish Warren and Joshua Tree groundwater basins. Many agencies have erected systems of barriers to allow more efficient percolation of ephemeral runoff from surrounding mountains. The concept of utilizing groundwater basins in this sparsely populated HR for storing water that would be pumped during drought years is getting much attention.

Groundwater Quality

The chemical character of groundwater in the Colorado River HR is variable. Cation concentration is dominated by sodium with calcium common and magnesium appearing less often. Bicarbonate is usually the dominant anion, although sulfate and chloride waters are also common. In basins with closed drainages, water character often changes from calcium-sodium bicarbonate near the margins to sodium chloride or chloride-sulfate beneath a dry lake. It is not uncommon for concentrations of dissolved constituents to rise dramatically toward a dry lake where saturation of mineral salts is reached. An example of this is found at Bristol Valley Groundwater Basin, where the mineral halite (sodium chloride) is formed and then mined by evaporation of groundwater in trenches in Bristol (dry) Lake. The TDS content of groundwater is high in many of the basins in this region. High fluoride content is common; sulfate content occasionally exceeds drinking water standards; and high nitrate content is common, especially in agricultural areas.

Two of the primary challenges in the Colorado River HR are overdraft in the Coachella Valley and leaking underground storage tanks. The EPA has not yet placed any contamination sites in this HR on the Superfund National Priorities List; however, one site is under consideration because of high pesticide levels.

Water Quality in Public Supply Wells

From 1994 through 2000, 314 public supply water wells were sampled in 23 of the 64 basins and subbasins in the Colorado River HR. Analyzed samples indicate that 270 wells, or 86 percent, met the state primary MCLs for drinking water standards. Forty-four wells, or 14 percent, have constituents that exceed one or more MCL. Figure 44 shows the percentages of each contaminant group that exceeded MCLs in the 44 wells.

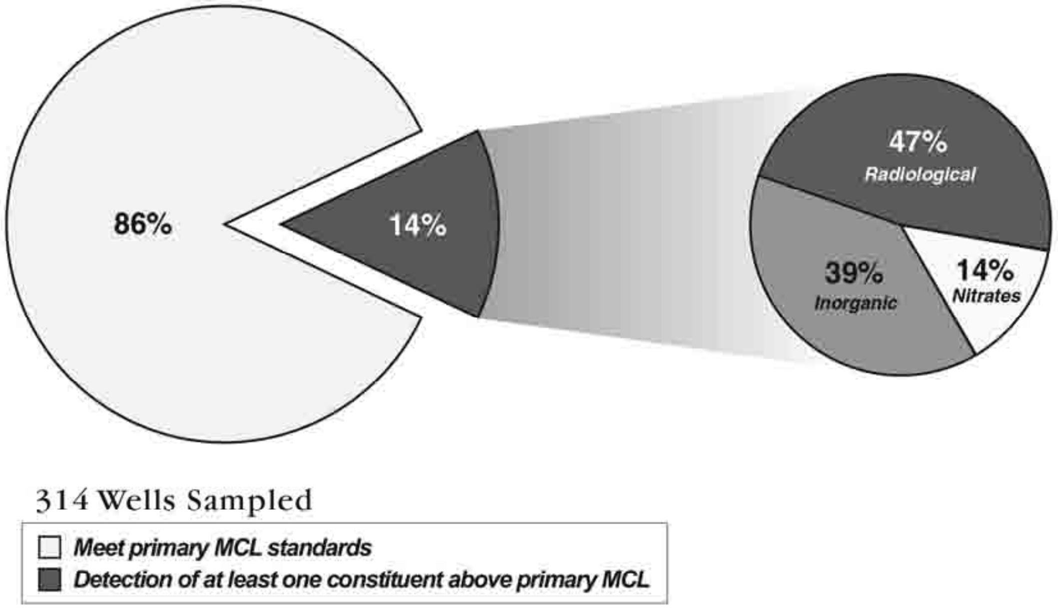

Figure 44 MCL exceedances in public supply wells in the Colorado River Hydrologic Region

Table 39 lists the three most frequently occurring contaminants in each contaminant group and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 39 Most frequently occurring contaminants by contaminant group in the Colorado River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Fluoride – 17		
Inorganics – Secondary	Iron – 38	Manganese – 26	TDS – 5
Radiological	Radium 228 – 3	Combined RA226 + RA228 – 3	Radium 226 – 1
Nitrates	Nitrate (as NO_3) – 6	Nitrate + Nitrite – 1	

Changes from Bulletin 118-80

Several modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report (Table 40). Jacumba Valley East Groundwater Basin (7-60) has been deleted because of lack of information about groundwater in this basin. The Pinyon Wash Area (7-57) and Whale Peak Area (7-58) groundwater basin names have been deleted because they are now incorporated into other larger basins. Similarly, Clark Valley (7-23) and Ocotillo Valley (7-25) groundwater basins are now the combined Ocotillo-Clark Valley Groundwater Basin (7-25). The Deadman Valley (7-13), Johnson Valley Area (7-18), and Coachella Valley (7-21) groundwater basins have been subdivided into subbasins in this report. The western boundary of Lucerne Valley Groundwater Basin (7-19) has been moved eastward from the HR boundary to the Helendale fault. Groundwater level elevations indicate that this fault is a groundwater barrier and that groundwater flows westward back under the surface divide into the Upper Mojave River Groundwater Basin (6-42). The boundary between Lucerne Valley (7-19) and Johnson Valley Area (7-18) groundwater basins is delineated in this report.

The boundaries of Twentynine Palms Valley (7-10), Copper Mountain Valley (7-11), Warren Valley (7-12), Deadman Lake (7-13), and Ames Valley (7-16) groundwater basins have been redrawn in light of newer groundwater level data. These data indicate that the Pinto Mountain fault is a groundwater barrier. Joshua Tree Groundwater Basin (7-62) is a new basin that has been delineated from parts of Copper Mountain Valley and Twentynine Palms Valley Groundwater Basins because the Pinto Mountain fault is such a strong barrier. Buck Ridge Fault Valley Groundwater Basin (7-54) was presented in Bulletin 118-80 as two unconnected deposits of water-bearing alluvium separated by outcrop of nonwater-bearing rocks. These water-bearing deposits have been designated as separate groundwater basins in this report, with the Buck Ridge Fault Valley Groundwater Basin (7-54) as the northern basin and Vandeventer Flat Groundwater Basin (7-63) presented as the southern basin.

Table 40 Modifications since Bulletin 118-80 of groundwater basins in Colorado River Hydrologic Region

Basin name	New number	Old number
Clark Valley	Delete – combined with 7-25	7-23
Ocotillo-Clark Valley	7-25 (now combined)	7-25
Pinyon Wash Area	Incorporated into 7-56	7-57
Whale Peak Area	Incorporated into 7-28	7-58
Jacumba Valley East	Deleted	7-60
Joshua Tree	7-62 (new)	
Vandeventer Flat	7-63 (new)	

Table 41 Colorado River Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
7-1	LANFAIR VALLEY	157,000	C	70	16	-	-	9	515	173-2,260
7-2	FENNER VALLEY	454,000	A	200	100	-	-	4	515	173-2,260
7-3	WARD VALLEY	961,000	A	260	180	-	-	1	-	327-589
7-4	RICE VALLEY	189,000	C	65	-	-	-	-	-	-
7-5	CHUCKWALLA VALLEY	604,000	C	3,900	1,800	12	-	10	-	424
7-6	PINTO VALLEY	183,000	A	1,480	900	-	-	1	-	-
7-7	CADIZ VALLEY	270,000	C	167	66	-	-	-	400	300-3000
7-8	BRISTOL VALLEY	498,000	A	3,000	-	-	-	-		300-298,000
7-9	DALE VALLEY	213,000	C	380	275	-	-	2	-	-
7-10	TWENTYNINE PALMS VALLEY	62,400	C	3,000	540	27	-	2	640	-
7-11	COPPER MOUNTAIN VALLEY	30,300	A	2,450	250	2	-	2	-	180-214
7-12	WARREN VALLEY	17,200	A	4,000	350	27	18	17	196	129-269
7-13	DEADMAN VALLEY									
7-13.01	DEADMAN LAKE	89,200	C	2,000	-	28	3	1	-	311-985
7-13.02	SURPRISE SPRING	29,300	C	1,370	680	26	6	9	177	141-1,050
7-14	LAVIC VALLEY	102,000	C	140	80	-	-	-	-	-
7-15	BESSEMER VALLEY	39,100	C	0	-	-	-	-	-	-
7-16	AMES VALLEY	110,000	C	2,000	-	19	3	11	459	-
7-17	MEANS VALLEY	15,000	C	0	-	1	-	-	-	-
7-18	JOHNSON VALLEY AREA									
7-18.01	SOGGY LAKE	76,800	C	-	-	6	-	1	-	300-2,000
7-18.02	UPPER JOHNSON VALLEY	34,800	C	-	-	-	-	-	-	3,000
7-19	LUCERNE VALLEY	148,000	A	1,000	-	22	9	21	301	200-5,000
7-20	MORONGO VALLEY	7,240	C	600	90	-	-	5	-	-
7-21	COACHELLA VALLEY									
7-21.01	INDIO	336,000	A	1,880	650	30	-	204	300	-
7-21.02	MISSION CREEK	49,000	A	3,500	715	5	-	15	<500	-
7-21.03	DESERT HOT SPRINGS	101,000	C	2,500	985	10	-	2	-	800-1,000
7-21.04	SAN GORGONIO PASS	38,700	A	1,000	0	17	8	5	-	106-205
7-22	WEST SALTON SEA	106,000	C	540	400	v	-	-	-	-
7-24	BORREGO VALLEY	153,000	A	2,000	0	10	10	25	-	300-2,440
7-25	OCOTILLO-CLARK VALLEY	223,000	C	3,500	1,760	1	-	2	-	-
7-26	TERWILLIGER VALLEY	8,030	C	100	-	-	-	1	-	500
7-27	SAN FELIPE VALLEY	2,340	C	500	30	-	-	1	-	-
7-28	VALLECITO-CARRIZO VALLEY	122,000	C	2,500	260	-	-	1	-	-
7-29	COYOTE WELLS VALLEY	146,000	A	-	-	25	6	9	-	-
7-30	IMPERIAL VALLEY	961,000	A	1,000	-	19	-	45	1088	498-7,280
7-31	OROCOPIA VALLEY	96,500	A	210	165	0	-	1	-	-
7-32	CHOCOLATE VALLEY	130,000	C	0	0	0	-	-	-	-
7-33	EAST SALTON SEA	196,000	C	0	0	1	-	4	-	-
7-34	AMOS VALLEY	130,000	C	100	50	3	-	1	-	-
7-35	OGILBY VALLEY	134,000	C	4,000	50	27	1	3	-	-

Table 41 Colorado River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
7-36	YUMA VALLEY	3,780	C	100	40	59	0	15	-	-
7-37	ARROYO SECO VALLEY	258,000	C	-	-	2	0	0	-	-
7-38	PALO VERDE VALLEY	73,400	A	-	-	11	-	19	840	658-1,030
7-39	PALO VERDE MESA	226,000	C	2,750	1,650	20	-	13	-	-
7-40	QUIEN SABE POINT VALLEY	25,300	C	25	-	-	-	3	-	-
7-41	CALZONA VALLEY	81,000	C	2,340	500	0	0	0	-	
7-42	VIDAL VALLEY	138,000	C	1,800	675	-	-	1	-	-
7-43	CHEMEHUEVI VALLEY	273,000	A	0	0	1	0	1	-	-
7-44	NEEDLES VALLEY	88,400	A	1,500	980	34	-	11	-	-
7-45	PIUTE VALLEY	176,000	C	1,500	200	-	-	-	-	-
7-46	CANEBRAKE VALLEY	5,420	C	125	-	-	-	-	-	-
7-47	JACUMBA VALLEY	2,450	A	1,000	-	-	-	3		296-6,100
7-48	HELENDALE FAULT VALLEY	2,620	C	-	-	-	-	-	-	-
7-49	PIPES CANYON FAULT VALLEY	3,390	C	-	-	-	-	-	-	-
7-50	IRON RIDGE AREA	5,250	C	-	-	-	-	-	-	-
7-51	LOST HORSE VALLEY	17,300	C	-	-	-	-	-	-	-
7-52	PLEASANT VALLEY	9,670	C	-	-	-	-	-	-	-
7-53	HEXIE MOUNTAIN AREA	11,200	C	-	-	-	-	-	-	-
7-54	BUCK RIDGE FAULT VALLEY	6,930	C	-	-	-	-	-	-	-
7-55	COLLINS VALLEY	7,080	C	1,500	-	-	-	-	-	-
7-56	YAQUI WELL AREA	15,000	C	0	-	-	-	1	-	-
7-59	MASON VALLEY	5,530	C	0	0	0	0	1	-	-
7-61	DAVIES VALLEY	3,570	C	0	0	0	0	-	-	-
7-62	JOSHUA TREE	33,800	A	2,200	1,110	25	5	14	180	117-185
7-63	VANDEVENTER FLAT	6,750	C	50	17	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

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Glossary

Glossary

A

acre-foot (af) The volume of water necessary to cover one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons.

adjudication A case that has been heard and decided by a judge. In the context of an adjudicated groundwater basin, landowners or other parties have turned to the courts to settle disputes over how much groundwater can be extracted by each party to the decision.

alluvial Of or pertaining to or composed of alluvium.

alluvium A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water, as a sorted or semi sorted sediment in the bed of the stream or on it's floodplain or delta, as a cone or fan at the base of a mountain slope**.**

anthropogenic Of human origin or resulting from human activity.

appropriative right The right to use water that is diverted or extracted by a nonriparian or nonoverlying party for nonriparian or nonoverlying uses. In California, surface water appropriative rights are subject to a statutory permitting process while groundwater appropriation is not.

aquitard A confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores ground water.

aquifer A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs.

aridity A term describing a climate or region in which precipitation is so deficient in quantity or occurs so infrequently that intensive agricultural production is not possible without irrigation.

artesian aquifer A body of rock or sediment containing groundwater that is under greater than hydrostatic pressure; that is, a confined aquifer. When an artesian aquifer is penetrated by a well, the water level will rise above the top of the aquifer.

artesian pressure Hydrostatic pressure of artesian water, often expressed in terms of pounds per square inch; or the height, in feet above the land surface, of a column of water that would be supported by the pressure.

artificial recharge The addition of water to a groundwater reservoir by human activity, such as putting surface water into dug or constructed spreading basins or injecting water through wells.

available groundwater storage capacity The volume of a groundwater basin that is unsaturated and capable of storing groundwater.

average annual runoff The average value of total annual runoff volume calculated for a selected period of record, at a specified location, such as a dam or stream gage.

average year water demand Demand for water under average hydrologic conditions for a defined level of development.

B

basin management objectives (BMOs) See management objectives

beneficial use One of many ways that water can be used either directly by people or for their overall benefit. The State Water Resources Control Board recognizes 23 types of beneficial use with water quality criteria for those uses established by the Regional Water Quality Control Boards.

borehole geophysics The general field of geophysics developed around the lowering of a variety of probes into a boring or well. Borehole logging provides additional information concerning physical, electrical, acoustic, nuclear and chemical aspects of the soils and rock encountered during drilling.

C

community water system A public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25 year-long residents (DHS 2000).

confined aquifer An aquifer that is bounded above and below by formations of distinctly lower permeability than that of the aquifer itself. An aquifer containing confined ground water. See artesian aquifer.

conjunctive use The coordinated and planned management of both surface and groundwater resources in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average surface water supply.

contaminant Any substance or property preventing the use or reducing the usability of the water for ordinary purposes such as drinking, preparing food, bathing washing, recreation, and cooling. Any solute or cause of change in physical properties that renders water unfit for a given use. (Generally considered synonymous with pollutant).

critical conditions of overdraft A groundwater basin in which continuation of present practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts. The definition was created after an extensive public input process during the development of the Bulletin 118-80 report.

D

deep percolation Percolation of water through the ground and beyond the lower limit of the root zone of plants into groundwater.

desalination A process that converts seawater or brackish water to fresh water or an otherwise more usable condition through removal of dissolved solids.

domestic well A water well used to supply water for the domestic needs of an individual residence or systems of four or fewer service connections.

drinking water system See public water system

drought condition Hydrologic conditions during a defined period when rainfall and runoff are much less than average.

drought year supply The average annual supply of a water development system during a defined drought period.

E

electrical conductivity (EC) The measure of the ability of water to conduct an electrical current, the magnitude of which depends on the dissolved mineral content of the water.

effective porosity The volume of voids or open spaces in alluvium and rocks that is interconnected and can transmit fluids.

environmental water Water serving environmental purposes, including instream fishery flow needs, wild and scenic river flows, water needs of fresh-water wetlands, and Bay-Delta requirements.

evapotranspiration (ET) The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces.

G

groundwater basin An alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and having a definable bottom.

groundwater budget A numerical accounting, the *groundwater equation*, of the recharge, discharge and changes in storage of an aquifer, part of an aquifer, or a system of aquifers.

groundwater in storage The quantity of water in the zone of saturation.

groundwater management The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a goal of long-term sustainability of the resource.

groundwater management plan A comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal or statutory authority.

groundwater mining The process, deliberate or inadvertent, of extracting groundwater from a source at a rate in excess of the replenishment rate such that the groundwater level declines persistently, threatening exhaustion of the supply or at least a decline of pumping levels to uneconomic depths.

groundwater monitoring network A series of monitoring wells at appropriate locations and depths to effectively cover the area of interest. Scale and density of monitoring wells is dependent on the size and complexity of the area of interest, and the objective of monitoring.

groundwater overdraft The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions.

groundwater quality See water quality

groundwater recharge facility A structure that serves to conduct surface water into the ground for the purpose of replenishing groundwater. The facility may consist of dug or constructed spreading basins, pits, ditches, furrows, streambed modifications, or injection wells.

groundwater recharge The natural or intentional infiltration of surface water into the zone of saturation.

groundwater source area An area where groundwater may be found in economically retrievable quantities outside of normally defined groundwater basins, generally referring to areas of fractured bedrock in foothill and mountainous terrain where groundwater development is based on successful well penetration through interconnecting fracture systems. Well yields are generally lower in fractured bedrock than wells within groundwater basins.

groundwater storage capacity volume of void space that can be occupied by water in a given volume of a formation, aquifer, or groundwater basin.

groundwater subbasin A subdivision of a groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

groundwater table The upper surface of the zone of saturation in an unconfined aquifer.

groundwater Water that occurs beneath the land surface and fills the pore spaces of the alluvium, soil, or rock formation in which it is situated. It excludes soil moisture, which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

H

hazardous waste Waste that poses a present or potential danger to human beings or other organisms because it is toxic, flammable, radioactive, explosive or has some other property that produces substantial risk to life.

hydraulic barrier A barrier created by injecting fresh water to control seawater intrusion in an aquifer, or created by water injection to control migration of contaminants in an aquifer.

hydraulic conductivity A measure of the capacity for a rock or soil to transmit water; generally has the units of feet/day or cm/sec.

hydrograph A graph that shows some property of groundwater or surface water as a function of time.

hydrologic cycle The circulation of water from the ocean through the atmosphere to the land and ultimately back to the ocean.

hydrologic region A study area consisting of multiple planning subareas. California is divided into 10 hydrologic regions.

hydrostratigraphy A geologic framework consisting of a body of rock having considerable lateral extent and composing a reasonably distinct hydrologic system.

hyporheic zone The region of saturated sediments beneath and beside the active channel and that contain some proportion of surface water that was part of the flow in the surface channel and went back underground and can mix with groundwater.

I

infiltration The flow of water downward from the land surface into and through the upper soil layers.

infiltration capacity The maximum rate at which infiltration can occur under specific conditions of soil moisture.

in-lieu recharge The practice of providing surplus surface water to historic groundwater users, thereby leaving groundwater in storage for later use.

ISI Integrated Storage Investigations Program, an element of the CALFED Bay Delta initiative.

J

joint powers agreement (JPA) An agreement entered into by two or more public agencies that allows them to jointly exercise any power common to the contracting parties. The JPA is defined in Chapter 5 (commencing with Section 6500) of Division 7 of Title 1 of the California Government Code.

L

land subsidence The lowering of the natural land surface due to groundwater (or oil and gas) extraction.

leaky confining layer A low-permeability layer that can transmit water at sufficient rates to furnish some recharge from an adjacent aquifer to a well.

lithologic log A record of the lithology of the soils, sediments and/or rock encountered in a borehole from the surface to the bottom.

lithology The description of rocks, especially in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

losing stream A stream or reach of a stream that is losing water by seepage into the ground.

M

management objectives Objectives that set forth the priorities and measurable criteria of local groundwater basin management. For example, one management objective could be to minimize degradation of groundwater quality with a criteria set that groundwater will not be degraded by more than 100 mg/l in terms of TDS.

maximum contaminant level (MCL) The highest drinking water contaminant concentration allowed under federal and State Safe Drinking Water Act regulations.

N

natural recharge Natural replenishment of an aquifer generally from snowmelt and runoff; through seepage from the surface.

nonpoint source Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, etc., carried to lakes and streams by surface runoff.

O

operational yield An optimal amount of groundwater that should be withdrawn from an aquifer system or a groundwater basin each year. It is a dynamic quantity that must be determined from a set of alternative groundwater management decisions subject to goals, objectives, and constraints of the management plan.

ordinance A law set forth by a governmental authority.

overdraft See groundwater overdraft

overlying right Property owners above a common aquifer possess a mutual right to the reasonable and beneficial use of a groundwater resource on land overlying the aquifer from which the water is taken. Overlying rights are correlative (related to each other) and overlying users of a common water source must share the resource on a pro rata basis in times of shortage. A proper overlying use takes precedence over all non-overlying uses**.**

P

perched groundwater Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater.

perennial yield The maximum quantity of water that can be annually withdrawn from a groundwater basin over a long period of time (during which water supply conditions approximate average conditions) without developing an overdraft condition.

perforated interval The depth interval where slotted casing or screen is placed in a well to allow entry of water from the aquifer formation.

permeability The capability of soil or other geologic formations to transmit water. See hydraulic conductivity.

pesticide Any of a class of chemicals used for killing insects, weeds or other undesirable entities. Most commonly associated with agricultural activities, but has significant domestic use in California.

point source A specific site from which wastewater or polluted water is discharged into a water body.

pollution (of water) The alteration of the physical, chemical, or biological properties of water by the introduction of any substance into water that adversely affects any beneficial use of water.

porosity The ratio of the voids or open spaces in alluvium and rocks to the total volume of the alluvium or rock mass.

possible contaminating activity (PCA) Human activities that are actual or potential origins of contamination for a drinking water source. PCAs include sources of both microbiological and chemical contaminants that could have an adverse effect upon human health (DHS 2000).

potentiometric surface The surface to which the water in a confined aquifer will rise in a tightly cased well.

prescriptive right rights obtained through the open and notorious adverse use of another's water rights. By definition, adverse use is not use of a surplus, but the use of non-surplus water to the direct detriment of the original rights holder.

primary porosity Voids or open spaces that were present when alluvium and rocks were originally deposited or formed.

public supply well A well used as a part of a public water system.

public water system A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. (DHS 2000).

pueblo right A water right possessed by a municipality which, as a successor of a Spanish or Mexican pueblo, entitled to the beneficial use of all needed, naturally-occurring surface and groundwater of the original pueblo watershed Pueblo rights are paramount to all other claims.

R

recharge Water added to an aquifer or the process of adding water to an aquifer. Ground water recharge occurs either naturally as the net gain from precipitation, or artificially as the result of human influence. See artificial recharge.

recharge basin A surface facility constructed to infiltrate surface water into a groundwater basin.

riparian right A right to use surface water, such right derived from the fact that the land in question abuts upon the banks of streams.

runoff The volume of surface flow from an area.

S

safe yield The maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect.

salinity Generally, the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater, salinity often refers to the concentration of chlorides in the water. See also total dissolved solids.

saline intrusion The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater bodies.

saturated zone The zone in which all interconnected openings are filled with water, usually underlying the unsaturated zone.

seawater intrusion barrier A system designed to retard, cease or repel the advancement of seawater intrusion into potable groundwater supplies along coastal portions of California. The system may be a series of specifically placed injection wells where water is injected to form a hydraulic barrier.

secondary porosity Voids in a rock formed after the rock has been deposited; not formed with the genesis of the rock, but later due to other processes. Fractures in granite and caverns in limestone are examples of secondary openings.

seepage The gradual movement of water into, through or from a porous medium. Also the loss of water by infiltration into the soil from a canal, ditches, laterals, watercourse, reservoir, storage facilities, or other body of water, or from a field.

semi-confined aquifer A semi-confined aquifer or leaky confined aquifer is an aquifer that has aquitards either above or below that allow water to leak into or out of the aquifer depending on the direction of the hydraulic gradient.

service area The geographic area served by a water agency.

specific conductance See electrical conductivity

specific retention The ratio of the volume of water a rock or sediment will retain against the pull of gravity to the total volume of the rock or sediment.

specific yield the ratio of the volume of water a rock or soil will yield by gravity drainage to the total volume of the rock or soil.

spring a location where groundwater flows naturally to the land surface or a surface water body.

stakeholders Any individual or organization that has an interest in water management activities. In the broadest sense, everyone is a stakeholder, because water sustains life. Water resources stakeholders are typically those involved in protecting, supplying, or using water for any purpose, including environmental uses, who have a vested interest in a water-related decision.

stratigraphy The science of rocks. It is concerned with the original succession and age relations of rock strata and their form, distribution, lithologic composition, fossil content, geophysical and geochemical properties—all characters and attributes of rocks as strata—and their interpretation in terms of environment and mode of origin and geologic history.

subsidence See land subsidence

subterranean stream Subterranean streams “flowing through known and definite channels” are regulated by California’s surface water rights system.

surface supply Water supply obtained from streams, lakes, and reservoirs.

sustainability Of, relating to, or being a method of using a resource so that the resource is not depleted or permanently damaged.

T

total dissolved solids (TDS) a quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter. See also salinity

toxic Poisonous, relating to or caused by a poison. Toxicity is determined for individual contaminants or for mixtures of contaminants as found in waste discharges.

transmissivity The product of hydraulic conductivity and aquifer thickness; a measure of a volume of water to move through an aquifer. Transmissivity generally has the units of ft^2/day or gallons per day/foot. Transmissivity is a measure of the subsurface's ability to transmit groundwater horizontally through its entire saturated thickness and affects the potential yield of wells.

transpiration An essential physiological process in which plant tissues give off water vapor to the atmosphere.

U

unconfined aquifer An aquifer which is not bounded on top by an aquitard. The upper surface of an unconfined aquifer is the water table.

underground stream Body of water flowing as a definite current in a distinct channel below the surface of the ground, usually in an area characterized by joints or fissures. Application of the term to ordinary aquifers is incorrect.

unsaturated zone The zone below the land surface in which pore space contains both water and air.

urban water management plan (UWMP) An UWMP is required for all urban water suppliers having more than 3,000 connections or supplying more than 3,000 acre-feet of water. The plans include discussions on water supply, supply reliability, water use, water conservation, and water shortage contingency and serve to assist urban water suppliers with their long-term water resources planning to ensure adequate water supplies for existing and future demands.

usable storage capacity The quantity of groundwater of acceptable quality that can be economically withdrawn from storage.

V

vadose zone See unsaturated zone

volatile organic compound (VOC) A manmade organic compound that readily vaporizes in the atmosphere. These compounds are often highly mobile in the groundwater system and are generally associated with industrial activities.

W

water quality Description of the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.

water table See groundwater table

water year A continuous 12-month period for which hydrologic records are compiled and summarized. Different agencies may use different calendar periods for their water years.

watershed The land area from which water drains into a stream, river, or reservoir.

well completion report A required, confidential report detailing the construction, alteration, abandonment, or destruction of any water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well. The reports were called *Water Well Drillers' Report* prior to 1991 and are often referred to as "driller's logs." The report requirements are described in the California Water Code commencing with Section 13750.

WQCP Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary.

Metric Conversions

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimeters (mm)	inches (in)	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	square millimeters (mm2)	square inches (in2)	0.00155	645.16
	square meters (m2)	square feet (ft2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometers (km2)	square miles (mi2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters	million gallons (10*)	0.26417	3.7854
	cubic meters (m3)	cubic feet (ft3)	36.315	0.028317
	cubic meters (m3)	cubic yards (yd3)	1.308	0.76455
	cubic dekameters (dam3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic meters per second (m3/s)	cubic feet per second (ft3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (k/W)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	eet head of water	0.32456	2.989
Specific Capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electrical Conductivity	microsiemens per centimeter (µS/cm)	micromnos per centermeter	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8X°C)+32	(°F-321/18

Appendices

Appendix A
Obtaining Copies of Supplemental Material

Bulletin 118 Update 2003 includes this report and supplemental material consisting of individual basin descriptions and a GIS-compatible map of each of the delineated groundwater basins in California. The supplemental material will be updated as new information becomes available and can be viewed or downloaded at http://www.waterplan.water.ca.gov/groundwater/118index.htm

Appendix B
The Right to Use Groundwater in California

California does not have a statewide management program or statutory permitting system for groundwater. Some local agencies have adopted groundwater ordinances under their police powers, or have adopted groundwater management programs under a variety of statutory authorities.

Prior to a discussion of groundwater management, it is helpful to understand some of the laws governing the right to use groundwater in California. When the Water Commission Act of 1913 (Stats. 1913, Ch. 586) became effective in 1914, appropriative surface water rights became subject to a statutory permitting process. This appropriation procedure can be found in Water Code Section 1200 *et seq*. Groundwater classified as underflow of a surface stream, a “subterranean stream flowing through a known and definite channel,” was made subject to the State permit system. However, most groundwater in California is presumed to be “percolating water,” that is, water in underground basins and groundwater which has escaped from streams. This percolating water is not subject to a permitting process. As a result, most of the body of law governing groundwater use in California today has evolved through a series of court decisions beginning in the early 20th century. Key cases are listed in Table B-1, and some of the most significant are discussed below.

Table B-1 Significant court cases related to the right to use groundwater in California

Case	Issues addressed
Katz v. Walkinshaw, 141 Cal. 116 (1903)	Established Correlative Rights Doctrine. Correlative rights of overlying users, and surplus supply available for appropriation among non-overlying users.
Peabody v. City of Vallejo, 2 Cal. 2d 351 (1935)	Limited riparian rights under the reasonable and beneficial use requirement of the 1928 constitutional amendment; requirement of reasonable and beneficial use.
Pasadena v. Alhambra, 33 Cal. 2d 908 (1949)	First basin adjudication in California; established Doctrine of Mutual Prescription.
Niles Sand and Gravel Co. v. Alameda County Water District, 37 Cal. App. 3d 924 (1974)	Established right to store water underground as a servitude.
Techachapi-Cummings County Water District v. Armstrong, 49 Cal. App. 3d 992 (1975)	Modified the Mutual Prescription Doctrine articulated in Pasadena v. Alhambra. Overlying owners' water rights must be quantified on the basis of current, reasonable and beneficial need, not past use. By analogy to riparian rights, factors to be considered include: the amount of water available, the extent of ownership in the basin, and the nature of projected use.
Los Angeles v. San Fernando, 14 Cal. 3d 199 (1975)	Significantly modified Mutual Prescription Doctrine by disallowing it against public entities (Civil Code section 1007); established pueblo right above overlying owner right; established right to store imported water underground and recapture when needed above the right of overlying landowner.
Wright v. Goleta Water District, 174 Cal. App. 3d 74 (1985)	The unexercised water rights of overlying owners are protected from appropriators; notice and opportunity must be given to overlying owners to resist any interference with their rights.
Hi-Desert County Water District v. Blue Skies Country Club,	Retention of overlying right; no acquisition of prescriptive right by 23 Cal. App. 4th 1723 (1994) overlying owner.
Baldwin v. Tehama County, 31 Cal. App. 4th 166 (1994)	City and County regulation of groundwater through police power. County limitations on export upheld.
City of Barstow v. Mojave Water Agency,	Held that in considering a stipulated physical solution 23 Cal. 4th 1224 (2000) involving equitable apportionment, court must consider correlativerights of parties that did not join the stipulation.

This table modified from Bachman and others 1997

Katz v. Walkinshaw (141 Cal. 116)

In the 1903 decision, *Katz v. Walkinshaw*, the California Supreme Court rejected the English Common Law doctrine of groundwater rights and established the Doctrine of Correlative Rights. Prior to the *Katz* decision, California had followed the doctrine articulated in the 1843 English decision of *Acton v. Blundell* (12 M. & W. 324, 152 Eng. Rep. 1223), which established that landowners enjoyed absolute ownership of groundwater underneath their property. The 1903 decision rejected the English Common Law approach as unsuitable for the "natural conditions" in California, and instead established the Correlative Rights Doctrine analogous to a riparian right. Each overlying landowner was entitled to make reasonable beneficial use of groundwater with a priority equal to all other overlying users. Water in excess of the needs of the overlying owners could be pumped and used on nonoverlying lands on a first-in-time, first-in-right basis under what is known as an appropriative right. An appropriative groundwater right, unlike its surface water counterpart, is not subject to a permitting process. Where overlying owners made full use of available supplies, appropriative rights were extinguished. Where there was insufficient water to meet even the needs of the overlying owners, the court applied the Correlative Rights Doctrine to apportion the available groundwater among the overlying landowners. Figure B-1 depicts the rights to use groundwater established in *Katz v. Walkinshaw*.

City of Pasadena v. City of Alhambra (33 Cal. 2d 908)

The 1949 decision, *Pasadena v. Alhambra*, added significant complexity to the right to use groundwater in California. This decision, involving the adjudication of the Raymond Basin, established the doctrine of mutual prescription. Groundwater levels in the basin had been declining for many years by the time court action was initiated. Most substantial pumpers, both overlying and appropriators, were joined in the action. Previously, appropriators only had a right to water surplus to the needs of overlying users. However, based upon a stipulation by most of the parties, the court in *Pasadena* adopted a program of proportionate reductions. These appropriators had each effectively gained a prescriptive right, similar to that of surface water rights, in which they had taken the water in an open, notorious, and hostile manner for at least five years. Mutual prescription provided groundwater rights to both overlying users and appropriators in depleted groundwater basins by prorating their rights based on the highest continuous amount of pumping during the five years following commencement of the overdraft. All of the users in the Raymond Basin were thus entitled to extract their portion of the court-approved safe yield of the basin.

City of Los Angeles v. City of San Fernando (14 Cal. 3d 199)

In 1975, in *Los Angeles v. San Fernando*, the California Supreme Court significantly limited the Mutual Prescription Doctrine introduced in Pasadena v. Alhambra. This opinion had far-reaching impacts on both the right to use groundwater and the practice of conjunctive use of groundwater and surface water to manage a basin. The case began in 1955, when the City of Los Angeles sued the cities of San Fernando, Glendale, Burbank and other pumpers, asserting a prior right to the San Fernando Valley groundwater basins in the northern part of the City of Los Angeles. The court, relying on Civil Code Section 1007, held that public agencies and public utilities cannot lose their groundwater rights by prescription. This holding effectively ruled out any future "mutual prescription" settlements or judgments involving rights held by public entities.

With respect to the native water supply of the San Fernando Basin, the court found that the City of Los Angeles had prior rights to all of this supply pursuant to its "pueblo right." Pueblo rights are traceable to rights recognized by the Spanish crown and the Mexican government. Under the Spanish/Mexican system, water rights were held in trust by pueblos for the benefit of all of its inhabitants. Under the Treaty of Guadalupe Hidalgo executed by Mexico and the United States in 1848, the municipal successors to Spanish/Mexican pueblos retained their pueblo rights upon the cession of California. In the San Fernando decision, the court confirmed Los Angeles' pueblo right, finding it superior to the rights of all overlying landowners. While a pueblo right is rare, it is an example of the complexity of the rights to use groundwater in California.

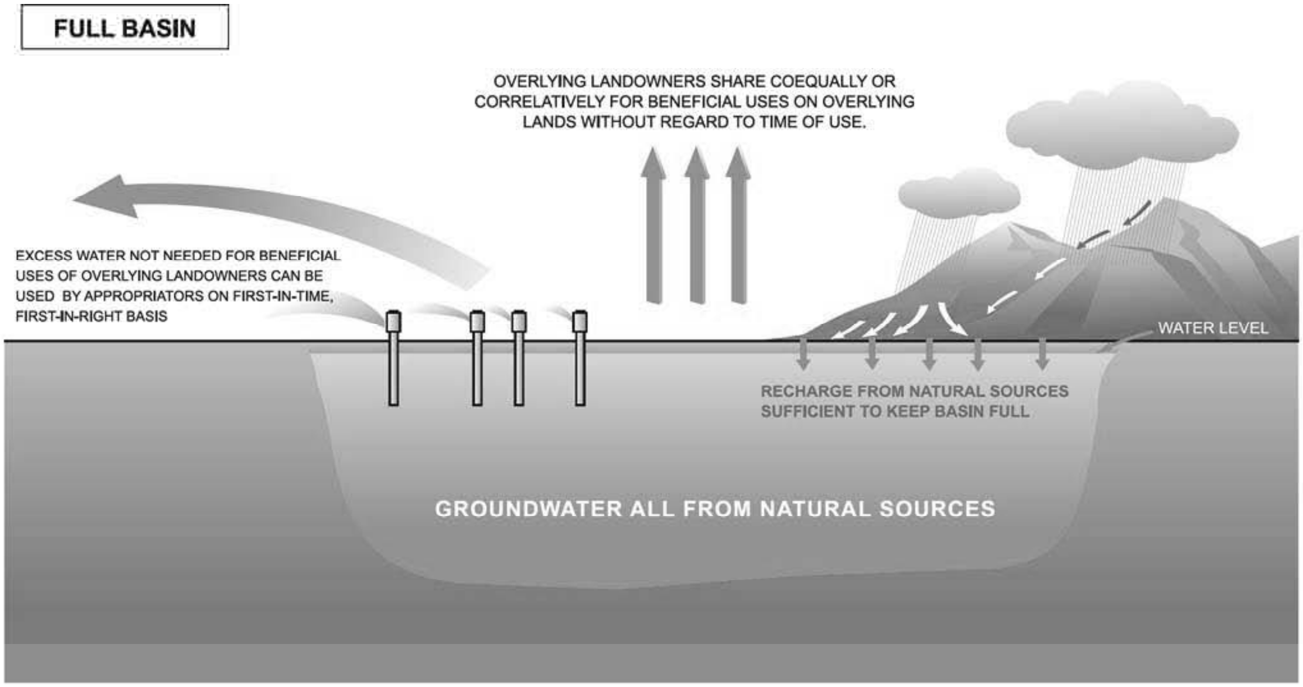

Figure B-1 Rights to groundwater use in full basin established in Katz v. Walkinshaw

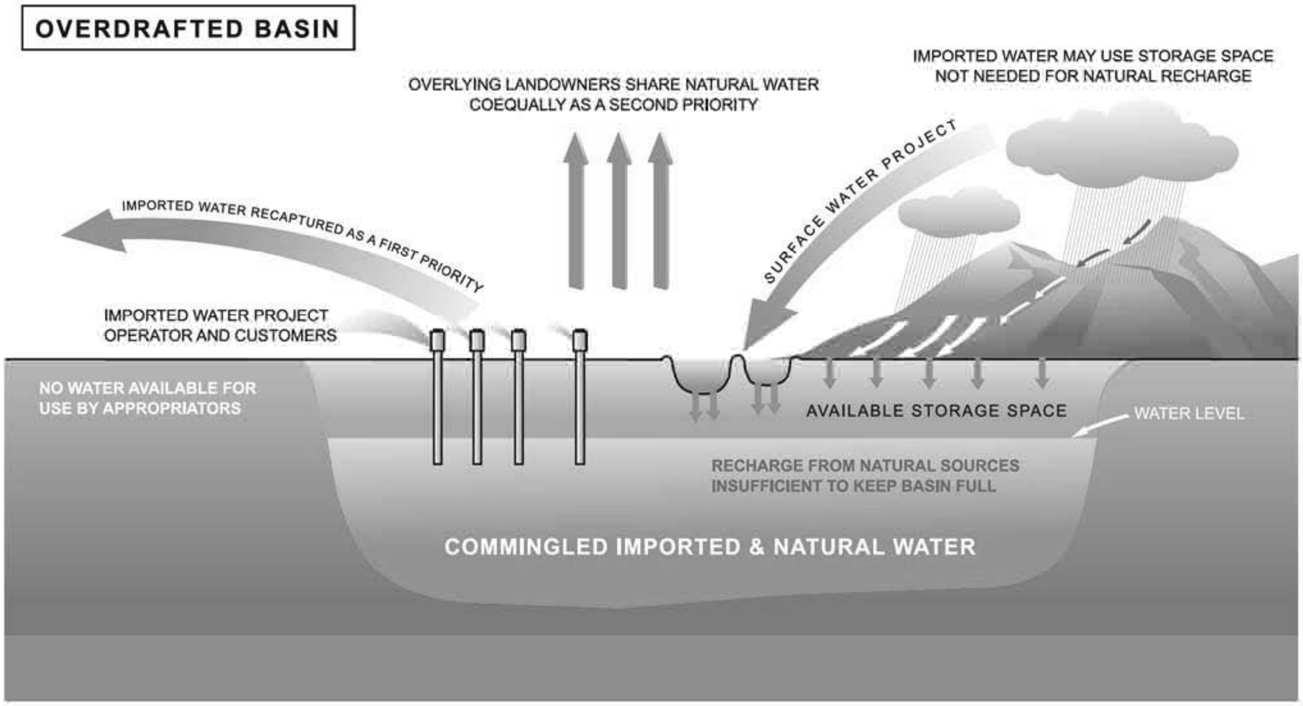

Figure B-2 Rights to groundwater use in overdrafted basin established in Los Angeles v. San Fernando

For the future of conjunctive use of groundwater basins, the court's holding with respect to the rights to available storage space in the Basin is significant. The court upheld the right of public agencies – namely the cities of San Fernando, Los Angeles, Burbank, and Glendale–to recapture the imported water they added to the Basin. The court held that the rights of the respective public agencies to recover such imported water are of equal priority to the City of Los Angeles' pueblo right, and that all such public agency rights are "prior to the rights dependent on ownership of overlying land or based solely upon appropriation of groundwater from the basin." The court remanded the case, directing the trial court to apportion the safe yield of the Basin accordingly.

The court noted that there did not appear to be any shortage of underground storage space in relation to the demand and, hence, the court did not find it necessary to determine priorities as to the future use of such space. The Judgment issued by the trial court on remand, however, provided: "To the extent of any future spreading or in lieu storage of import water or reclaimed water by Los Angeles, Glendale, Burbank or San Fernando, the party causing said water to be so stored shall have a right to extract an equivalent amount of ground water from the San Fernando Basin." Pursuant to the Judgment, a court-appointed Watermaster now manages the groundwater extraction and storage rights within the ULARA. Figure B-2 depicts the rights to use groundwater established in Los Angeles v. San Fernando in an overdrafted basin where water has been stored.

City of Barstow v. Mojave Water Agency (23 Cal. 4th 1224)

In 2000, the California Supreme Court partially overturned the 1995 adjudication of the Mojave River Basin. The trial court had approved a negotiated settlement (or stipulated agreement) that failed to include a well-by-well determination of water rights. The trial court held the negotiated settlement to be binding on all users in the basin, including some pumpers who had not agreed to the settlement. The lower court decision was based on the doctrine of "equitable apportionment," in which the available water is shared based on concepts of equity and fairness. The Court of Appeal had partially reversed the lower court, and held that the trial court did not have the authority to ignore California's traditional water rights doctrine giving overlying users a priority right to beneficial and reasonable use of the groundwater. The Court of Appeal affirmed the trial court's negotiated settlement except as it applied to two of the parties. First, the Court of Appeal reversed the holding against a non-negotiating party since the trial court had ignored that party's existing overlying water rights. Secondly, the Court of Appeal reversed the trial court's judgment as it applied to a company, where the negotiated agreement did not give the company a water-allowance equal to its actual water use. The Supreme Court affirmed the Court of Appeal decision, but reversed the judgment applying to the company's water-allowance. The Supreme Court also affirmed that the trial court could not apply the doctrine of equitable apportionment when overlying water users had already established a prior water right. The Court stated that, while the trial court could impose a physical solution (such as the negotiated settlement), the court could not simply ignore affected owners' legal water rights. Equitable apportionment, thus, remains a tool for adjudicating basin groundwater rights, but only if all parties stipulate to its use.

Appendix C
Required and Recommended Components of Local Groundwater Management Plans

Section 10750 et seq. of the Water Code, commonly referred to as Assembly Bill 3030, stipulates certain procedures that must be followed in adopting a groundwater management plan under this section.

Amendments to Section 10750 et seq. added the requirement that new groundwater management plans prepared under Section 10750 et seq. must include component 1 below (SB1938 (Stats 2002, Ch 603)).

In addition, the amendments mandate that if the agency preparing the groundwater management plan intends to apply for funding administered by the California Department of Water Resources (DWR) for groundwater or groundwater quality projects, the agency must prepare and implement a groundwater management plan that includes components 2, 3, 6, 7 and 9 below. DWR recommends that all the components below be included in any groundwater management plan to be adopted and implemented by a local managing entity.

Consideration and development of these components for the specific conditions of the basin to be managed under the plan will help to ensure effective groundwater management. In developing these criteria, DWR recognizes that the goal of a groundwater management plan and the goal of an ordinance to manage groundwater should be the same—assurance of a long-term, sustainable, reliable, good quality groundwater supply. Such efforts can benefit greatly from cooperative management within the basin or region.

None of the suggested data reporting in the components below should be construed as recommending disclosure of information that is confidential under State law.

1. Include documentation that a written statement was provided to the public "describing the manner in which interested parties may participate in developing the groundwater management plan," which may include appointing a technical advisory committee (Water Code § 10753.4 (b)).
2. Include a plan by the managing entity to "involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin." (Water Code § 10753.7 (a)(2)). A local agency includes "any local public agency that provides water service to all or a portion of its service area"
   (Water Code § 10752 (g)).
3. Provide a map showing the area of the groundwater basin, as defined by DWR Bulletin 118, with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan (Water Code § 10753.7 (a)(3)).
4. Establish an advisory committee of stakeholders (interested parties) within the plan area that will help guide the development and implementation of the plan and provide a forum for resolution of controversial issues.
5. Describe the area to be managed under the plan, including:
   a. The physical structure and characteristics of the aquifer system underlying the plan area in the context of the overall basin.

   b. A summary of the availability of historical data including, but not limited to, the components in Section 7 below.
   c. Issues of concern including, but not limited to, issues related to the components in Section 7 below.
   d. A general discussion of historical and projected water demands and supplies.

6. Establish management objectives (MOs) for the groundwater basin that is subject to the plan. (Water Code § 10753.7 (a)(1)).
7. Include components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping. (Water Code § 10753.7 (a)(1)). Consider additional components listed in Water Code § 10753.8 (a) through (l).
8. For each MO, describe how meeting the MO will contribute to a more reliable supply for long-term beneficial uses of groundwater in the plan area, and describe existing or planned management actions to achieve MOs.
9. Adopt monitoring protocols for the components in Section 7 (Water Code § 10753.7 (a)(4)). Monitoring protocols are not defined in the Water Code, but the section is interpreted to mean developing a monitoring program capable of tracking changes in conditions for the purpose of meeting MOs.
10. Describe the monitoring program, including:
    a. A map indicating the general locations of any applicable monitoring sites for groundwater levels, groundwater quality, subsidence stations, or stream gages.
    b. A summary of monitoring sites indicating the type (groundwater level, groundwater quality, subsidence, stream gage) and frequency of monitoring. For groundwater level and groundwater quality wells, indicate the depth interval(s) or aquifer zone monitored and the type of well (public, irrigation, domestic, industrial, monitoring).
11. Describe any current or planned actions by the local managing entity to coordinate with other land use, zoning, or water management planning agencies or activities (Water Code § 10753.8 (k), (l)).
12. Provide for periodic report(s) summarizing groundwater basin conditions and groundwater management activities. The report(s), prepared annually or at other frequencies as determined by the local management agency, should include:
    a. Summary of monitoring results, including a discussion of historical trends.
    b. Summary of management actions during the period covered by the report.
    c. A discussion, supported by monitoring results, of whether management actions are achieving progress in meeting MOs.
    d. Summary of proposed management actions for the future.
    e. Summary of any plan component changes, including addition or modification of MOs, during the period covered by the report.
    f. Summary of actions taken to coordinate with other water management and land use agencies, and other government agencies.
13. Provide for the periodic re-evaluation of the entire plan by the managing entity.
14. For local agencies not overlying groundwater basins, plans should be prepared including the above listed components and using geologic and hydrologic principles appropriate to those areas (Water Code § 10753.7 (a)(5)).

Appendix D
Groundwater Management Model Ordinance

In developing this model ordinance, the California Department of Water Resources recognizes that the goal of a groundwater management plan and the goal of an ordinance to manage groundwater should be the same—assurance of a long-term, sustainable, reliable, good quality groundwater supply. Such efforts require cooperative management within the region or sub-region.

Chapter X

Groundwater Management Ordinance

Sections:
X.01 Declaration of Findings
X.02 Purpose
X.03 Declaration of Intent
X.04 Definitions
X.05 Groundwater Management Program
X.06 Management Objectives
X.07 Monitoring Program Network
X.08 Monitoring Frequency
X.09 Changes in Monitoring
X.10 Review of Technical Data
X.11 Data Dissemination
X.12 Actions when MO Noncompliance is Reported
X.13 Regional Coordination
X.14 Integrated Resource Management
X.15 Data Relating to Export and Substitution of Groundwater

X.01 Declaration of Findings - The Board finds that:

A. The protection of the groundwater resource for its use within the County is of major concern to the residents of the County for the protection of their health, welfare, and safety.
B. The reliability and sustainability of the groundwater supply for all beneficial uses are of critical importance to the economic, social, and environmental well-being of the County.
C. A lack of effective groundwater management may have significant negative impacts, including, but not limited to:
  1. Lower groundwater levels leading to additional expenses from:
    a) Increased energy consumption.
    b) The need to deepen existing wells.
    c) The need to build new wells.
    d) The need to destroy non-functioning wells.
  2. Costly damage to public roads, bridges, canals, and other structures caused by land subsidence.
  3. Reduction of surface and subsurface flows leading to the potential loss of critical riparian and wetland habitat.
  4. Degradation of groundwater quality.

D. It is essential for management purposes to adopt a monitoring program addressing groundwater levels, groundwater quality, land subsidence, and surface water flow and quality where it directly impacts or is impacted by groundwater.

X.02 Purpose - In support of the findings above, the County has determined that this groundwater management ordinance is necessary to ensure that:

A. Groundwater continues to be a reliable and sustainable resource.
B. The extraction of groundwater does not result in significant adverse economic, environmental, or social impacts.
C. Groundwater quality is protected.
D. Excessive land surface subsidence from groundwater extraction is prevented.

X.03 Declaration of Intent

A. The County intends to foster prudent groundwater management practices by establishing a policy that encourages appropriate management of the resource based on recommendations by a committee of stakeholders.
B. The County intends that its groundwater management activities occur as an open and public process that considers input from all stakeholders in the County.
C. The County intends to work cooperatively with interested local agencies to further develop and implement joint groundwater management activities.
D. The County does not intend to regulate, in any manner, the use of groundwater, except as a last resort to protect the groundwater resource.
E. The County intends to act as an enforcing agency should the local resource become threatened.
F. The County does not intend to infringe upon the rights of surface water users in the managed area.
G. The County does not intend to limit other authorized means of managing groundwater within the County.

X.04 Definitions

A. “Aquifer” means a geologic formation that stores groundwater and transmits and yields significant quantities of water to wells and springs. Significant quantity is an amount that that satisfies local needs and may range from thousands of gallons per minute to less than 5 gpm, depending on rock type and intended use.
B. “Board” means the Board of Supervisors of the County.
C. “District” means a district or municipality, located wholly or partially within the boundaries of the County, that is a purveyor of water for agricultural, domestic, or municipal use.
D. “Enforcement Agency” means the Board as the enforcement agency under this chapter.
E. “Groundwater” means all water beneath the surface of the earth below the zone of saturation, but does not include subterranean streams flowing in known and definite channels.
F. “Groundwater Basin” means an aquifer or series of aquifers with a reasonably defined lateral and vertical extent, as defined in Bulletin 118 by Department of Water Resources. “Non-basin areas” are outside defined groundwater basins and contain smaller amounts of groundwater in consolidated sediments or fractured hard rock.
G. “Groundwater Export” means the conveyance of groundwater outside of the boundaries of the County and outside of the boundaries of any district that is partially within the County.
H. “Groundwater Substitution” means the voluntary use of an available groundwater supply instead of surface water for the purposes of using the surface water outside the County and outside the boundaries of any district that is partially within the County.

I. “Land Subsidence” means the lowering of the ground surface caused by the inelastic consolidation of clay beds in the aquifer system.
J. “Management Objective”(MO) means a condition identified for each subunit to ensure that the groundwater supply is reliable and sustainable. The MOs set acceptable conditions with respect to groundwater levels, groundwater quality, inelastic land surface subsidence, and surface water flows and quality. Compliance with the MO is tracked by a monitoring program and threshold values that are adopted for each Management Objective.
K. “Recharge” means flow to groundwater storage from precipitation, and infiltration from streams, irrigation, spreading basins, injection wells, and other sources of water.
L. “Reliability” means having an available, predictable, and usable groundwater supply at any given point in time.
M. “Stakeholder” means an individual or an entity, such as a water supplier or a county resident, with a permanent interest in the availability of the groundwater resource.
N. ”Subunit” means any subdivision of a groundwater basin or non-basin area in the County created for the purposes of representation of stakeholders and the establishment of local area management objectives.
O. “Sustainable” means the groundwater resource is maintained for use by residents in the basin over a prolonged period of time.
P. “Technical Advisory Committee” means a committee of persons knowledgeable in groundwater management, hydrology, and hydrogeology established for the purpose of providing technical guidance to the Water Advisory Committee.
Q. “Threshold values” mean the limits established by the WAC for groundwater levels, groundwater quality, land surface subsidence, and surface water flow and quality that are not to be exceeded if the MOs are to be met.
R. “Water Advisory Committee” (WAC) means a multimember advisory body established for the purpose of aiding the Board in providing effective management of the groundwater resources in the County, and representing all of the subunits that are identified.
S. “Water Management Entities” means any local agency, or group of agencies, authorized to manage groundwater.

X.05 Groundwater Management Program

A. The County recognizes that effective groundwater management is key to maintaining a reliable and sustainable resource. For the purposes of establishing an effective groundwater management program, the Board shall appoint a WAC to establish MOs and make recommendations to the Board to ensure that MOs are met.
B. For purposes of establishing a WAC, the groundwater basins and non-basin areas of the County will be divided into subunits based on hydrogeologic principles and institutional boundaries. These subunits shall be established by the Board based on public input to address the groundwater management needs of the County. The WAC shall consist of members that represent each subunit. Upon establishment of the subunits, the Board shall appoint a member to represent each subunit on the WAC.
C. The WAC shall have the following responsibilities to the Board:
    1. Recommend MOs for each groundwater management subunit.
    2. Recommend a groundwater monitoring network for purposes of tracking MOs.
    3. Recommend the frequency of monitoring.
    4. Propose changes in monitoring.
    5. Ensure monitoring data receive technical review.
    6. Ensure that monitoring data are made available to the public.

7. Recommend actions to resolve noncompliance with MOs.

D. For the purposes of providing technical advice to the WAC in carrying out its responsibilities, a technical advisory committee (TAC) shall be established. The TAC shall consist of local experts or a combination of local expertise and technical consultants from private and public organizations that are nominated by the WAC and approved by the Board. Individuals appointed to the TAC should be highly knowledgeable in groundwater management, hydrology, and hydrogeology. The TAC shall review technical data collected by monitoring programs within the County and advise the WAC.

X.06 Management Objectives

A. To ensure that the County maintains a reliable and sustainable groundwater supply, MOs for groundwater levels, groundwater quality, land subsidence, and surface water flow and quality shall be adopted for each subunit. Threshold values that are not to be exceeded shall be defined for each MO.

B. Compliance with the MOs will be determined by evaluation of data collected from groundwater level, groundwater quality, land subsidence, and surface water flow and quality monitoring networks. Evaluation of these data with respect to threshold values shall be the basis for determining compliance with the MOs.

C. Each WAC member shall recommend MOs for their subunit. The WAC shall develop a comprehensive set of recommendations for all subunits, and the Board shall adopt these MOs for the County. MOs may differ from subunit to subunit, but the established MOs shall be consistent with the overall goal of supply reliability for the County.

D. Groundwater management practices based on the established MOs for one subunit of the County shall not adversely impact adjacent subunits.

X.07 Monitoring Program Network

The WAC shall develop County-wide monitoring programs to collect representative data on groundwater levels, groundwater and surface water quality, land surface subsidence, and stream flow and quality. Each subunit shall propose its own monitoring program, and the WAC shall adopt a comprehensive monitoring program for the County. The data collected, showing current conditions and changes over time as a result of groundwater extraction, shall be evaluated by the WAC in consultation with the TAC. The WAC will recommend policies and actions to ensure that MOs for each subunit are met. The collection and evaluation of the data shall be based on scientifically sound principles, and shall incorporate appropriate quality assurance and quality control protocols.

A. Groundwater levels: The groundwater level monitoring network shall be proposed by the WAC and approved by the Board. The intent of the groundwater level monitoring network is to measure water levels in selected wells that can adequately determine representative conditions in the aquifer system for determination of compliance with the MOs. The network will include selected municipal, domestic, and irrigation wells owned by water districts, private parties, and municipal and industrial water suppliers. Where needed, dedicated monitoring wells may be installed. Participation by well owners will be voluntary.

B. Water Quality: The groundwater quality monitoring network shall be proposed by the WAC and approved by the Board. The intent of the groundwater quality monitoring network is to monitor selected wells that can adequately determine representative groundwater quality conditions in the aquifer system for identification of compliance with the MOs. The network will include selected municipal, domestic, and irrigation wells owned by water districts, private parties, and municipal and industrial water suppliers. Where needed, dedicated monitoring wells may be installed. Participation by well owners will be voluntary.

C. Land Subsidence: The land subsidence program and network shall be proposed by the WAC and approved by the Board. The intent of the land subsidence monitoring is to detect land subsidence for determination of compliance with the MOs. The network may include benchmarks that are surveyed for changes in elevation throughout the County, based on the judgment of the WAC of the need for such a program.

D. Surface Water Flow and Quality: The surface water flow and quality network shall be proposed by the WAC and approved by the Board. The intent of this network is to detect changes in surface water flow or surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping for evaluation of compliance with MOs.

X.08 Monitoring Frequency

The recommended frequency of collection of data for each of the parameters listed above shall be determined by the WAC. Initially, each parameter should be measured at the frequencies outlined below, unless the WAC notes upon evaluation of existing data that more frequent monitoring or additional analyses are called for.

A. Groundwater levels should be measured at least three times during the year: one measurement prior to the period of highest groundwater use, one measurement during peak groundwater use, and one measurement following the period of highest groundwater use (approximately the months of ______, ______, and ______).

B. Groundwater quality measurements of electrical conductivity, temperature, and pH should be obtained at least twice annually during the periods of highest and lowest groundwater use (approximately the months of _____ and ______). Upon evaluation of the data, the WAC may propose analyses for other constituents.

C. Selected benchmarks in the County land subsidence monitoring network should be surveyed every five years at a minimum. These surveys should be conducted following aquifer recovery and prior to the period of highest groundwater extraction (approximately the month of_____).

D. Measurement of surface water flow and quality in areas determined to directly affect groundwater levels or quality or that are affected by groundwater pumping shall be obtained at least ___ times per month as long as there are flows in the channel.

X.09 Changes in Monitoring

If evaluation of the groundwater level, groundwater quality, land subsidence, surface water flow, or surface water quality data indicates a need for more or less frequent measurements or analyses, the WAC may propose a change in the monitoring frequency. Similarly, if evaluation of the data indicates that additional monitoring sites are necessary, the WAC may propose an additional or a reduced number of sites for data collection. The Board shall adopt these changes when supported by credible evidence.

X.10 Review of Technical Data

A. The TAC shall propose and the WAC shall adopt standard methods using scientifically sound principles for review and analysis of the collected data. The TAC will meet, as needed and requested by the WAC, to evaluate the technical data and shall report their findings at appropriate meetings of the WAC. The WAC shall meet at least __ times per month during the period of maximum groundwater use (months of _____ through ______) and quarterly during the off season (months of ______ through ______), or as necessary.

B. During the period of highest groundwater use, the WAC meetings will focus on data review and analysis with respect to compliance with the current MOs. During the period of low groundwater use, the WAC meetings will focus on a review of compliance with MOs for the previous period of high groundwater use and consideration of the need for changes to the MOs.

X.11 Data Dissemination

The WAC, in addition to establishing methods for data collection and evaluation, shall establish methods for data storage and dissemination. The WAC shall disseminate the monitoring data and evaluation reports through public presentations and through a County-maintained groundwater Internet site. At a minimum, the WAC shall publicly present findings from the monitoring program to the Board twice annually.

X.12 Actions when MO Noncompliance is Reported

A. Action by Technical Advisory Committee. In the event that the TAC identifies an area that is not in compliance with the MOs, or if noncompliance is reported by any other means, the TAC shall report to the WAC on the regional extent and magnitude of the noncompliance. This information shall also be released to the public no later than ___ days from the time that noncompliance with MOs was identified. The TAC shall then collect all available pertinent hydrologic data, investigate possible causes for noncompliance with MOs, and recommend actions to the WAC to bring the area into compliance. These recommendations shall be made no later than ___ days after the report of noncompliance is released to the public. The TAC shall first make recommendations that focus on correcting the noncompliance through negotiations with all parties in the affected area.

B. Action by Water Advisory Committee. The WAC shall act as lead negotiator in re-establishing compliance with the MO. If negotiations with parties in the affected area do not result in timely and positive action to re-establish compliance with MOs for the basin, the WAC may recommend a plan to the Board to modify, reduce or terminate groundwater extraction in the affected area or take other necessary actions. Such a plan will be recommended to the Board only after the WAC has thoroughly reviewed the recommendations of the TAC at a public meeting. The modification, reduction, or termination of groundwater extraction in the affected area shall first be applied to wells involved in any export or substitution programs, and then to other wells if necessary. Domestic wells shall not be considered for any modification, reductions, or termination of groundwater extraction.

C. Action by Board of Supervisors. The Board of Supervisors, using its police powers, shall act as the enforcement agency for this ordinance. Any recommendation of the WAC may be appealed to the Board within __ working days.

X.13 Regional Coordination

Management decisions recommended by the WAC and adopted by the Board shall not deleteriously affect groundwater resources in any portions of groundwater basins or non-basin areas that share a common groundwater resource in adjacent counties. To accomplish this goal, the WAC shall meet and coordinate with water management entities outside the County that overlie a common groundwater basin at least twice per year once prior to the period of highest groundwater use and once following the period of highest groundwater use.

X.14 Integrated Resource Management

A. To ensure integration of planning activities within the County, the WAC shall inform County departments involved with groundwater related activities, including but not limited to Land Use or Zoning, Planning, Public Works, Utilities, and Environmental Health, of all WAC meetings and actions regarding MOs. In turn, these County departments shall take into consideration the adopted MOs when approving development or zoning changes or construction projects that may rely on or affect groundwater quantity or quality.

B. To the greatest extent practicable, the WAC should also integrate resource management planning with other agencies within the basin. Resource activities that could benefit from integrated planning with groundwater management include, but are not limited to:
- Groundwater management planning by other agencies—agricultural, municipal, industrial, local government
- Watershed management plans
- Urban water management plans
- Management and disposal of municipal solid waste and municipal sewage
- Drinking water source assessment and protection programs
- Public water system emergency and disaster response plans
- Surface water and groundwater conjunctive management programs
- Expansion of surface and groundwater facilities
- Water efficiency programs
- Water recycling programs
- Environmental habitat construction or restoration programs
- Water quality protection programs
- Recharge programs
- Transportation infrastructure planning

X.15 Data Relating to Export and Substitution of Groundwater

A. Districts, persons, or contractors intending to operate a groundwater export or groundwater substitution program shall submit the following data to the WAC __ working days prior to commencing the program:
1. A description of the project with the total amount of groundwater to be exchanged or substituted
2. The dates over which the project will take place.
3. A statement of the anticipated impacts of the project relative to adopted MOs.
4. A discussion of possible contingencies in the event of MO noncompliance.
5. A map showing the location of the wells to be used by the program.
6. A summary of any monitoring program proposed.
7. All required environmental documentation.

B. While the program is in operation, the following information shall be provided to the WAC at least ___ times per month:
1. All static and pumping groundwater level measurements made in the pumping well during the period of extraction for the export or substitution program.
2. The amount of groundwater extracted from each well per week.
3. Static groundwater level measurements in at least __ of the most proximal wells to the project pumping wells that can be practicably monitored.

C. All costs for providing such information to the WAC shall be borne by the project participants.

Note: Although the terms “County” and “Board” are used throughout the model ordinance for clarity, the model could be used by any local government or agency with appropriate authority or powers.

Appendix E
SWRCB Beneficial Use Designations[1]

Agricultural Supply (AGR) – Uses of water for farming, horticulture, or ranching including, but not limited to irrigation, stock watering, or support of vegetation for ranch grazing.

Aquaculture (AQUA) – Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Cold Freshwater Habitat (COLD) – Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST) – Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Freshwater Replenishment (FRSH) – Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

Groundwater Recharge (GWR) – Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Hydropower Generation (POW) – Uses of water for hydropower generation.

Industrial Process Supply (PRO) – Uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND) – Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Inland Saline Water Habitat (SAL) – Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Marine Habitat (MAR) – Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Migration of Aquatic Organisms (MIGR) – Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Municipal and Domestic Supply (MUN) – Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Navigation (NAV) – Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Noncontact Water Recreation (REC-2) – Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Ocean Commercial and Sport Fishing (COMM) – Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

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[1] From SWRCB 2000

Preservation of Biological Habitats of Special Significance (BIOL) – Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) – Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance or plant or animal species established under State or federal law as rare, threatened or endangered.

Shellfish Harvesting (SHELL) – Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Spawning, Reproduction, and/or Early Development (SPWM) – Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Warm Freshwater Habitat (WARM) – Uses of water that support warmwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Water Contact Recreation (REC-1) – Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Wildlife Habitat (WILD) – Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Appendix F
Federal and State MCLs and Regulation Dates for Drinking Water Contaminants

	U.S. Environmental Protection Agency		California Department of Health Services	
Contaminant	**MCL (mg/L)**	**Date[a]**	**MCL (mg/L)**	**Effective date**
Inorganics				
Aluminum	0.05 to 2[b]	1/91	1 0.2[b]	2/25/89 9/8/94
Antimony	0.006	7/92	0.006	9/8/94
Arsenic	0.05 0.01	eff: 6/24/77 2001	0.05	77
Asbestos	7 MFL[c]	1/91	7 MFL[c]	9/8/94
Barium	1 2	eff: 6/24/77 1/91	1	77
Beryllium	0.004	7/92	0.004	9/8/94
Cadmium	0.010 0.005	eff: 6/24/77 1/91	0.010 0.005	77 9/8/94
Chromium	0.05 0.1	eff: 6/24/77 1/91	0.05	77
Copper	1.3[d]	6/91	1[b] 1.3[d]	77 12/11/95
Cyanide	0.2	7/92	0.2 0.15	9/8/94 6/12/03
Fluoride	4 2[b]	4/86 4/86	2	4/98
Lead	0.05[e] 0.015[d]	eff: 6/24/77 6/91	0.05[e] 0.015[d]	771 2/11/95
Mercury	0.002	eff: 6/24/77	0.002	77
Nickel	Remanded	0.1	9/8/94	
Nitrate	(as N)10	eff: 6/24/77	(as N03) 45	77
Nitrite (as N)	1	1/91	1	9/8/94
Total Nitrate/Nitrite (as N)	10	1/91	10	9/8/94
Selenium	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Thallium	0.002	7/92	0.002	9/8/94
Radionuclides				
Uranium	30 g/L	12/7/00	20 pCi/L	1/1/89
Combined radium-226 & 228	5 pCi/L	eff: 6/24/77	5 pCi/L	77
Gross Alpha particle activity	15 pCi/L	eff: 6/24/77	15 pCi/L	77
Gross Beta particle activity	dose of 4 millirem/yr	eff: 6/24/77	50 pCi/L[f]	77

	U.S. Environmental Protection Agency		California Department of Health Services	
Contaminant	**MCL (mg/L)**	**Date[a]**	**MCL (mg/L)**	**Effective date**
Strontium-90	8 pCi/L	eff: 6/24/77 now covered by Gross Beta	8 pCi/L[f]	77
Tritium	20,000 pCi/L	eff: 6/24/77 now covered by Gross Beta	20,000 pCi/L[f]	77
VOCs				
Benzene	0.005	6/87	0.001	2/25/89
Carbon Tetrachloride	0.005	6/87	0.0005	4/4/89
1,2-Dichlorobenzene	0.6	1/91	0.6	9/8/94
1,4-Dichlorobenzene	0.075	6/87	0.005	4/4/89
1,1-Dichloroethane	- -	- -	0.005	6/24/90
1,2-Dichloroethane	0.005	6/87	0.0005	4/4/89
1,1-Dichloroethylene	0.007	6/87	0.006	2/25/89
cis-1,2-Dichloroethylene	0.07	1/91	0.006	9/8/94
trans-1,2-Dichloroethylene	0.1	1/91	0.01	9/8/94
Dichloromethane	0.005	7/92	0.005	9/8/94
1,3-Dichloropropene	- -	- -	0.0005	2/25/89
1,2-Dichloropropane	0.005	1/91	0.005	6/24/90
Ethylbenzene	0.7	1/91	0.68 0.7 0.3	2/25/89 9/8/94 6/12/03
Methyl-tert-butyl ether (MTBE)	- -	- -	0.005[b] 0.013	1/7/99 5/17/00
Monochlorobenzene	0.1	1/91	0.03 0.07	2/25/89 9/8/94
Styrene	0.1	1/91	0.1	9/8/94
1,1,2,2-Tetrachloroethane	- -	- -	0.001	2/25/89
Tetrachloroethylene	0.005	1/91	0.005	5/89
Toluene	1	1/91	0.15	9/8/94
1,2,4 Trichorobenzene	0.07	7/92	0.07	9/8/94
1,1,1-Trichloroethane	0.200	6/87	0.200	2/25/89
1,1,2-Trichloroethane	0.005	7/92	0.032 0.005	4/4/89 9/8/94
Trichloroethylene	0.005	6/87	0.005	2/25/89
Trichlorofluoromethane	- -	- -	0.15	6/24/90
1,1,2-Trichloro-1,2,2- Trifluoroethane	- -	- -	1.2	6/24/90
Vinyl chloride	0.002	6/87	0.0005	4/4/89
Xylenes	10	1/91	1.750	2/25/89

	U.S. Environmental Protection Agency		California Department of Health Services	
Contaminant	**MCL (mg/L)**	**Date[a]**	**MCL (mg/L)**	**Effective date**
SVOC's				
Alachlor	0.002	1/91	0.002	9/8/94
Atrazine	0.003	1/91	0.003 0.001	4/5/89 6/12/03
Bentazon	- -	- -	0.018	4/4/89
Benzo(a) Pyrene	0.0002	7/92	0.0002	9/8/94
Carbofuran	0.04	1/91	0.018	6/24/90
Chlordane	0.002	1/91	0.0001	6/24/90
Dalapon	0.2	7/92	0.2	9/8/94
Dibromochloropropane	0.0002	1/91	0.0001 0.0002	7/26/89 5/3/91
Di(2-ethylhexyl)adipate	0.4	7/92	0.4	9/8/94
Di(2-ethylhexyl)phthalate	0.006	7/92	0.004	6/24/90
2,4-D	0.10.07	eff: 6/24/77 1/91	0.1 0.07	77 9/8/94
Dinoseb	0.007	7/92	0.007	9/8/94
Diquat	0.02	7/92	0.02	9/8/94
Endothall	0.1	7/92	0.1	9/8/94
Endrin	0.0002 0.002	eff: 6/24/77 7/92	0.0002 0.002	77 9/8/94
Ethylene Dibromide	0.00005	1/91	0.00002 0.00005	2/25/89 9/8/94
Glyphosate	0.7	7/92	0.7	6/24/90
Heptachlor	0.0004	1/91	0.00001	6/24/90
Heptachlor Epoxide	0.0002	1/91	0.00001	6/24/90
Hexachlorobenzene	0.001	7/92	0.001	9/8/94
Hexachlorocyclopentadiene	0.05	7/92	0.05	9/8/94
Lindane	0.004 0.0002	eff: 6/24/77 1/91	0.004 0.0002	77 9/8/94
Methoxychlor	0.1 0.04	eff: 6/24/77 1/91	0.1 0.04 0.03	77 9/8/94 6/12/03
Molinate	- -	- -	0.02	4/4/89
Oxamyl	0.2	7/92	0.2 0.05	9/8/94 6/12/03
Pentachlorophenol	0.001	1/91	0.001	9/8/94
Picloram	0.5	7/92	0.5	9/8/94
Polychlorinated Biphenyls	0.0005	1/91	0.0005	9/8/94
Simazine	0.004	7/92	0.010 0.004	4/4/89 9/8/94

Contaminant	U.S. Environmental Protection Agency MCL (mg/L)	Date[a]	California Department of Health Services MCL (mg/L)	Effective date
Thiobencarb	- -	- -	0.07 0.001[b]	4/4/89 4/4/89
Toxaphene	0.005 0.003	eff: 6/24/77 1/91	0.005 0.003	77 9/8/94
2,3,7,8-TCDD (Dioxin)	$3x10^{-8}$	7/92	$3x10^{-8}$	9/8/94
2,4,5-TP (Silvex)	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Disinfection Byproducts				
Total trihalomethanes	0.10 0.080	11/29/79 eff: 11/29/83 eff: 1/1/02[g]	0.10	3/14/83
Total haloacetic acids	0.060	eff: 1/1/02[g]		
Bromate	0.010	eff: 1/1/02[g]		
Chlorite	1.0	eff: 1/1/02[g]		
Treatment Technique				
Acrylamide	TT[h]	1/91	TT[h]	9/8/94
Epichlorohydrin	TT[h]	1/91	TT[h]	9/8/94

Source: http://www.dhs.ca.gov/ps/ddwem/chemicals/MCL/EPAandDHS.pdf

a. "eff." indicates the date the MCL took effect; any other date provided indicates when EPA established (that is, published) the MCL.

b. Secondary MCL.

c. MFL = million fibers per liter, with fiber length > 10 microns.

d. Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.

e. The MCL for lead was rescinded with the adoption of the regulatory action level described in footnote d.

f. MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.

g. Effective for surface water systems serving more than 10,000 people; effective for all others 1/1/04.

h. TT = treatment technique, because an MCL is not feasible.

Federal and State MCLs – updated 05/23/03

Appendix G
Development of Current Groundwater Basin/Subbasin Map

This Bulletin 118 update represents the first time that groundwater basin boundaries have been released as a digital coverage. The basin boundaries for the revised groundwater basin map were primarily defined using geologic contacts and hydrogeologic barriers. Specifically the identification of the groundwater basins was initially based on the presence and areal extent of unconsolidated alluvial sediments identified on 1:250,000 scale, geologic maps published by the California Department of Conservation, Division of Mines and Geology. The identified groundwater basin areas were then further evaluated through review of relevant geologic and hydrogeologic reports and well completion reports, and using the basin definition criteria listed in Table 8. Basin boundaries that are specified in each of the court decisions has been used for the boundaries of adjudicated basins.

Well completion reports for wells present in basin areas that were identified from the geologic map were reviewed to identify the depth to the top of the water table and the top of impermeable bedrock. If there was less than 25 feet of permeable material present or if there was no groundwater present within the permeable material, the area was eliminated from the map. The well completion reports were also reviewed to determine if water supply wells located within the delineated basin area were extracting groundwater from the permeable materials underlying the area or from the bedrock beneath the permeable material. If the wells only extracted groundwater from the bedrock, the area was eliminated from the map. This resulted in the elimination of some areas identified as basins in previous Bulletin 118 publications. If there were no wells present in basin areas identified from the geologic map and no other information on the geology underlying these areas, the areas were retained in the current version of the map. Additional hydrogeologic information might or might not verify that these areas should be retained as groundwater basins.

Groundwater basins were delineated and separated from each other by the following restrictions on groundwater flow. For more detail on the types of basins and the flow boundaries of those basins, see Table 8.

Impermeable Bedrock. Impermeable bedrock with lower water yielding capacity. These include consolidated rocks of continental and marine origin and crystalline/or metamorphic rock.

Constrictions in Permeable Materials. A lower permeability material, even with openings that are filled with more permeable stream channel materials, generally forms a basin boundary for practical purposes. While groundwater may flow through the sediment-filled gaps, the flow is restricted to those gaps.

Fault. A fault that crosses permeable materials may form a barrier to groundwater movement if movement along the fault plane has created fine material that impedes groundwater movement or juxtaposed low permeability material adjacent to an aquifer. This is usually indicated by noticeable difference in water levels in wells and/or flow patterns on either side of the fault. Not all faults act as barriers to groundwater flow.

Low Permeability Zone. Areas of clay or other fine-grained material that have significant areal or vertical extent generally form a barrier to groundwater movement within the basin but do not form basin boundaries.

Groundwater Divide. A groundwater divide is generally considered a barrier to groundwater movement from one basin to another for practical purposes. Groundwater divides have noticeably divergent groundwater flow directions on either side of the divide with the water table sloping away from the divide. The location of the divide may change as water levels in either one of the basins change, making such a "divide" less useful. Such a boundary is often used for subbasins.

Adjudicated Basin Boundaries. The basin boundaries established by court order were used for all adjudicated basins. These court-decided boundaries affect the location of natural boundaries of adjoining basins. Some adjudicated basins are represented as subbasins in this bulletin.

Available reports on the geologic and hydrogeologic conditions in the delineated basin areas were also reviewed to determine if there was information that would further define the boundaries of the basin areas. This review resulted in changes to some of the basin boundaries identified in previous versions of Bulletin 118.

Several of the larger groundwater basins were further subdivided into groundwater subbasins in Bulletin 118-80 and additional large groundwater basins were subdivided during this 2003 revision. The subbasin boundaries were also primarily defined using geologic contacts and hydrogeologic divides where possible. If this was not possible, political or institutional boundaries were used.

The hydrogeologic information contained in the basin descriptions that supplement this update of Bulletin 118 includes only the information that was available in California Department of Water Resources (DWR) files through reference searches and through limited contact with local agencies. Local agencies may have conducted more recent studies that have generated additional information about water budgets and aquifer characteristics. Unless the agency notified DWR or provided a copy of the recent reports to DWR staff that recent information has not been included in the basin descriptions. Therefore, although Senate Bill 610 refers to groundwater basins identified as overdrafted in Bulletin 118, it would be prudent for local water suppliers to evaluate the potential for overdraft of any basin included as a part of a water supply assessment.

Persons interested in collecting groundwater information in accordance with the Water Code as amended by SB 221 and SB 610 may start with the information in Bulletin 118, but should follow up by consulting the references listed for each basin and contacting local water agencies to obtain any new information that is available. Otherwise, evaluation of available groundwater resources as mandated by SB 221 and SB 610 may not be using the most complete and recent information about water budgets and aquifer characteristics.

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated.

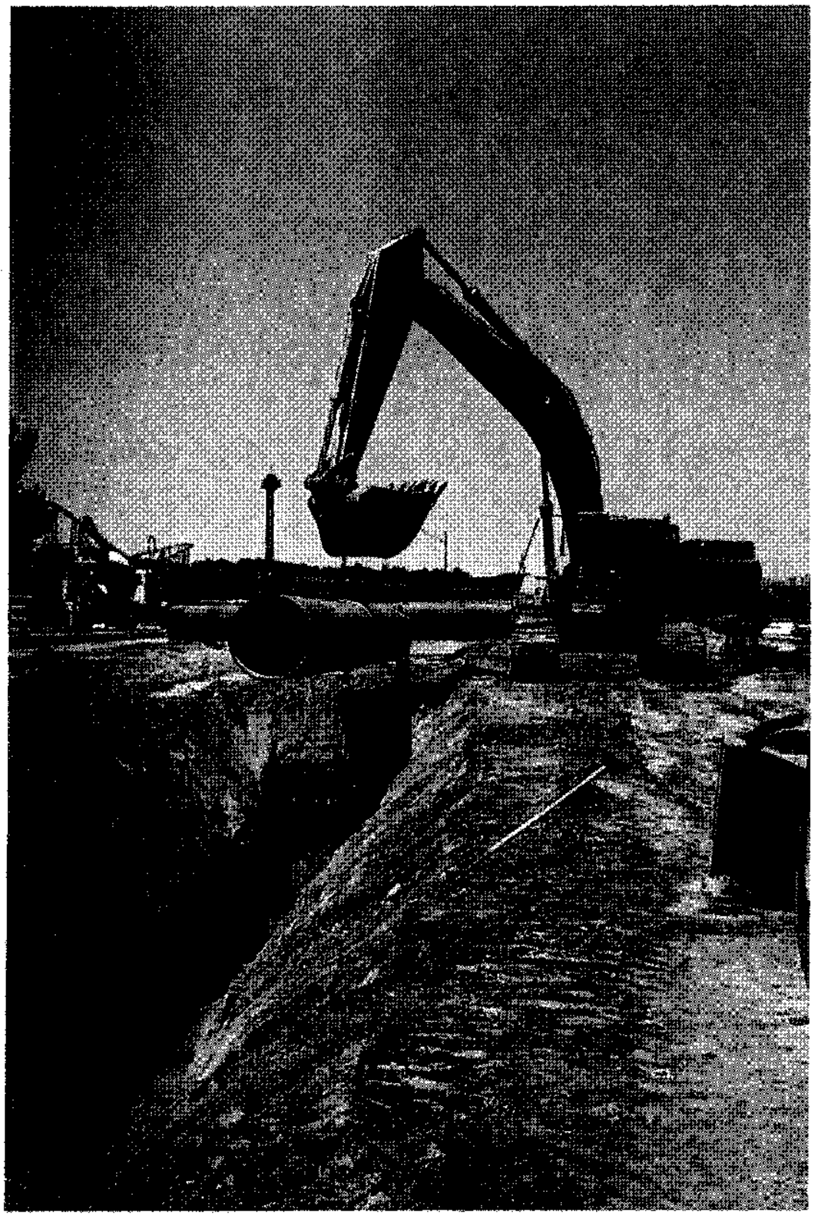
In many other basins where much less is known and understood about the basin, boundaries will probably change as a better understanding of the basin is developed. A procedure for collecting information from all the stakeholders should be developed for use statewide so that agreement on basin boundaries can be achieved.

CLWA Data Document Providing Economic Justification for
Proposed Facility Capacity Fees, April 19, 2003

Castaic Lake Water Agency

Data Document

Providing Economic Justification for Proposed Facility Capacity Fees



April 19, 2003

Castaic Lake Water Agency
Memorandum

April 18, 2003

To: Board of Directors

From: Laurie Foster
Finance Officer

Subject: 2003 Data Document

Enclosed for your review is the Castaic Lake Water Agency Data Document Providing Justification for Proposed Facility Capacity Fees dated April 19, 2003. Please bring this document to the April 30, 2003 Public Hearing forming water service areas for Castaic Lake Water Agency 2003/04 and taking all necessary actions to set and fund the Agency's annual capital budget.

LAF

Enclosure

Cc (w/out enclosure): Dan Masnada, Russ Behrens

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Castaic Lake Water Agency
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April 2003

Report Purpose

This report provides the data concerning the estimated cost of facilities to supply water for new development, and the proposed method and basis for allocating the costs among those lands on which new development occurs, as required by Section 26.1 (c) (3) of the Castaic Water District Law. The following discussion addresses the Castaic Lake Water Agency's proposed Fiscal Year 2003/04 Facility Capacity Fee program in the context of estimated long-term costs of the Capital Improvement Program (CIP) activities of the Agency.

The CIP is a plan [within the meaning of §26.1 of the CLWA act] for the following purposes:

(1) To obtain additional facilities, works, property, improvements, and supplies of water.

(2) To increase or enlarge, as may be appropriate, its existing capacity and facilities for obtaining, importing, transporting, and delivering additional quantities of water to retail water distributors within the agency which are in need of additional water supplies.

(3) To finance or reimburse the agency for advancing the cost of acquiring facilities, works, property, improvements, and supplies of water and to allocate that cost among lands within water service areas of the agency which, by reason of new development or new construction thereon, will need new water service and will be benefited by making the additional supplies of agency water available for purchase by the retail water distributors that will supply those lands with water.

Agency water made available through CIP activities will be sold to retail water distributors who in turn, will serve Agency water to lands on which new water-utilizing development may occur as and when approved by municipal and County planning agencies. Neither the CIP nor the adoption of Facility Capacity Fees commits the Agency to proceed with any project identified in the CIP. The purpose of the CIP is to identify and estimate the cost of projects which would be able to produce additional water supplies needed in the event new development is approved and constructed. The ultimate decision to proceed with any water supply, storage, treatment, or transmission project will depend upon growth patterns, development approvals given by city and county planning authorities, cost, and the feasibility and environmental impacts of each project. The Facility Capacity Fees contemplated herein will produce revenue only if new development actually occurs, and will not provide funding for water supply projects if no development occurs.

This report also presents background information concerning the proposed methods and basis for allocating the estimated long-term cost of Agency CIP activities to those lands which have been designated by planning agencies to accommodate new development. In addition, the report updates previous data document reports by recognizing the water demand of development which has occurred within the Agency since the adoption of the last Facility Capacity Fees.

This report is consistent with the recently submitted Urban Water Management Plan dated December 2000 which was prepared as required by State law. The Urban Water Management Plan reviews water demand and source of supply over near and long-term periods.

The Agency's water planning documents such as the Draft Integrated Water Resources Plan, Phase I dated February 8, 1998, and the Urban Water Management Plan are used as a source for the development of the Agency's CIP.

This report sets forth economic justification for the creation of revised facility capacity fee rates to fund new development's fair share of the proposed CIP activities identified and recommended by the Agency's Engineer.

Background

The proposed Facility Capacity Fee is structured to provide an identified equitable means of funding future Agency CIP activities between existing users and future development which creates new water demand. The Agency's enabling act, (West's Water Code-Appendix, Chapter 103), describes the manner in which the Agency's annual capital budget, including Facility Capacity Fees, shall be established, continued, and/or funded each year.

When the Facility Capacity Fee Program was first developed, the Agency recognized that only by reviewing and revising the data document analysis of the fee annually, would it flexibly and fairly account for and explain changing assumptions and conditions. Therefore, the program included an annual review to ensure that any difference between what had been forecast and what was actually occurring, was accounted for in later revisions and that there were accurate tracking mechanisms of the monies collected and expended in furtherance of the Agency CIP activities.

Legislation

The continuing concern regarding water supplies for new development has resulted in legislation in the form of Senate Bill No. 221 and SB 610. The legislation requires planning and permitting agencies to obtain from local water providers written verification that adequate water supplies for proposed projects are available. Since this is new legislation, the exact nature of the written verification is still uncertain. The CIP reflects a variety of projects from which the Agency can select appropriate alternatives to ensure that an adequate water supply can be made available for whatever development is approved by the city and county planning authorities.

State Water Project Reliability

The State Department of Water Resources recently published a draft report describing the State Water Project's ability to deliver the water that is requested by the State Contractors. The State is capable of providing on the average 75% of the requested amount. However, project deliveries have dropped as low as 19% in the driest years. Further, the aforementioned legislation requires assurance of water delivery under varying drought conditions. With this in mind, the Agency's Engineer has developed the CIP to provide sufficient supply, storage, and banking facilities to accommodate the worse case situation.

Projected Water Demand

The cornerstone of the Agency's CIP is to identify projects which could provide an adequate water supply under any number of future demand scenarios. The selection of appropriate projects will depend upon actual growth patterns. The CIP includes projects which would be able to accommodate the maximum anticipated water demand, as well as lesser demands which may occur. The development of the demand projections includes the following:

1. Ultimate demand based on current land use designations
2. Timing of future demand increases

3. Location of future demand increases
4. Effect of water conservation efforts to mitigate increase in demand
5. Potential use of recycled water as an additional source of water

The Agency maintains a database of every parcel within its service area. Information regarding the parcel's land use designation, projected water demand if the parcel remains vacant, and potential water use if developed, is annually updated. As the Agency service area has matured, growth patterns have changed in response to market demand and land availability. The CIP in turn has been updated to take these changes into consideration.

The Agency's computer-generated model uses information obtained from Los Angeles and Ventura County assessor records, and utilizes land use information as identified by the County assessors. For obvious reasons, the data lags actual conditions and thus the model does not reflect up-to-the-minute conditions. The model also includes estimated construction costs for various water supply, storage, treatment, and distribution projects and thus is capable of producing close approximations of actual costs. Since the process is repeated annually, it reflects current information. See Appendix A-1 for projected water demand by WSA.

Economic Climate

The last three years we have seen an economic downturn in the general economy. However, the demand for housing has resulted in a relatively stable housing market in the Santa Clarita Valley. This can be attributed to an acute demand for housing and relatively low mortgage rates. The State Department of Finance and the Southern California Association of Governments predict continued strong growth for Southern California.

The demand for housing can be demonstrated by a comparison of the median price of a detached house in the first quarter of 1999 ($289,945) to the third quarter of 2002 ($388,704). The price of an attached home in the fourth quarter of 1998 was $166,950 compared to a price of $279,990 in the third quarter of 2002.

CIP Scheduling

In accordance with standard industry practice, the Agency's CIP activities require a relatively long planning horizon. Also standard is the assumption that cycles of "boom and bust" will occur. Thus, the plan must be flexible enough to accommodate adjustments in the scheduling of projects. The Agency has an adopted policy of conservatism. **That is, the Agency will only build or acquire what it needs in such a manner as to insure that the**

Agency's water supply and facilities needs are continuously met subject to an adequate margin of safety. The policy mitigates the Agency's exposure to building facilities prematurely and having to operate underutilized facilities inefficiently. This further protects the existing user from funding the operation of facilities needed for future growth.

Policies

The Agency has two primary policies that are used as a guide in the preparation of the CIP and Facility Capacity Fees.

Fairness Policy

This policy simply states that the benefiting user pays according to the actual cost of the service. Certain facilities are required for existing as well as future users, and there are other facilities that are required only by new users. For example, changes in higher water quality standards are a benefit to existing users. Thus, the cost of providing the higher water quality is appropriately paid by existing users. The need for additional treatment capacity, on the other hand, is growth induced and thus a responsibility of the new user.

The cost of facilities benefiting both existing and future users is allocated between such uses based upon the proportional benefit. The proportional benefit is determined by taking the total capacity of the facility in terms of the number of acre-feet of annual demand it is designated to serve and allocating a share of the cost to current users reflecting the total annual demand in acre-feet of the current users who benefit from the facility. For instance, if a reservoir provides storage which is necessary to provide reliability for 5,000 acre-feet of annual demand, and the current users who will benefit from the reservoir represent 2,500 acre-feet of annual demand, then 50% of the cost of the reservoir would be allocated to current users and only 50% of the cost would be calculated into the Facility Capacity Fees for the area benefited by the reservoir reflecting the additional demand generated by future users.

Conservative Economic Policy

As previously discussed, the Agency will only build or acquire what it needs in such a manner as to insure that the Valley's water supply needs are continuously met. This policy is particularly important in the water utility industry as it is difficult to build in small increments to match growth needs on a yearly basis. On the other hand, building too soon and too large results in excessive capital and operating costs with an insufficient number of customers to pay for the service.

Water Plan

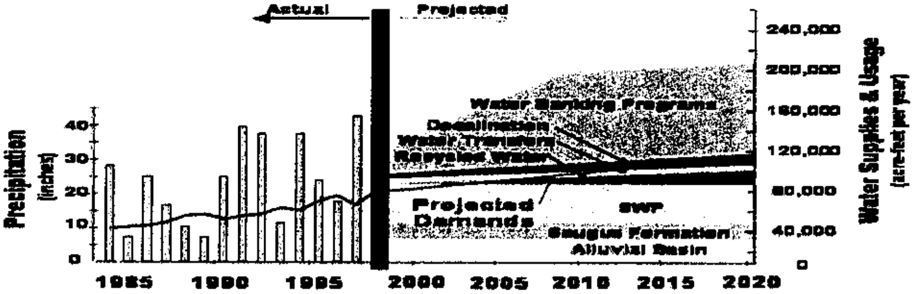
The foundation for the Agency's proposed CIP is land use and other statistical data conforming to applicable land uses. The Agency's consultants have developed and the Agency benefits from a computerized model that catalogs all of the available land within the Agency. The model captures each parcel's existing and authorized land uses, as maintained by the Assessor and planning agencies. Potential water demands (if the lands are developed or more intensively developed) are computed using extrapolations from existing consumption data. This information enables the Agency to determine, with reasonable accuracy, the amount of water required to meet the projected needs of the Santa Clarita Valley.

Using information obtained from the local retail purveyors, the database also contains information concerning where and when the water demand could materialize, based upon their best estimates of development. The County of Los Angeles Department of Regional Planning also supplies a report on proposed development from its development monitoring system.

Water Demand Model

This report has examined the approved land uses throughout the entire Castaic Lake Water Agency service area and the associated water demands. In this regard, a range of water demands was developed using a range of densities for specific general plan land use classifications. For the purpose of this report in determining Facility Capacity Fees, the decision was made to continue the previous practice of using the mid-range value of densities and historic water consumption.

The Draft IWRP water demand model calculated the projected future demand for the currently designated allowable land uses within the Castaic Lake Water Agency service area at approximately 175,000 acre-feet of water without conservation savings. The updated water demand for this report, with conservation, is 169,000 acre-feet. The total demand has changed slightly as a result of land use changes. However, as land is developed portions are dedicated to such uses as streets and parking lots that do not generate a water demand. Conversely, some land is developed for uses which result in a higher water use than projected. As a result the demand at build-out is still projected to be within the ranges developed in the Draft IWRP.



As noted in the above figure, the projected water demand for 2020 is slightly more than 100,000 acre-feet, which exceeds the current reliable supply. The Agency's CIP includes additional water acquisition, recycled water, as well as water banking and storage projects to meet the future demands. These additional sources may be pursued as demand becomes more certain.

Projected Sales of Facility Capacity Fees

The financing of the Agency's Capital program is based primarily on the revenue derived from the Facilities Capacity Fees. The financial community does not consider this revenue source as stable and, as a result, is reluctant to issue a high credit rating, which, in turn, makes it difficult to secure reasonably priced bond insurance.

In 1991 the Agency issued its first bonds to begin construction of capital facilities. In order to demonstrate that the Facility Capacity Fees were a credit worthy security for the bonds, it was necessary to demonstrate exceptional conservatism in the Agency's projection of sales.

Further, the Agency had no track record of annual sales of capacity to demonstrate the reliability of strength of the building market in the Santa Clarita Valley. The Agency developed forecasts based on County general plans and development activity by the local purveyors. This, in turn, was translated into a series of scenarios projecting possible income under various economic conditions.

Based upon historical connection data and housing sales, it was determined that Facility Capacity Fee sales would be based on a reduced number from the forecasted water demand (see Appendix A-2). This was necessary based on the financial community's concern with a variable revenue stream that was further complicated by the fact that certain development can occur that is not subject to the building permit process, thus escaping payment of the Facility Capacity Fees. In addition, landowners can develop their land using groundwater and not take any Agency water. These developments create a demand for water but they are not accountable to the Agency.

As shown in Appendix B, annual sales of capacity have been highly variably since the program was implemented. Based on the Agency's history of sales, the maintenance of cash reserves has enabled the Agency to sell a total of three bond issues all backed with insurance and a sound credit rating.

Water Conservation

The Agency has signed a memorandum of understanding with other urban water suppliers, public advocacy organizations and other interested parties. The California Urban Water Conservation Council has the responsibility for monitoring the implementation of the MOU. A major effort of this coalition is the implementation of Best Management Practices as a means of achieving water conservation goals.

There are 14 Best Management Practices. The Agency is currently involved in a pilot study for the implementation of these practices. It is anticipated that the conservation effort will reduce the water demand by approximately 10% or more.

The agency has an extensive program for the education of grade school children concerning water, its source, use and care. The Agency's conservation garden demonstrates the use of drought tolerant plants and ground covers that can be attractive while using minimum amounts of water.

Capital Improvement Program

The Agency's proposed CIP activities have been developed to fulfill the Agency's stated mission, which is to provide reliable, quality water at a reasonable cost to the Santa Clarita Valley. Thus, the proposed CIP is structured to include facilities for the treatment, storage, and transmission of water as well as the acquisition of additional water supplies. Since the State Water Project is not complete and water deliveries are variable, the proposed CIP contains certain elements to increase reliability through a combination of additional water supplies, water banking, storage and conjunctive use.

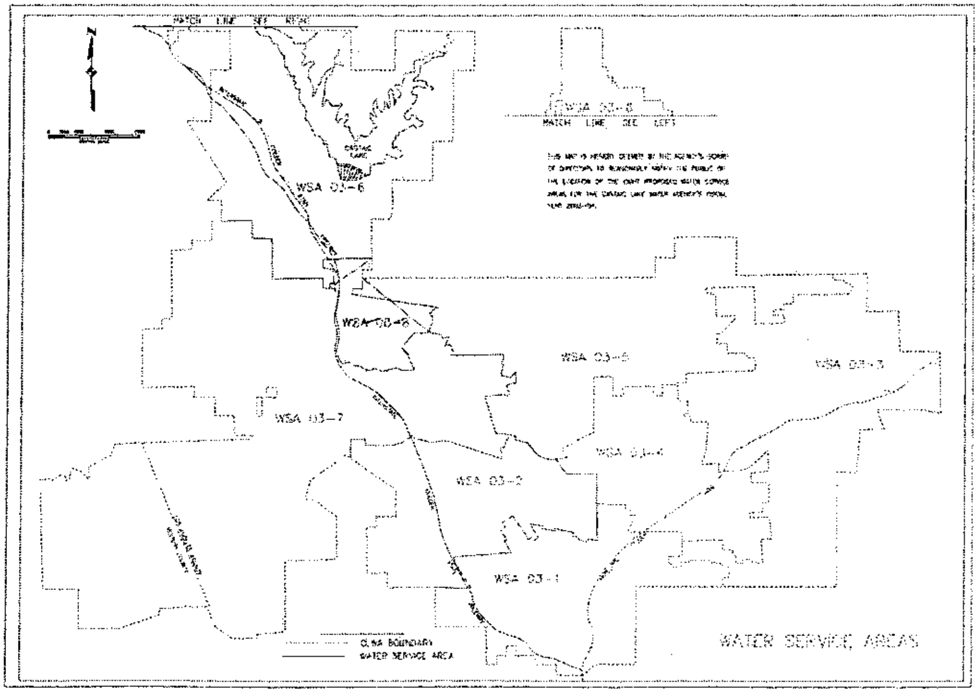
Water Service Areas

In keeping with Agency policy that the benefiting user pays, it was determined that the distribution of cost would be fairly apportioned by dividing the Agency's service area into logical hydraulic water service areas (WSAs). This enables the engineers to plan and distribute costs on a cost of service basis.

The Agency Engineer has determined that 26 specific Sub-WSAs and eight water service areas (see map below and Appendix C for an enlarged map) constitute the most practical building blocks for establishing water needs and, in turn, Agency capital facilities. Additionally, these Sub-WSAs are used in determining the areas of benefit for each capital project. These Sub-WSAs are then grouped into logical configurations to form a smaller number of WSAs and to conform to Agency policy in providing planned transmission facilities to each proposed WSA.

Multiple alternative configurations have been considered and evaluated. As a result of this evaluation, eight WSAs were established for the Agency's Capital Facility Program for Fiscal Year 1991/92. This configuration has been used every year since then, and it is proposed that the eight existing WSAs be maintained for FY 2003/04.

Water Service Areas



Water Demand by WSA

The Agency's computerized database provides water demand based on the aforementioned Sub-WSAs. The data is then analyzed to determine the Agency facilities needed for each Sub-WSA, taking into consideration the availability of local groundwater and water conservation. The net water demand is then translated into specific facilities, sizes, phasing, and cost.

Distribution of Benefits

After facility requirements are determined, costs are allocated to WSAs and then to existing or future users based on the projected benefits to be derived from the project. Each of the individual projects within the CIP are evaluated to determine from where within the Agency the project provides benefits (i.e., WSA) and who benefits from the project (existing or future users). Based on the determination of the distribution of benefits, the costs for the project are distributed accordingly. Specific details of this procedure are provided in the following section (Existing and Future User Benefits) and Appendix D.

Program Financing

Since the facilities have to be in place before development can take place, capital projects are typically debt-financed. The cost of financing is an additional cost of the program and is included as part of the project cost. In addition, portions of projects benefit existing users as well as future users. Thus, it is necessary to distribute the debt in the same manner as projects benefit (i.e., existing and future).

Agency Revenues

The Agency's authorized revenue sources are as follows:

1 Water rates
2 Facility Capacity Fees
3 Ad valorem taxes for authorized debt service
    a. State Water Project
4 Portion of 1% basic property tax levy
5 Water Standby Charges
6 Interest on investments

Existing Users Funding

Existing users could fund their portion of the Agency program through the following:

1 Portion of 1% property tax (current practice)

2 Water rates (currently not in effect)

3 Parcel charges (currently not in effect)

4 Ad valorem taxes for State Water Project (current practice)

Future Users Funding

1 Facility Capacity Fees (current practice)

2 Interest on Investments (current practice)

3 Parcel Charges (currently not in effect)

4 Portion of 1% property tax (current practice)

5 Ad valorem taxes for the State Water Project (current practice)

Existing and Future User Benefits

The allocation between existing and future users is developed based on benefits received from each facility described as follows and in Appendix D.

The existing water treatment facilities (Rio Vista and Earl Schmidt) require upgrading to meet new drinking water treatment standards issued by the State of California and United States Environmental Protection Agency. These improvements are allocated to existing users.

Emergency storage improvements included in the capital improvement plan benefit existing and future users by providing protection against short term loss of imported water supplies. Planned new storage facilities accommodate the needs of existing and future users, and costs are shared between them. This storage is provided at water treatment plant sites and along pipeline routes.

New potable water supply projects are allocated to future users and include additional potable water supplies (such as State Water Project water).

Recycled water distribution projects are allocated between existing and future users as each benefit. The development of recycled water improves the Agency's overall water supply reliability although it will be distributed in those areas where it is most cost effective and efficient to do so.

There are two types of State Project Water reliability enhancement projects, water supply banking and Saugus aquifer wells. These projects firm up the reliability of the State Water Project water by providing an alternative supply during periods of reduced State Water Project deliveries. These projects are allocated to existing and future users.

Pipeline and pump station projects are required to convey State Water Project water to new users and all costs are allocated to future users.

Several projects (listed as System Appurtenances projects) provide improvements needed to accommodate delivery of State Water Project water and are allocated to future users.

Water treatment expansion projects are required to accommodate future users and are allocated to future users.

A description of each project included in the Draft Capital Improvement Plan (CIP) and allocation between existing and future users is provided in Appendix D. Appendix D-1 is provides a summary of the entire Draft CIP and distribution of estimated project costs among water supply, supply banking, pipeline, pump stations, storage and water treatment. Appendix D-2 provides a summary of cost allocations between existing and future users. Appendix D-3 is the projected construction schedule.

Standard Unit of Benefit

In order to distribute benefits, it is necessary to establish a "unit of benefit" that can be applied as a standard of measure. The Agency's unit measure is an **acre foot of water per year.** There is a direct nexus between the demand for an acre foot of water and the capital facilities required to supply that acre foot of water.

For example, the unit of measure for water supplies is acre feet per year. Storage is measured in acre feet and transmission is measured in acre-feet per year. Water demand is also measured in acre-feet per year. Historical consumption records for the Santa Clarita Valley indicate that the water demand for a single family dwelling ranges from 0.5 acre-feet per year to as high as 0.8 acre-feet per year based on the dwelling size and location.

Water Needs by Water Service Area

Water demands within the Agency's service area are met by both groundwater produced by retail purveyors and imported water provided by the Agency. This year recycled water will also become a source of non-potable supply to meet current and future non-potable demands. The sizing of the proposed Agency facilities is based on the demand for Agency potable and non-potable water. The additional potable and non-potable water needed to satisfy the demand was projected using a computerized water demand model as well as production records from the Agency and the four local purveyors.

Supplemental Water Needs

The Agency is now able to provide recycled water as a non-potable supply, thus augmenting the water supply to the service area. The additional water needed to satisfy the demand (referred to as supplemental water demand) was projected using a computerized water demand model as well as production records from the Agency and the four local retail purveyors.

The Agency's water demand model provides a forecast of total demand in the future for each Sub-WSA. The supplemental water demand for each Sub-WSA was determined by mathematically balancing the estimated future water demand by taking into account the configuration of the Agency and purveyor distribution systems and the potential use of recycled water. By using this mathematical approach, the optimum blend of local groundwater and supplemental water is achieved. Details of the mathematical model are set forth in Appendix E.

Water and Facility Cost Allocations

The "optimum blend" provides the hydraulic data required to size Agency water supply and treatment facilities. Projects derived from this technical process are labeled "Agency-wide" projects. The hydraulic data are used to size the transmission lines. Accordingly, these projects are labeled "WSA-specific" projects. An estimate of project cost is calculated, and the project is scheduled based on projected water demand. As a matter of Agency policy, "Agency-wide" projects include the cost of acquisition of additional water supply, water treatment facilities, and storage. "Agency-wide" projects are considered to have equal benefit regardless of geographic location within the service area.

Thus, the component of the facility capacity fee for the cost per acre foot of this portion of the CIP is the same for all WSAs regardless of location within the Agency's service area. The costs are then allocated to existing and future users. The portion which is determined to be attributable to future users becomes the "base" number for the calculation of the Facility Capacity Fee. The "base" number represents the costs of acquiring, treating, and storing an acre foot of water anywhere within the Agency service area.

As a matter of policy, "WSA-specific" projects include the cost of Agency Transmission facilities. These costs are allocated to the WSAs based on the relative benefits of a transmission project to a specific WSA. Accordingly, each WSA's share of the proposed pipeline's cost was calculated in proportion to each WSA's share of the capacity based on supplemental water demand. The resulting capital cost to convey an acre foot of water varies accordingly from WSA to WSA. The future users' benefits from the Agency's CIP was obtained (after excluding the existing users' benefits) by combining each WSA's share of the Agency-wide projects and the WSA-specific projects.

Facility Capacity Fee Calculation Methodology

As discussed earlier, each WSA's estimated water demand is expressed in acre feet per year, and is based upon combining land use codes with actual water usage from the purveyors.

Using the CIP costs and incremental water demands, the financial computer models are analyzed and mathematically calculate the cost per acre foot per WSA for "WSA-specific" transmission, and cost per acre foot for "Agency-wide" storage, banking, and treatment.

The Agency's financial model calculates these costs using a number of assumptions, including estimated future water demand (acre feet), construction inflation, general inflation, cost of borrowed money, interest earnings, and increase in assessed value. (See Appendices E and F) for a detailed explanation of the model and its method of calculation and assumptions.) Most important, the financial model also utilizes the cash flow approach to determine when funds would have to be borrowed. For the FY 2003/04 Facility Capacity Fee calculation, the financial model is based on the most recent CIP requirements and the updated forecast for water demand. The Agency generally conducts an annual review and update of the CIP as well as the Facility Capacity Fee schedule. As the area develops, there will be a shift in demand from WSA to WSA based on a number of factors such as changes in anticipated development, type of developments, etc.

The annual update provides an opportunity to revise the capital needs and resulting costs in response to actual conditions. The location, size, and timing of facilities are done in accordance with District Policy. Facilities are to be available five years ahead of need. This policy precludes the construction of facilities far in advance of need, thus eliminating the cost of maintaining underutilized facilities. Further, it precludes growth inducement since the facilities are only constructed to meet the needs of authorized development. In summary, the financial model was designed to incorporate all parameters concerning the CIP, estimated water demands, and assumptions that impact the Facility Capacity Fee.

Fiscal Year 2003/04 Facility Capacity Fees

The proposed CIP in FY 2003/04 dollars is estimated at about $455 million (Appendix D). The specific amount of expenditure of capital funds will be authorized by the Board of Directors after consideration is given to a variety of physical factors and the needs of the purveyors. The proposed Facility Capacity Fees by water service area for FY 03-04 are as noted:

WSA	Charge Per Acre Foot	
	FY 1999/2000	FY 2003/04
99-1	**$ 9,056**	**$ 8,771**
99-2	**$ 9,142**	**$ 9,336**
99-3	**$ 9,451**	**$ 12,833**
99-4	**$ 8,498**	**$ 11,479**
99-5	**$ 8,772**	**$ 9,900**
99-6	**$ 7,984**	**$ 8,213**
99-7	**$ 8,554**	**$ 9,446**
99-8	**$ 8,889**	**$ 8,856**

Some of the fees are increasing and others are decreasing. The change is due to a number of factors, including the distribution of past debt and estimated imported water demands by the WSAs. The CIP likewise changed in that the acquisition of the Santa Clarita Water Company (SCWC) reduced capital needs while the re-evaluation of the State Water Project's reliability resulted in the need to acquire more water and increase groundwater banking programs.

Apportionment of Costs and Benefits

The current CIP models were developed using a variety of sources of revenue including Facility Capacity Fees, portion of 1% property taxes, interest earnings and other miscellaneous income. Multiple models were analyzed in order to establish a proforma that would match the appropriate revenue sources with expenditures, thus complying with law and achieving the equities required by the fairness doctrine adopted by the Board of Directors.

Because of the detailed and comprehensive cash flow modeling, the appropriate WSA Facility Capacity Fees were developed to match their proportionate share of the CIP facilities attributable to growth. **That portion of the CIP that is attributable to benefits to the existing users is funded through revenue other than from Facility Capacity Fees.**

The State Water Project costs (fixed and variable) have been paid through existing voter approved ad valorem taxes for all properties within the agency's service area. The undeveloped property assessed value is $846,968,711 (5% of total assessed value) and developed property assessed value is $16,352,999,197 (95% of total assessed value) as of August 2002.

Planning Horizon

The Agency's long-range capital program consists of major water supply projects needed to supply the proposed development authorized by the appropriate planning agencies. The plan takes into consideration the following factors:

1. It includes facilities which include water acquisition, treatment, storage, and transmission pipelines
2. It utilizes cost data and timing for input into the Facility Capacity Fee model
3. It involves a time-phased program to accommodate the projected need five years in advance

The traditional approach used by the water industry is to plan infrastructure alternatives as far into the future as practical and update it as often as annually to ensure the plan will reasonably take into account changed circumstances as they occur. The Agency's CIP program is designed in a manner that allows the Agency to modify specific projects in response to changed conditions and at the same time maintain the fiscal integrity of the program. The timing and location of actual water demand has changed over the past 17-plus years and the CIP program as well as the charges have responded to these changes.

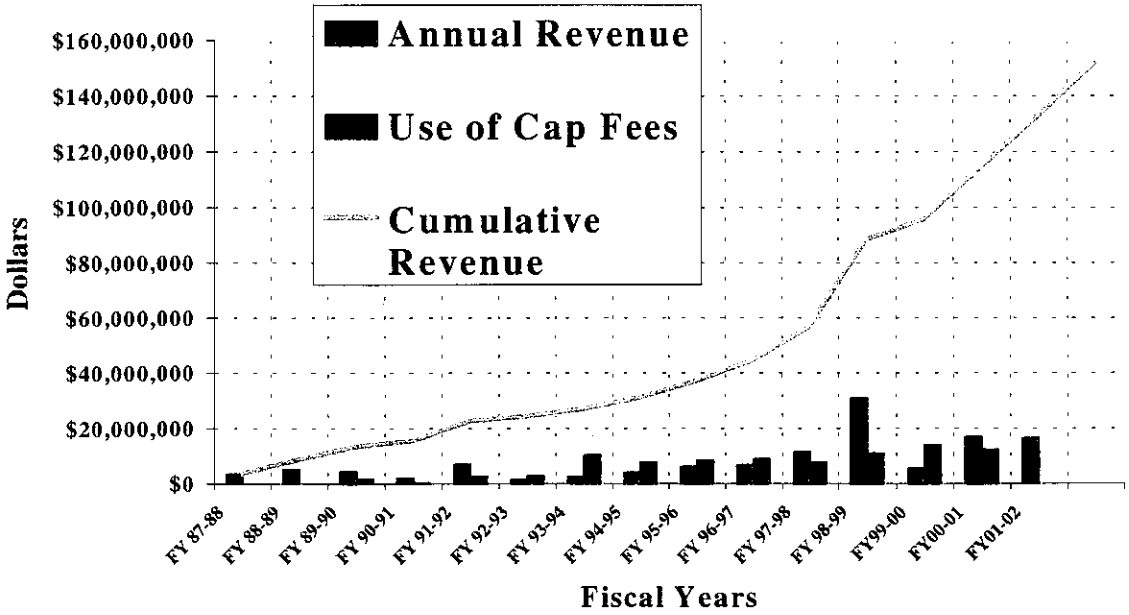
The legislature has recognized the need for long-range water planning in California as exemplified in the requirement for water agencies to provide an Urban Water Management Plan every five years. This plan takes into consideration water demands under various hydrological cycles for at least 20 or more years. Further, the legislature recently passed SB 221 and SB 610, which place greater emphasis on long-term water planning because it mandates that water purveyors provide assurance of water supplies 20 or more years into the future.

Water Supply Planning and Development in California requires very long planning horizons. For this reason the Agency has adopted a 50-year planning horizon for its planning model.

CIP Financing

Since the majority of the Agency's Capital programs are required for future needs, it was determined that the program would be debt-financed. This excludes the existing rate payer from funding growth related costs. Existing users only pay for the benefits they derive from the agency's CIP. This is in keeping with the Agency Policy of "Benefiting User Pays." In addition, water supply facilities last many generations and it would place an undue burden on existing users if the CIP were to be funded on a pay as you go basis. Debt financing allows each generation to pay for what it uses. This is also in keeping with the Agency Policy of "Benefiting User Pays." This can be best demonstrated by the history of Facility Capacity Fee Revenues.

Summary of Facility Capacity Fee Revenue



Facility Capacity Fees collected in one fiscal year may not be expended until future fiscal years. Likewise, in some years, there will not be sufficient Facility Capacity Fees collected to cover the cost of the CIP or other such expenses (such as payments on existing Agency Certificates of Participation). The financial model incorporates the impact of these timing conditions. In addition, reserve funds have been set aside to ensure the economic viability of the CIP and to provide security for the repayment of Certificates of Participation issued by the Agency to fund its CIP as described in this Data Document and in prior year Agency data documents.

Capital Replacement

The cost of system maintenance and replacement, as well as upgrades to comply with water quality regulations, is a responsibility of the existing user and as such is not funded from Facility Capacity Fees.

Summary

The foregoing program is intended to comply with the Board-adopted policies of conservatism and fairness. Conservatism will be achieved through the measured construction of those facilities necessary to maintain an advance supply of water to meet the needs of those developments authorized by the planning agencies.

Implementation of the Fairness Doctrine is accomplished through the use of a mixture of revenue sources that match the benefit to the cost. The proposed Facility Capacity Fee is calculated to fund that portion of the CIP attributable to growth-related facilities. That portion of the CIP attributable to existing users is funded by other sources.

Through the use of the aforementioned water resources, the optimization of the entire Santa Clarita Valley's water resources is achievable. Thus, the **Santa Clarita Valley is provided with reliable, quality water at a reasonable cost.**

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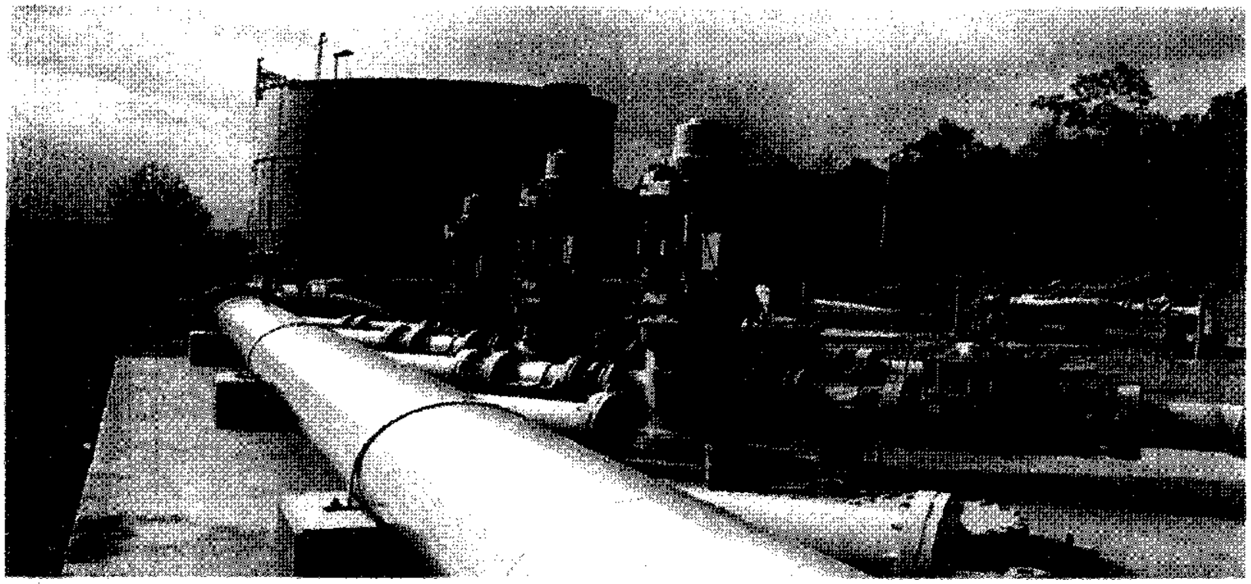
APPENDICES



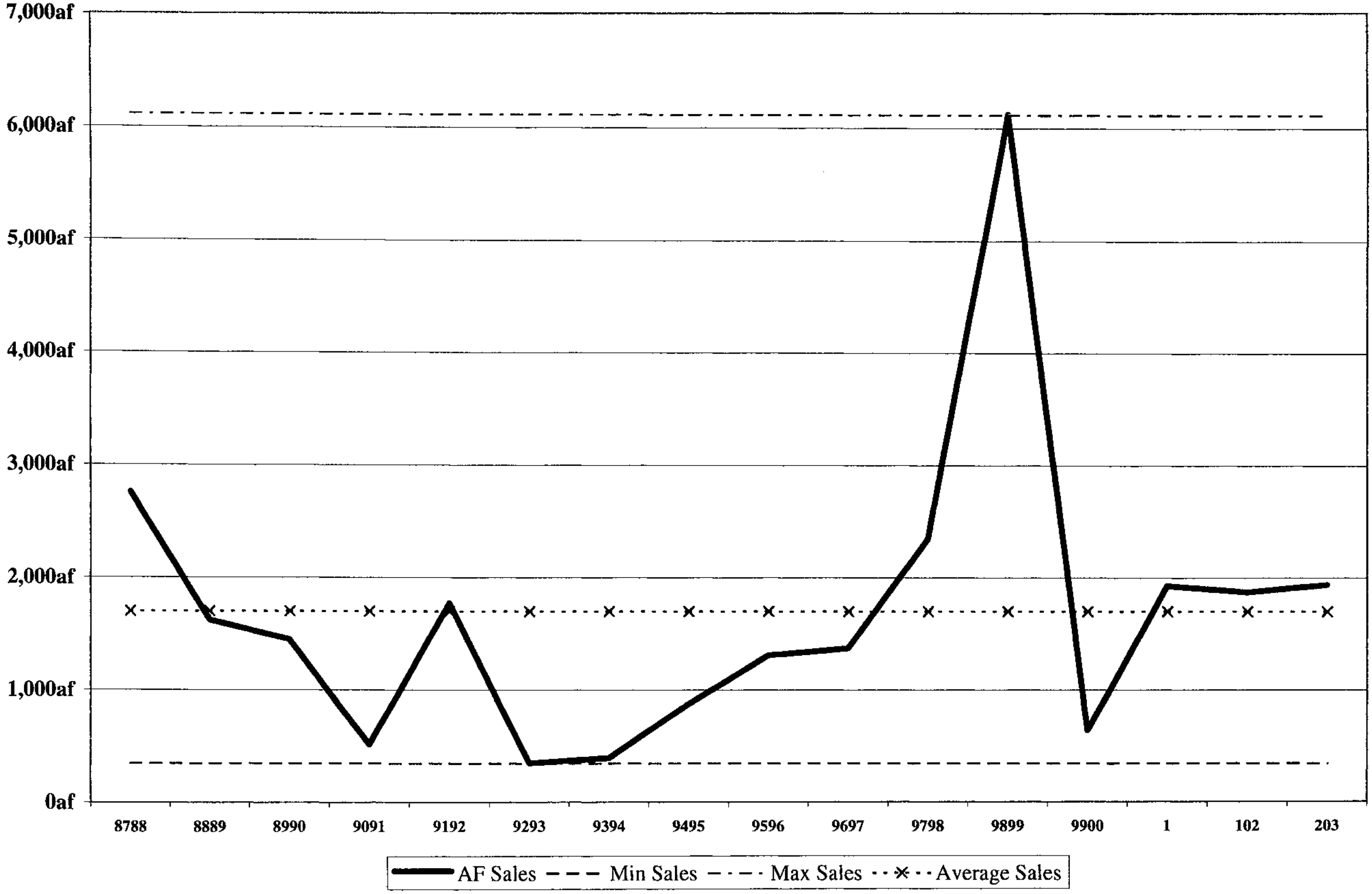
Projected Annual Increase In Water Demand in Acre-Feet

WSA	1	2	3	4	5	6	7	8	Totals
2004	331	191	597	268	425	185	1,086	14	3,096
2005	334	151	530	237	400	192	988	14	2,847
2006	345	130	492	219	381	202	931	22	2,722
2007	271	8	157	56	135	166	372	19	1,184
2008	244	7	80	27	110	164	304	20	955
2009	241	33	31	4	101	165	293	20	888
2010	215	26	24	31	76	168	236	21	797
2011	189	9	93	33	55	172	203	21	775
2012	312	16	118	97	262	246	240	28	1,320
2013	300	10	257	45	253	288	573	30	1,756
2014	286	9	243	112	239	285	541	32	1,747
2015	276	12	238	109	229	283	525	34	1,706
2016	265	17	232	106	226	278	506	37	1,666
2017	257	10	234	105	219	274	497	43	1,638
2018	249	10	234	105	219	269	491	43	1,621
2019	244	12	237	106	220	264	491	43	1,618
2020	280	12	317	146	284	285	632	46	2,003
2021	298	67	361	168	303	295	708	48	2,247
2022	304	78	382	179	320	298	743	48	2,351
2023	307	112	395	185	339	298	763	49	2,446
2024	307	137	403	189	349	296	775	49	2,506
2025	307	144	410	192	350	294	784	49	2,530
2026	306	184	415	195	356	292	792	49	2,589
2027	305	174	420	198	352	289	798	44	2,580
2028	304	155	424	200	355	286	805	17	2,547
2029	304	139	429	203	358	284	811	18	2,546
2030	304	147	434	205	317	281	818	18	2,524
2031	304	154	439	157	318	279	826	19	2,497
2032	304	162	344	163	334	277	659	20	2,263
2033	301	169	339	169	339	275	679	21	2,292
2034	302	176	351	175	346	274	698	22	2,344
2035	304	183	364	180	345	273	718	23	2,390
2036	307	190	376	186	340	272	738	24	2,433
2037	336	220	433	214	386	292	840	28	2,749
2038	298	229	449	221	398	294	868	29	2,787
2039	296	229	449	212	396	289	865	29	2,765
2040	261	229	448	212	363	285	805	29	2,631
2041	261	229	448	212	363	280	805	29	2,626
2042	261	229	447	212	363	276	805	29	2,621
2043	261	229	446	212	363	272	805	29	2,616
2044	261	229	446	212	363	200	805	29	2,544
2045	261	229	445	212	363	200	805	29	2,543
2046	261	229	445	212	363	200	805	29	2,543
2047	261	229	444	212	363	200	805	29	2,542
2048	261	229	436	212	363	200	805	29	2,534
2049	261	229	436	212	363	200	805	29	2,534
2050	174	153	201	141	242	133	537	19	1,599
Total	13,221	6,153	16,377	7,662	14,309	11,774	32,192	1,406	103,059

Projected Annual Sales in Acre-Feet

	1	2	3	4	5	6	7	8	Totals
2004	182	105	328	147	234	102	597	8	1,703
2005	184	83	292	130	220	106	544	8	1,566
2006	190	71	271	121	209	111	512	12	1,497
2007	149	4	86	31	74	91	205	11	651
2008	134	4	44	15	61	90	167	11	525
2009	133	18	17	2	56	91	161	11	489
2010	118	14	13	17	42	93	130	11	439
2011	104	5	51	18	30	94	112	12	426
2012	171	9	65	53	144	135	132	16	726
2013	165	5	142	25	139	159	315	17	966
2014	157	5	134	61	131	157	297	18	961
2015	152	7	131	60	126	156	289	19	939
2016	146	9	128	58	124	153	278	20	916
2017	141	6	129	58	120	151	273	24	901
2018	137	6	129	58	121	148	270	24	891
2019	134	7	130	59	121	145	270	24	890
2020	154	7	175	81	156	156	348	25	1,101
2021	164	37	199	93	166	162	390	26	1,236
2022	167	43	210	98	176	164	409	27	1,293
2023	169	61	217	102	186	164	419	27	1,345
2024	169	75	222	104	192	163	426	27	1,378
2025	169	79	225	106	192	162	431	27	1,392
2026	168	101	228	107	196	161	435	27	1,424
2027	168	96	231	109	194	159	439	24	1,419
2028	167	85	233	110	195	158	443	9	1,401
2029	167	77	236	111	197	156	446	10	1,400
2030	167	81	239	113	174	155	450	10	1,388
2031	167	85	241	87	175	153	454	11	1,373
2032	167	89	189	90	184	152	362	11	1,245
2033	165	93	186	93	187	151	373	12	1,260
2034	166	97	193	96	190	151	384	12	1,289
2035	167	100	200	99	190	150	395	13	1,315
2036	169	104	207	102	187	150	406	13	1,338
2037	185	121	238	118	212	160	462	15	1,512
2038	164	126	247	122	219	162	478	16	1,533
2039	163	126	247	116	218	159	476	16	1,521
2040	144	126	246	116	199	157	443	16	1,447
2041	144	126	246	116	199	154	443	16	1,444
2042	144	126	246	116	199	152	443	16	1,442
2043	144	126	246	116	199	150	443	16	1,439
2044	144	126	245	116	199	110	443	16	1,399
2045	144	126	245	116	199	110	443	16	1,399
2046	144	126	245	116	199	110	443	16	1,398
2047	144	126	244	116	199	110	443	16	1,398
2048	144	126	240	116	199	110	443	16	1,394
2049	144	126	240	116	199	110	443	16	1,394
2050	96	84	111	78	133	73	295	11	880
Total	7,271	3,383	9,006	4,212	7,867	6,472	17,702	769	56,682

Castaic Lake Water Agency
Historic Water Facilities Fee Sales (Acre Feet)



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Appendix B

Table D
Castaic Lake Water Agency
FY 03/04 Capital Improvement Project Allocations

Project	Description
Water Supply Projects Projects 1 through 13 Recycled Water – Phase IB through Phase XI, Recycled water ASR project and associated environmental studies.	Cost of design and construction of the Reclaimed Water System phases as developed in the Draft Master Plan Update. Existing users pay share of project based on their share (65,490 AF – 38.75%) of the 2050 demand (168,950 AF) of the agency. Future users pay 61.24%. Projects increase system reliability. Project cost shared by all sub-WSAs.
Project 14 Additional Water Supply Purchase (40,000 AF)	Cost of acquiring additional water supply to increase level of contractual State Water Project contracts (or other water supply). Additional supply required due to recently identified reliability of current SWP contracts. Future users pay all costs and shared by all sub-WSAs.
Water Supply Banking Projects Projects 15 through 20 Water Supply Banking I, II, III and IV: Suagus Wells 1, 2, 3, and 4	Existing users pay a share of the project costs based on their share of imported water demand (36,839 AF – 36.29%) of the 2050 demand (101,520 AF). Future users allocated 63.71%. Project cost is shared by all sub-WSAs.
Pipeline/PS/Storage Projects Project 21 Honby Extension and Storage II.	Cost of design and construction of the pipeline, reservoir, and pump station. Existing users pay a share of the cost of the storage facilities based on their share of demand. Future users pay the cost of pipeline, pump station, and their share of the storage facilities. First phase of project. Storage facilities cost shared by all sub-WSAs. Pipeline and pump station cost shared by sub-WSAs 88-23, 25, 26, 33, and 36.
Project 22 Lateral Extension (Pitchess)	Cost of design and construction of pipeline from the Castaic Conduit west to the west side of Interstate 5. New pipeline to serve future users. Future users pay all project costs. Pipeline cost is shared by sub-WSAs 88-2 and 15.
Project 23 Lateral Ext. & Storage	Cost of design and construction of the Lateral Extension & Storage Project. The pipeline begins at the Newhall Parallel at the Santa Clara River and travels west into the mountains west of interstate 5. This project includes a reservoir near its terminus. Existing users pay a share of the cost of the storage facilities based on their share of demand. Future users pay cost of pipeline and their share of the storage facilities. Storage facilities cost is shared by all sub-WSAs. Pipeline

Project	Description
	cost is paid by sub-WSA 88-12 and 15.
Project 24 Honby and Newhall Parallel II (Honby Parallel)	Cost of design and construction of the Honby Parallel from RVWTP to Sand Canyon Road. Project includes pipeline, reservoir, and pump station. Existing users pay a share of the cost of the storage facilities based on their share of demand. Future users pay the cost of pipeline, pump station, and their share of the storage facilities. Storage facilities cost shared by all sub-WSAs. Pipeline and pump station costs shared by sub-WSAs 88-23, 25, 26, 33 and 36.
Project 25 Honby & Newhall Parallel III (Newhall Parallel 2)	Cost of design and construction of the pipeline. Future users pay all costs. Pipeline cost shared by sub-WSAs 88-23, 25, 26, 33, and 36.
Project 26 System Appurtenances I (CC)	Cost associated with relocation of the Castaic Conduit. Project enhances capacity of treatment system. Future users pay the entire cost. Project cost shared by all sub-WSAs.
Project 27 System Appurtenances II (MWD Cap.)	Cost associated with capacity in MWD system to deliver SWP to CLWA. Future users pay the entire cost. Project cost shared by all sub-WSAs.
Project 28 Additional Water Supply IX (SWP peaking)	Cost associated with delivery systems to deliver SWP to CLWA. Future users pay the entire cost. Project cost shared by all sub-WSAs.
Water Treatment Projects Project 29 ESFP Ozone/Contact Clarifiers/Wash-water Treatment	Cost of design and construction of Earl Schmidt Water Treatment Plant water quality upgrades needed to meet Clean Water Act. Project cost is allocated to existing users.
Project 30 Earl Schmidt Expansion 56 MGD – 1 (Treatment)	Cost of design and construction for the expansion of ESFP from 25 to 56 MGD. Future users pay the entire cost of expansion. Project cost is shared by all sub-WSAs.
Project 31 Earl Schmidt Exp. 56 MGD II (Intake Pump)	Future users will pay the entire cost for pump station improvements required to expand ESFP from 25 to 56 MGD. Total project cost is shared by all sub-WSAs.
Project 32 Earl Schmidt Storage Improvements 56 MGD III (storage)	Cost of design and construction of improvements to storage facilities at the ESFP. Existing users pay a share of the cost of the storage facilities based on their share of imported water demand (36,839 AF existing users and 101,520 AF for all

Project	Description
	users 2050). Project cost is shared by all sub-WSAs.
Project 33 Rio Vista Exp. 60 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 30 MGD to 60 MGD. Future users pay entire cost of the treatment plant expansion. Project cost is shared by all sub-WSAs.
Project 34 Rio Vista Exp. 90 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 60 MGD to 90 MGD. Future users pay the entire cost of treatment plant expansion. Project cost shared by all sub-WSAs
Project 35 Rio Vista Exp. 90 MGD (Storage)	Cost of design and construction of additional storage capacity at the RVWTP. Existing users pay for a share of the cost of the storage facilities based on their share of imported demand (36,839 AF existing users and 101,520 AF for all users in 2050). Project cost is shared by all sub-WSAs.
Project 36 Rio Vista Exp. 120 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 90 MGD to 120 MGD. Future users pay the entire cost of treatment plant expansion. Project cost shared by all sub-WSAs.
Project 37 Rio Vista Exp. 130 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 120 MGD to 130 MGD. Future users pay the entire cost of treatment plant expansion. Project cost shared by all sub-WSAs.
Projects 38, 39 and 40 Water Quality Improvements I, II and III	Cost of Improvements to the existing water treatment plants to meet changes in the State Drinking Water Act. Existing users pay entire costs.

Castaic Lake Water Agency
FY03-04 Capital Improvement Program

	Project	Total Cost	Treatment/Storage/Supply		Pipeline	
	Water Supply Projects		Percent	Cost	Percent	Cost
1	Recycled Water - Phase IB	$4,547,000	100.00%	$4,547,000	0.00%	$0
2	Recycled Water - Phase II	$10,618,000	100.00%	$10,618,000	0.00%	$0
3	Recycled Water - Phase III	$9,072,000	100.00%	$9,072,000	0.00%	$0
4	Recycled Water - Phase IV	$12,809,000	100.00%	$12,809,000	0.00%	$0
5	Recycled Water - Phase V	$1,746,000	100.00%	$1,746,000	0.00%	$0
6	Recycled Water - Phase VI	$4,718,000	100.00%	$4,718,000	0.00%	$0
7	Recycled Water - Phase VII	$9,268,000	100.00%	$9,268,000	0.00%	$0
8	Recycled Water - Phase VIII	$5,453,000	100.00%	$5,453,000	0.00%	$0
9	Recycled Water - Phase IX	$1,804,000	100.00%	$1,804,000	0.00%	$0
10	Recycled Water - Phase X	$1,783,000	100.00%	$1,783,000	0.00%	$0
11	Recycled Water - Phase XI	$762,000	100.00%	$762,000	0.00%	$0
12	Recycled Water - ASR	$8,337,000	100.00%	$8,337,000	0.00%	$0
13	Recycled Water Environmental Studies	$515,000	100.00%	$515,000	0.00%	$0
14	Additional Supply Purchase (40,000 AFY)	$60,000,000	100.00%	$60,000,000	0.00%	$0
	Subtotal	**$131,432,000**		**$131,432,000**		**$0**
	Water Supply Banking Projects					
15	Water Supply Banking I	$17,366,000	100.00%	$17,366,000	0.00%	$0
16	Water Supply Banking II	$17,366,000	100.00%	$17,366,000	0.00%	$0
17	Water Supply Banking III	$17,366,000	100.00%	$17,366,000	0.00%	$0
18	Water Supply Banking IV	$17,366,000	100.00%	$17,366,000	0.00%	$0
19	Saugus Aquifer Wells 1 and 2	$2,745,000	100.00%	$2,745,000	0.00%	$0
20	Saugus Aquifer Wells 3 and 4	$2,745,000	100.00%	$2,745,000	0.00%	$0
	Subtotal	**$74,954,000**		**$74,954,000**		**$0**
	Pipeline/PS/Storage Projects					
21	Honby Extension & Storage II	$16,366,000	20.70%	$3,388,000	79.30%	$12,978,000
22	Lateral Extension (Pitchess)	$2,138,000	0.00%	$0	100.00%	$2,138,000
23	Lateral Extension & Storage II	$12,269,000	37.96%	$4,657,000	62.04%	$7,612,000
24	Honby & Newhall Parallel II (Honby Parallel)	$24,462,000	29.84%	$7,300,000	70.16%	$17,162,000
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	$2,719,000	0.00%	$0	100.00%	$2,719,000
26	System Appurtenances I (CC)	$6,559,000	0.00%	$0	100.00%	$6,559,000
27	System Appurtenances II (MWD Cap.)	$6,898,000	0.00%	$0	100.00%	$6,898,000
28	Additional Water Supply IX (SWP Peaking)	$5,490,000	0.00%	$0	100.00%	$5,490,000
	Subtotal	**$76,901,000**		**$15,345,000**		**$61,556,000**
	Water Treatment Projects					
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	$9,762,000	100.00%	$9,762,000	0.00%	$0
30	ESFP Exp. 56 MGD I (Treatment)	$9,084,000	100.00%	$9,084,000	0.00%	$0
31	ESFP Exp. 56 MGD II (Intake Pump)	$4,944,000	100.00%	$4,944,000	0.00%	$0
32	ESFP Exp. 56 MGD III (Storage)	$19,842,000	100.00%	$19,842,000	0.00%	$0
33	Rio Vista Exp. 60 MGD	$23,683,000	100.00%	$23,683,000	0.00%	$0
34	Rio Vista Exp. 90 MGD (Treatment)	$30,699,000	100.00%	$30,699,000	0.00%	$0
35	Rio Vista Exp. 90 MGD (Storage)	$9,173,000	100.00%	$9,173,000	0.00%	$0
36	Rio Vista Exp. 120 MGD	$22,438,000	100.00%	$22,438,000	0.00%	$0
37	Rio Vista Exp. 130 MGD	$11,500,000	100.00%	$11,500,000	0.00%	$0
38	Water Quality Improvements I	$8,365,000	100.00%	$8,365,000	0.00%	$0
39	Water Quality Improvements II	$11,309,000	100.00%	$11,309,000	0.00%	$0
40	Water Quality Improvements III	$11,309,000	100.00%	$11,309,000	0.00%	$0
	Subtotal	**$172,108,000**		**$172,108,000**		**$0**
	Total Capital Improvement Program Cost	**$455,395,000**	**86.48%**	**$393,839,000**	**13.52%**	**$61,556,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Existing vs Future Cost Allocation

			Existing Users Share of Costs		Future Users Share of Costs	
	Project	Project Cost (2003 $)	Percent	Cost (2003)	Percent	Cost
	Water Supply Projects					
1	Recycled Water - Phase IB	$4,547,000	38.76%	$1,763,000	61.24%	$2,784,000
2	Recycled Water - Phase II	$10,618,000	38.76%	$4,116,000	61.24%	$6,502,000
3	Recycled Water - Phase III	$9,072,000	38.76%	$3,517,000	61.24%	$5,555,000
4	Recycled Water - Phase IV	$12,809,000	38.76%	$4,965,000	61.24%	$7,844,000
5	Recycled Water - Phase V	$1,746,000	38.76%	$677,000	61.24%	$1,069,000
6	Recycled Water - Phase VI	$4,718,000	38.76%	$1,829,000	61.24%	$2,889,000
7	Recycled Water - Phase VII	$9,268,000	38.76%	$3,593,000	61.24%	$5,675,000
8	Recycled Water - Phase VIII	$5,453,000	38.76%	$2,114,000	61.24%	$3,339,000
9	Recycled Water - Phase IX	$1,804,000	38.76%	$699,000	61.24%	$1,105,000
10	Recycled Water - Phase X	$1,783,000	38.76%	$691,000	61.24%	$1,092,000
11	Recycled Water - Phase XI	$762,000	38.76%	$295,000	61.24%	$467,000
12	Recycled Water - ASR	$8,337,000	38.76%	$3,232,000	61.24%	$5,105,000
13	Recycled Water Environmental Studies	$515,000	38.76%	$200,000	61.24%	$315,000
14	Additional Supply Purchase (40,000 AFY)	$60,000,000	0.00%	$0	100.00%	$60,000,000
	Subtotal	**$131,432,000**	**21.07%**	**$27,691,000**	**78.93%**	**$103,741,000**
	Water Supply Banking Projects					
15	Water Supply Banking I	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
16	Water Supply Banking II	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
17	Water Supply Banking III	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
18	Water Supply Banking IV	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
19	Saugus Aquifer Wells 1 and 2	$2,745,000	36.29%	$996,000	63.71%	$1,749,000
20	Saugus Aquifer Wells 3 and 4	$2,745,000	36.29%	$996,000	63.71%	$1,749,000
	Subtotal	**$74,954,000**	**36.29%**	**$27,200,000**	**63.71%**	**$47,754,000**
	Pipeline/PS/Storage Projects					
21	Honby Extension & Storage II	$16,366,000	7.51%	$1,229,000	92.49%	$15,137,000
22	Lateral Extension (Pitchess)	$2,136,000	0.00%	$0	100.00%	$2,136,000
23	Lateral Extension & Storage II	$12,269,000	13.77%	$1,690,000	86.23%	$10,579,000
24	Honby & Newhall Parallel II (Honby Parallel)	$24,462,000	10.83%	$2,649,000	89.17%	$21,813,000
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	$2,719,000	0.00%	$0	100.00%	$2,719,000
26	System Appurtenances I (CC)	$6,559,000	0.00%	$0	100.00%	$6,559,000
27	System Appurtenances II (MWD Cap.)	$6,898,000	0.00%	$0	100.00%	$6,898,000
28	Additional Water Supply IX (SWP Peaking)	$5,490,000	0.00%	$0	100.00%	$5,490,000
	Subtotal	**$76,901,000**	**7.24%**	**$5,568,000**	**92.76%**	**$71,333,000**
	Water Treatment Projects					
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	$9,762,000	100.00%	$9,762,000	0.00%	$0
30	ESFP Exp. 56 MGD I (Treatment)	$9,084,000	0.00%	$0	100.00%	$9,084,000
31	ESFP Exp. 56 MGD II (Intake Pump)	$4,944,000	0.00%	$0	100.00%	$4,944,000
32	ESFP Exp. 56 MGD III (Storage)	$19,842,000	36.29%	$7,200,000	63.71%	$12,642,000
33	Rio Vista Exp. 60 MGD	$23,683,000	0.00%	$0	100.00%	$23,683,000
34	Rio Vista Exp. 90 MGD (Treatment)	$30,699,000	0.00%	$0	100.00%	$30,699,000
35	Rio Vista Exp. 90 MGD (Storage)	$9,173,000	36.29%	$3,329,000	63.71%	$5,844,000
36	Rio Vista Exp. 120 MGD	$22,438,000	0.00%	$0	100.00%	$22,438,000
37	Rio Vista Exp. 130 MGD	$11,500,000	0.00%	$0	100.00%	$11,500,000
38	Water Quality Improvements I	$8,365,000	100.00%	$8,365,000	0.00%	$0
39	Water Quality Improvements II	$11,309,000	100.00%	$11,309,000	0.00%	$0
40	Water Quality Improvements III	$11,309,000	100.00%	$11,309,000	0.00%	$0
	Subtotal	**$172,108,000**	**29.79%**	**$51,274,000**	**70.21%**	**$120,834,000**
	Total Capital Improvement Program Cost	**$455,395,000**	**24.54%**	**$111,733,000**	**75.46%**	**$343,662,000**
	Existing Total Water Demand - 2003 (AFY)	65,491				
	Future Total Water Demand - 2050 (AFY)	168,950				
	Share Existing (total)	38.76%				
	Share Future (total)	61.24%				
	Existing Imported Demand (AFY)	36,839				
	Future Imported Demand (AFY)	101,520				
	Share Existing (imported)	36.29%				
	Share Future (imported)	63.71%				
	Water Banking Allocation:					
	Existing Users Requirements (AFY	36,839				
	Future Users Requirements (AFY	101,520				
	Existing Users allocatior	36.29%				
	Future Users allocatior	63.71%				

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2004	2005	2006	2007	2008	2009
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004	$2,784,000					
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006	$1,950,600	$1,950,600	$2,600,800			
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007		$1,666,500	$1,666,500	$2,222,000		
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008			$2,353,200	$2,353,200	$3,137,600	
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009				$320,700	$320,700	$427,600
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010					$866,700	$866,700
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						$1,702,500
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005	$2,297,250	$2,807,750				
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004	$315,000					
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$7,346,850**	**$6,424,850**	**$6,620,500**	**$4,895,900**	**$4,325,000**	**$2,996,800**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004	$11,064,000					
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004	$1,749,000					
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004	$1,749,000					
	Subtotal			**$74,954,000**	**$47,754,000**		**$14,562,000**	**$0**	**$0**	**$0**	**$0**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005	$7,568,500	$7,568,500				
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004	$2,138,000					
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005	$3,173,700	$7,405,300				
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005	$815,700	$1,903,300				
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005	$1,967,700	$4,591,300				
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$15,663,600**	**$21,468,400**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006	$0	$0	$0			
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006	$2,725,200	$2,725,200	$3,633,600			
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006	$1,483,200	$1,483,200	$1,977,600			
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006	$3,792,600	$3,792,600	$5,056,800			
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010					$4,736,600	$7,104,900
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$6,365,000	$0	2009				$0	$0	$0
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010					$0	$0
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$8,001,000**	**$8,001,000**	**$10,668,000**	**$0**	**$4,736,600**	**$7,104,900**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$45,573,450**	**$35,894,250**	**$17,288,600**	**$4,895,900**	**$9,061,800**	**$10,101,700**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2010	2011	2012	2013	2014	2015
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010	$1,155,600					
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011	$1,702,500	$2,270,000				
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012	$1,001,700	$1,001,700	$1,335,600			
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013		$331,500	$331,500	$442,000		
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014			$327,600	$327,600	$436,800	
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014			$140,100	$140,100	$186,800	
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$3,859,800**	**$3,603,200**	**$2,134,800**	**$909,700**	**$623,600**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014					$11,064,000	
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$11,064,000**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						$4,362,600
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010	$5,490,000					
	Subtotal			**$76,901,000**	**$71,333,000**		**$5,490,000**	**$0**	**$0**	**$0**	**$0**	**$4,362,600**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010	$11,841,500					
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010	$0					
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015				$0	$0	$0
	Subtotal			**$172,108,000**	**$120,834,000**		**$11,841,500**	**$0**	**$0**	**$0**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$465,395,000**	**$343,662,000**		**$21,191,300**	**$3,603,200**	**$2,134,800**	**$909,700**	**$11,687,600**	**$4,362,600**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2016	2017	2018	2019	2020	2021	2022
	Water Supply Projects												
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004							
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006							
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007							
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008							
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009							
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010							
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011							
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012							
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013							
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014							
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014							
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005							
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004							
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032							
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Supply Banking Projects												
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004							
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014							
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022							$11,064,000
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028							
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004							
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004							
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$11,064,000**
	Pipeline/PS/Storage Projects												
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005							
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004							
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005							
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017	$6,543,900	$10,906,500					
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005							
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005							
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035							
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010							
	Subtotal			**$76,901,000**	**$71,333,000**		**$6,543,900**	**$10,906,500**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects												
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006							
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006							
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006							
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006							
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010							
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026							
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026							
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040							
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048							
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009							
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010							
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015							
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$465,395,000**	**$343,662,000**		**$6,543,900**	**$10,906,500**	**$0**	**$0**	**$0**	**$0**	**$11,064,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2023	2024	2025	2026	2027	2028
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010						
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						$11,064,000
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,964,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$11,064,000**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010						
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026		$6,139,800	$9,209,700	$15,349,500		
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026		$1,168,800	$1,753,200	$2,922,000		
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010						
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$7,308,600**	**$10,962,900**	**$18,271,500**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$455,396,000**	**$343,662,000**		**$0**	**$7,308,600**	**$10,962,900**	**$18,271,500**	**$0**	**$11,064,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2029	2030	2031	2032	2033	2034
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010						
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032				$60,000,000		
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$60,000,000**	**$0**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010						
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010						
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$0**	**$0**	**$0**	**$60,000,000**	**$0**	**$0**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2035	2036	2037	2038	2039	2040
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010						
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035	$6,898,000					
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$6,898,000**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010						
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040				$4,487,600	$6,731,400	$11,219,000
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010						
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$0**	**$0**	**$4,487,600**	**$6,731,400**	**$11,219,000**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$6,898,000**	**$0**	**$0**	**$4,487,600**	**$6,731,400**	**$11,219,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2048	2049	2050	Totals
	Water Supply Projects									
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004				$2,784,000
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006				$6,502,000
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007				$5,555,000
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008				$7,844,000
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009				$1,069,000
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010				$2,889,000
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011				$5,675,000
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012				$3,339,000
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013				$1,105,000
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014				$1,092,000
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014				$467,000
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005				$5,105,000
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004				$315,000
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032				$60,000,000
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$103,741,000**
	Water Supply Banking Projects									
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004				$11,064,000
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014				$11,064,000
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022				$11,064,000
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028				$11,064,000
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004				$1,749,000
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004				$1,749,000
	Subtotal			**$74,964,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$47,754,000**
	Pipeline/PS/Storage Projects									
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005				$15,137,000
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004				$2,138,000
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005				$10,579,000
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017				$21,813,000
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005				$2,719,000
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005				$6,559,000
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035				$6,898,000
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010				$5,490,000
	Subtotal			**$76,901,000**	**$71,333,000**		**$0**	**$0**	**$0**	**$71,333,000**
	Water Treatment Projects									
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006				$0
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006				$9,084,000
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006				$4,944,000
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006				$12,642,000
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010				$23,683,000
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026				$30,699,000
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026				$5,844,000
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040				$22,438,000
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048	$5,750,000			$11,500,000
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009				$0
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010				$0
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015				$0
	Subtotal			**$172,108,000**	**$120,834,000**		**$5,750,000**	**$0**	**$0**	**$120,834,000**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$5,750,000**	**$0**	**$0**	**$343,662,000**

CASTAIC LAKE WATER AGENCY
FACILITY CAPACITY FEE
FINANCIAL MODEL

OVERVIEW

Purpose

This paper provides an explanation of how Castaic Lake Water Agency (CLWA) has developed its facility capacity fee financial model and how the fees will be used to partially pay for the Capital Improvement Program (CIP) and/or any debt incurred attributable to it. The explanation includes a description of how the factors used to calculate the facility capacity fees are derived and the basis for the assumptions used.

Long-term accurate predictions of the future are difficult, if not impossible, to make. Therefore, good financial health requires a periodic review of the fees to ensure timely response to changing conditions.

The final product of this model is an annual update of the Agency's Facility Capacity Fee (Fee) for each of its water service areas (WSAs).

Projection of Future Water Demand

The need for Capital Facilities is driven by the projected demand for water. Projected water demand has been determined, for purposes of planning capital facilities development, from a parcel database generated by the Agency using County assessor use codes. These codes reflect the uses that are currently permitted for each parcel under the planning agency's current zoning ordinances. This database is on file with the Agency. The use codes are assigned a water demand recognizing that in many cases the use code permits a range of uses and thus a range of water demand. The projected demand of all of the parcels based upon their authorized uses is determined and accumulated to derive projected future demand.

Most of the vacant land is zoned for a particular land use by one of three local planning agencies: the County of Los Angeles, County of Ventura or the City of Santa Clarita. CLWA's water demand model (including both current and future consumption) uses the

Agency's database of all vacant and improved land within its service area. All county assessor parcels within the Agency's boundaries are contained in this database. A description of many planning attributes of each parcel is maintained by the County and the City of Santa Clarita on a parcel-by-parcel basis and continually updated. The Agency's database is periodically adjusted by matching the actual water delivered by the purveyors to the parcels in the database. This information is then extrapolated to the remaining vacant parcels. This provides the Agency with an estimate of the ultimate demand based on the currently authorized land uses. Each year the process is repeated as land is developed or the use changes, giving the Agency a better indication of water demand. Because the location and nature of development depends upon many factors, water demand can change in location, timing, or quantity.

The next step is to project when these demands will materialize. With the help of the purveyors, who provide historical data, and LA County Department of Regional Planning, which supplies growth projections into the future, the time of the demand is then estimated. It is recognized that the timing projections are merely best estimates based upon data available at the time. Actual water demand may change as a result of changes in the economic climate, for example, interest rates, general economy, etc. The projection of the timing of future demand determines when various elements of the CIP will need to be commenced in order to have capacity available in time to meet demand.

The timing is critical in that early construction results in increased borrowing which in turn increases interest costs. Early construction results in lower inflated project costs as a partial offset. If facilities are not commenced at the appropriate time capacity may be unavailable at the time needed by development, with the resulting delays and costs to private entities.

Water Services Areas

This section discusses how WSAs and sub-WSAs are used in capital planning and long-range financial planning.

For each land use type, there is a range of water demand factors related to development and use of that land. Specific demand factors for each sub-WSA are developed based on historical water use. These demand factors are applied to the vacant parcel information in the database to yield potential water demand within the Agency service area.

Development plans and other available planning documents are reviewed to determine a potential growth rate. This growth rate is merged with water demand to produce an incremental increase in total water demand over any given planning horizon for the Agency service area.

A model of the available groundwater in each sub-WSA has been developed based on purveyor information and is contained in a report entitled "2000 Urban Water Management Plan", which is on file with the Agency. The available groundwater is subtracted from total water demand to yield the requirement for imported water.

Capital Facilities

The imported water demands are then translated into Capital Facility requirements. For compliance with the Agency Act, this particular activity is conducted on a water service area basis. The capital facility requirements are estimated in a manner which considers the amount of local water that is available, the anticipated demand for imported water, and the facilities required to treat and convey imported water to service those demands. The Capital Improvement Program, prepared by Kennedy Jenks, details the facilities planned to meet future demand. The Engineering News Record Index is used in projecting the inflationary pressures on utility construction costs for facilities the construction of which is expected to be done many years in the future.

Existing versus Future Needs

The Capital Improvement Program is then further examined to determine what portion of the CIP is necessary to accommodate existing service demand versus that which is necessary to accommodate future demands. The allocation is set forth in the body of the data document. The legal basis for the Facility Capacity Fee is that it can be attributed only to those facilities that are required to serve new users. Thus, that portion of the Capital Program attributable to existing users is removed to produce capital requirements for future users only, which provides the basis for the fees.

Board Policy

In developing the Facility Capacity Fee Program, the Board established policies with regard to the sources of revenue to fund the Capital Program. Facility capacity for **future growth** (future users' share of the CIP) are funded as follows:

—A portion of 1% property tax

—Standby charges, if levied

—Interest on investments

—Capital Facility Fees

That portion of the Capital Program attributable to **existing users** is funded by:

—A portion of 1% property tax

—Standby charges, if levied

—Interest on investments

—A portion of water sales attributable to the Capital Program

—Existing ad valorem tax in excess of the 1% basic levy, which is authorized to pay the State Water Project liability of the Agency.

Basic Structure of the Model as it Relates to the Formation of the Agency's Water Service Areas

For the purposes of developing the CIP and assigning rates and charges on a cost of service approach, the Agency developed 26 sub-water service areas ("Sub-WSAs") which are aggregated into 8 water service areas ("WSAs"). (See Figure 1.) The WSAs are required by the Agency's Act, and are recorded with the State Board of Equalization as well as the County of Los Angeles. This enables the Agency to levy different water rates, standby charges, tax rates, and capital facility fees by WSA. This is a special power authorized by the Agency's Act in an effort to accommodate a rapidly growing Agency in a developing area. The cost of service approach aptly reflects the needs of the area.

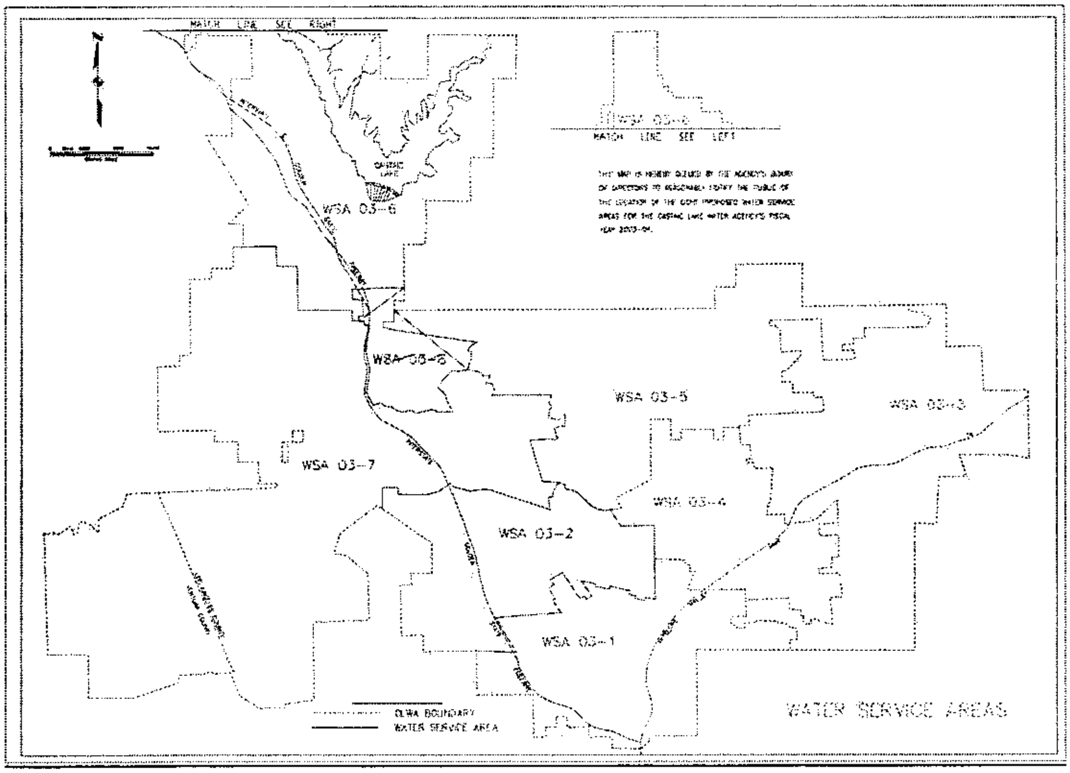


Figure 1
Water Service Area Map

Specific Benefit to WSA

The Agency's financing authority is based on a benefit assessment theory, which means that there must be an appropriate nexus between the amount of the charge and the cost of providing the benefit within each of the WSAs. The Agency Act allows the Board of Directors the flexibility to develop two or more WSAs. When the Agency was first divided into WSAs, there were four WSAs. Later, it was decided that eight would be more appropriate. Another important element is that each WSA can have its own unique set of charges, though the law does not require that the charges be different.

Agency-Wide Benefit

The Agency's CIP allocated to each WSA is based upon Board policy as follows: the cost attributable to acquire, treat and store water is considered an Agency-wide benefit, because the water is available for use in any WSA. Thus, the Fee that is derived from the calculation of these costs is applied uniformly across the entire Agency service area.

Water Service Area Specific Benefit

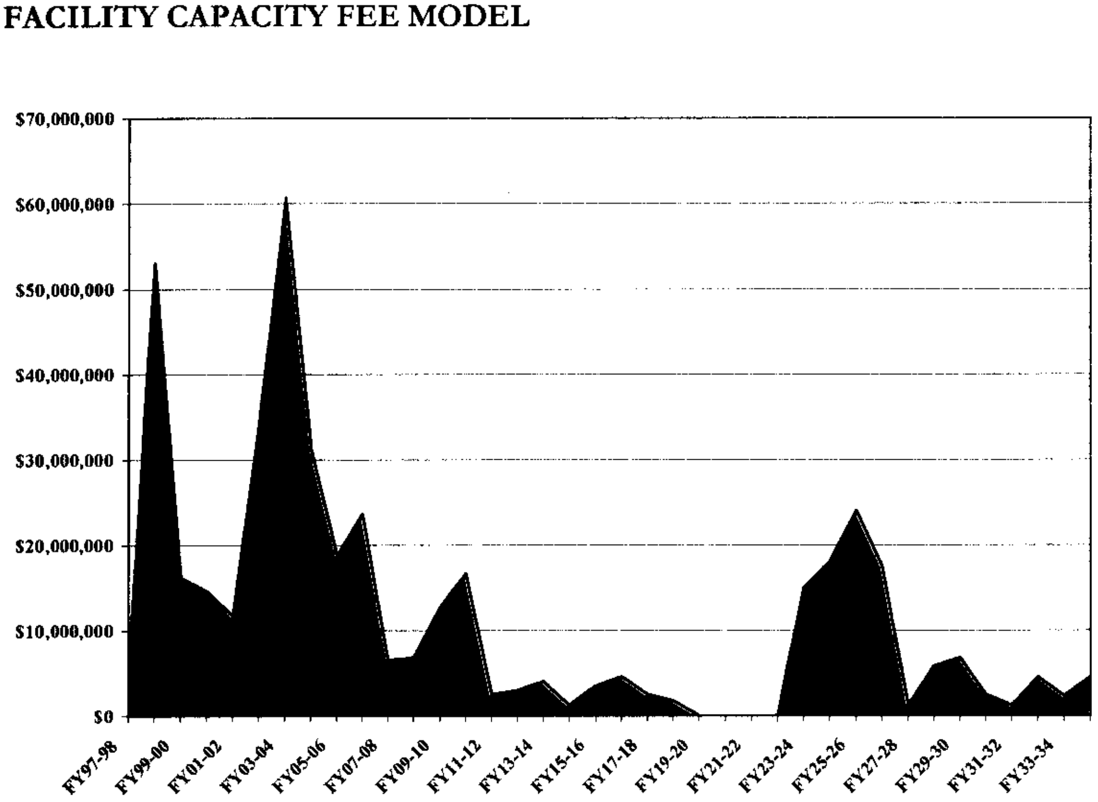
The transmission of the water to the various WSAs is considered to be a WSA-specific benefit. Thus, a cost of service approach is used that takes into consideration pipeline length, diameter, and other engineering parameters. The capital projects are apportioned to each of the water service areas in proportion to these mathematical relationships and then translated into a Fee for pipelines. This Fee is then aggregated with the treatment, storage, and water purchases component to create the total Facility Capacity Fee for each WSA.

Capital Project Scheduling

The design and later construction of capital facilities are commenced approximately five years ahead of need to ensure that shortages do not occur. The rate of demand for water varies each year. While growth may be relatively small in one year, it gradually accumulates. For practical purposes, water facilities cannot be built in small increments; pipelines come in standard sizes, and it does not make economic sense to construct many parallel small pipes to respond to growing demands when one large pipeline can be planned in advance.

Therefore, Agency engineers are required to make estimates of the reasonable capacities required for the water user areas and to design pipelines appropriately. On the other hand, treatment, storage, and water supply can be more economically added by incremental units, though even these units must also be economically sized. For treatment purposes, expansion of existing treatment facilities according to staged facility enlargement plans is reasonable. Capital expenditures for the facilities projected in the CIP will take place over more than thirty (30) years, as shown in Figure 2. The expenditures under the CIP, however, are not uniformly spread; there may be years with little or no design/construction activity and then several years of intense capital outlay requirements.

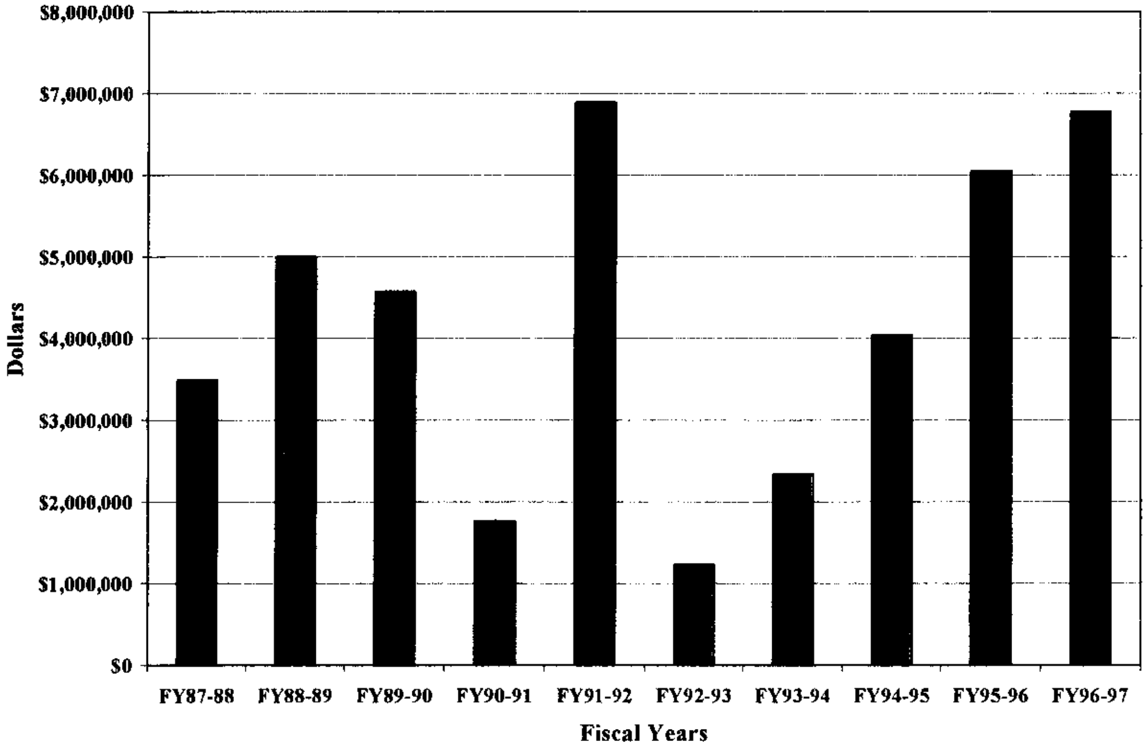
Figure 2
Sample Capital Improvement Program



Without a systematic approach, the CIP would result in dramatic swings in fees. This would not be fair or equitable. As a result, a system was developed that recognizes the growth of the water demand compared to the requirements for capital facilities which are built in a less regular manner. Since many of the facilities are large and must be built prior to need, funds will likely not be available when needed to build these facilities. Thus, cash flow projections are developed which identify borrowing requirements and timing. With the cash outflow estimated, the next step is to consider sources of cash to offset the expense. These sources are 1% tax monies, standby charges, interest on investments, and Facility Capacity Fees.

Note that the flow of revenues is not always smooth. In recent years, 1% property tax funds have been relatively stable. However, facility capacity fees, which are a primary source of revenue for construction of facilities under the CIP, vary dramatically as the economy changes, as shown in Figure 3. The capacity fee model has to consider the above parameters and translate them into a Fee that has a consistent long-term growth trend based upon known facts in order to avoid large changes on a year-to-year basis.

Figure 3
Facility Capacity Fee Collection History



Model Logic

The model is designed in such a way that it considers the cash demands on a year-by-year basis, and then accounts for anticipated revenues on a year-to-year basis as depicted in Figure 4. Note that there are wide discrepancies in the cash flow. Thus, it is necessary for the model to analyze how much money will be needed to cover the cumulative effect of all expenses during the study period (Figure 5). (The numbers used in Figures 4 and 5 are for illustration purposes only). Of course, cumulative revenue has to equal the cumulative expense amount although the expenses and the revenues may not match each other year by year (Figure 4). The model goes through repeated iterations to achieve the balance of cumulative revenue and expense.

Figure 4
Sample Cash Flow of Facility Capacity Fee Revenue v. Expense

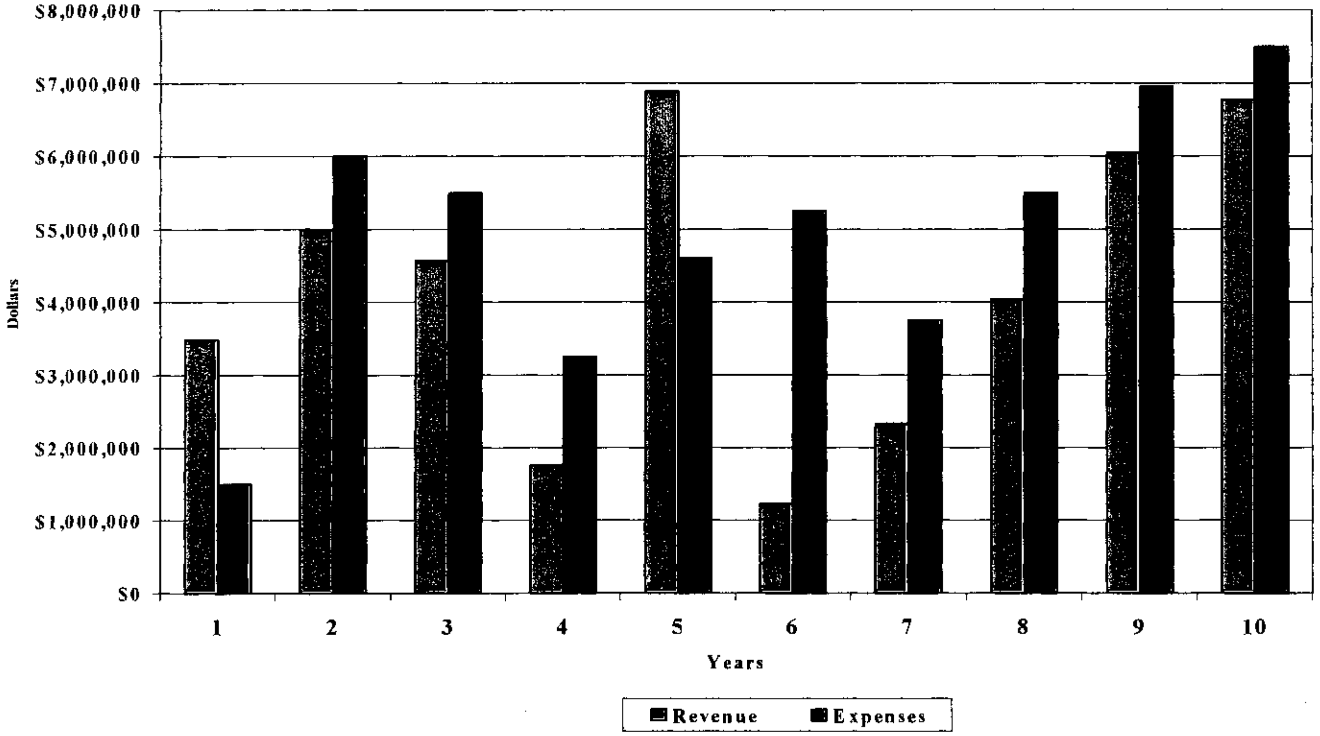
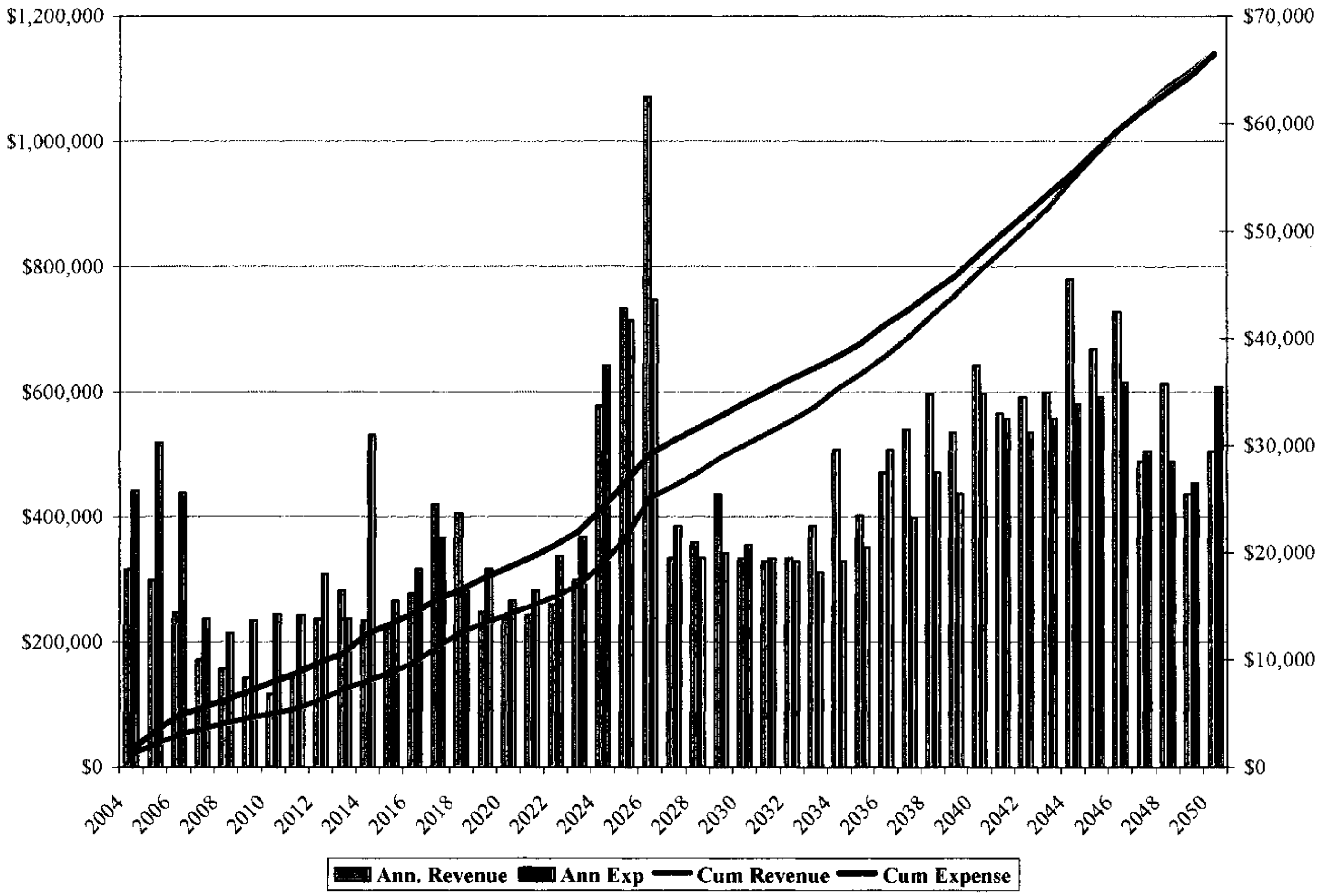


Figure 5
Example of Cumulative Revenue & Expenses



Variables/Assumptions

General

Although conceptually straightforward, the Fee calculation is mathematically complex. There are countless permutations and combinations that enter into the calculation. However, in order to obtain valid results, certain basic assumptions are made. These assumptions are examined each year to determine if they are still appropriate. The model contains many variables. For example, if the expenditures accelerate, the borrowings must be accelerated, which could mean an increase in interest cost, which adds to total costs. On the other hand, this can be offset by an increase in cash flow from the sale of Facility

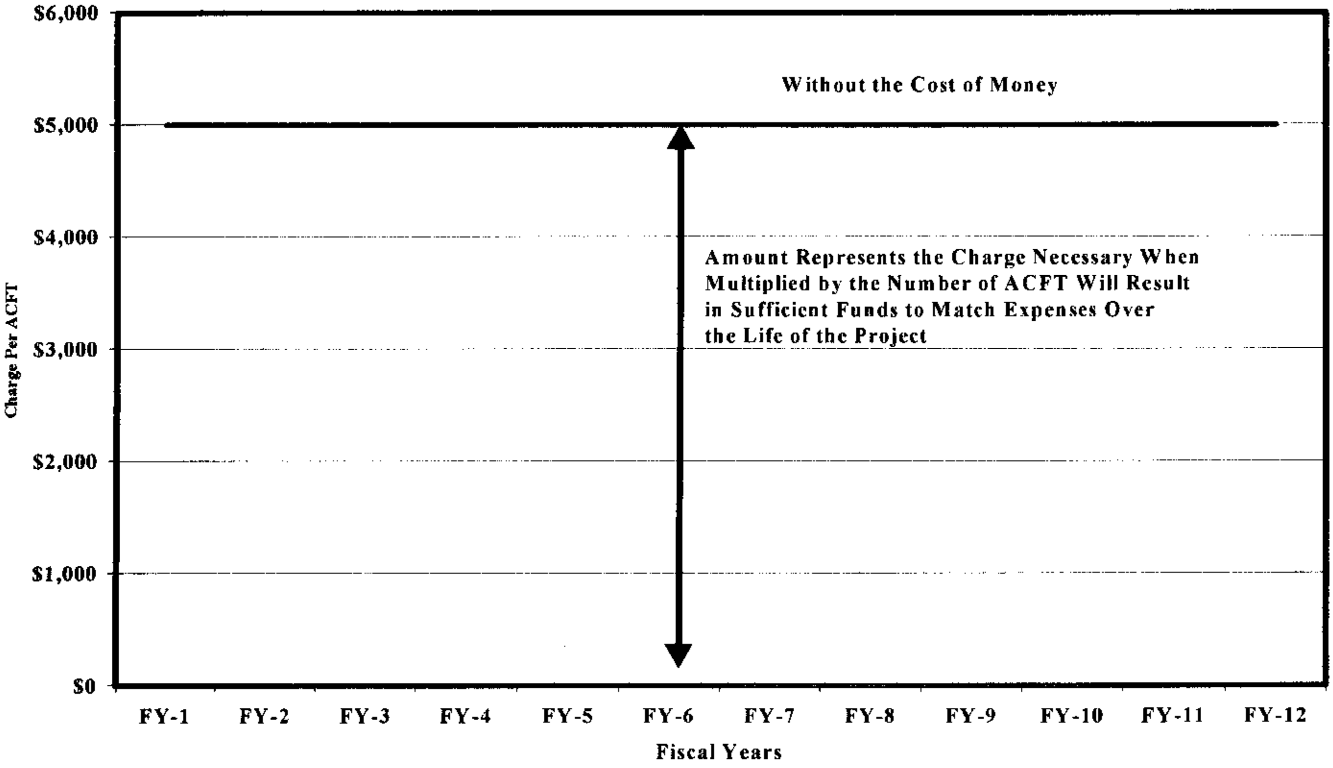
Capacity Fees and other revenue sources. This process is done on an annual basis, allowing minor adjustments and thus avoiding any abrupt changes and shortfalls in revenue. The key elements of the model are described below:

Inflation

Another major factor that is taken into consideration is the value of a dollar over time. Obviously, a dollar today is not a dollar 50 years hence. Thus, it is necessary to take into consideration the general economy or the CPI. This number is used in the model to recognize that a Fee paid today is different in value than a fee paid in 2030. Thus, it is necessary to reduce the fees in the near term recognizing that they are worth more having been paid in the early years.

Assuming no inflation and that a dollar today is worth a dollar in the future, all that would be required is a flat rate to accumulate the cash requirement as depicted in Figure 6.

Figure 6
Example of Flat Fee



Note that the connection fee <u>rate</u> is a horizontal line. The distance above the X-axis is sufficient so that when multiplied by the anticipated growth in sales, that volume of cash flow will equal the volume of cash expenditures. However, costs are subject to inflation, cost of borrowing, and a CIP schedule that may vary. Thus, cash needs can dramatically change depending upon the assumptions.

Interest Income and Expense of Borrowing

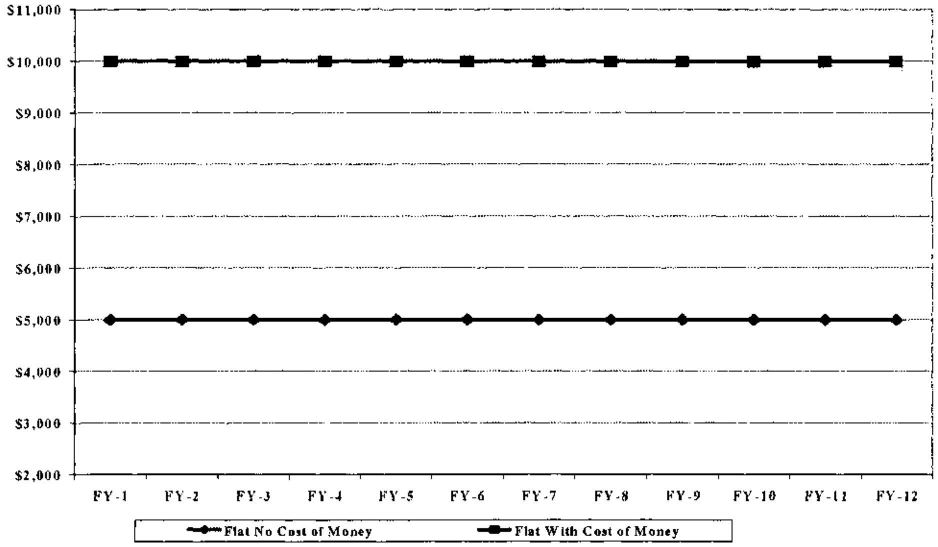
The assumed interest cost for borrowing is based on the 3-year Treasury interest rate less 50 basis points, or 6.49%. The Agency invests in relatively short-term taxable paper and borrows at long-term tax-exempt rates. Since it is practically impossible to predict over 50 years what the interest rates will do the Agency determined that a prudent approach would be to use the three-year treasury rate as a guide. This approach recognizes that there are times when the Agency will earn more on interest than it pays for debt and others when it will earn less than it pays (as is the current situation). The interest cost for borrowing is based on a three-year Treasury rate less 50 basis points to approximate a high-grade tax-exempt municipal bond rate. The Agency borrows approximately every 3 to 5 years an amount expected to meet the Agency's capital needs as scheduled by the engineers.

Good planning requires that capacity be available in time to meet expected demand. Since the lead time necessary to construct facilities requires that construction be commenced before fees are collected from the prospective development it is necessary for the Agency to borrow money necessary to construct facilities and then recover the cost from the Facility Capacity Fee. Interest on unspent funds is based on the current 3-year Treasury interest rate less 100 basis points, or 5.99%, to insure that the model assumes that interest earnings will be lower than borrowing costs.

It was determined that since public agencies invest over short periods of time and borrow over longer periods it was prudent to be conservative in the application of interest rates for borrowing as well as earnings. For that reason, the average interest paid and earned by the Agency was adjusted by 100 basis points to derive an interest rate to be used for calculation.

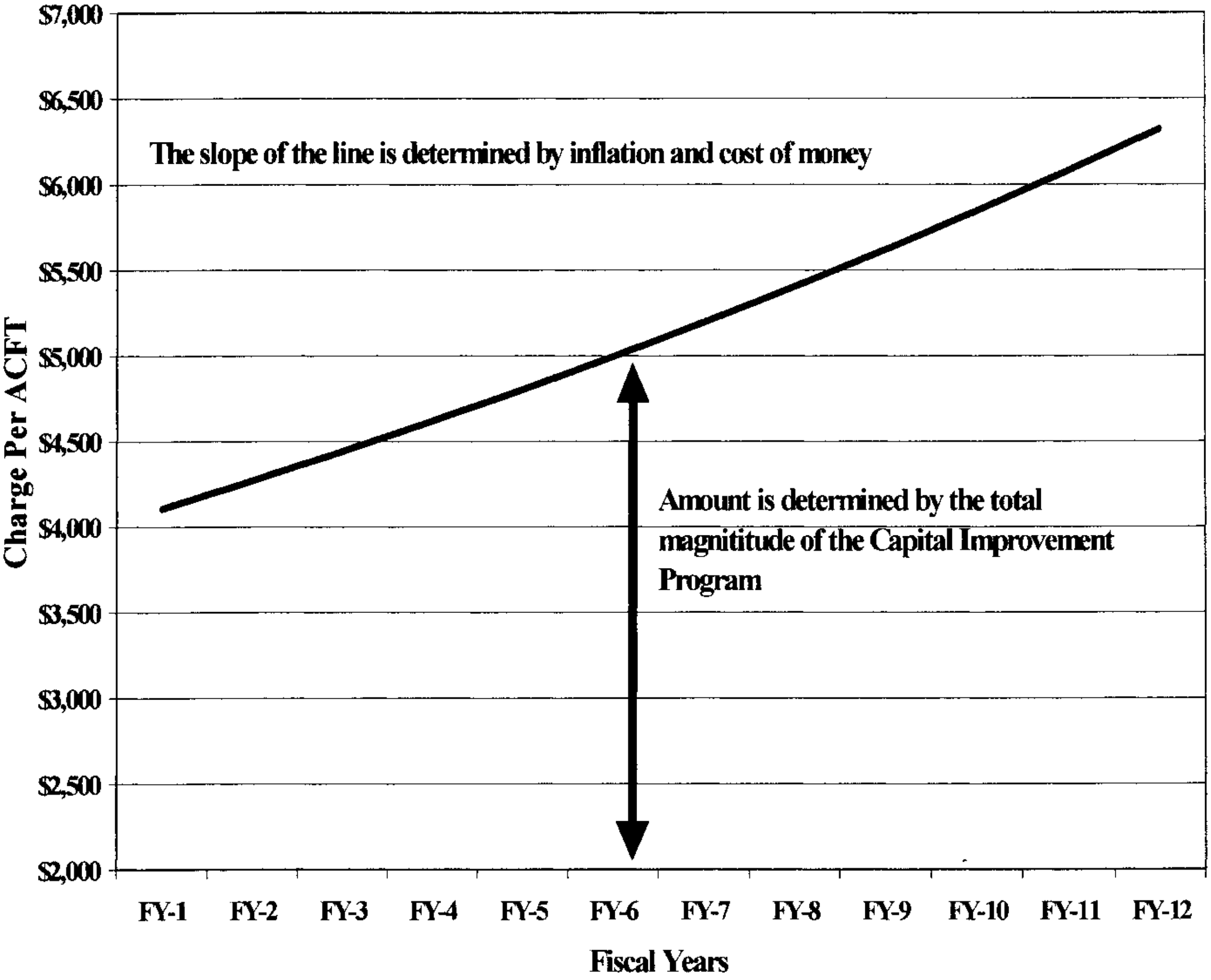
When the cost of money is added, the charge has to escalate each year to take this into account. If there is a shift in the CIP, this could result in greater or lesser cash requirements. It may also require an adjustment in the amplitude of the line, but may not necessarily change the slope, as depicted in Figure 7. If there is an unusual influx of cash in certain periods, it can then be reinvested, thereby increasing revenues. Thus the entire line can be shifted down, indicating a lower facility capacity fee rate, as a result of less borrowing and thus lower interest costs.

Figure 7
Facility Capacity Fee with Cost of Money



The model also has to take into consideration inflation in addition to the cost of money. As a result, the Capital Fee Schedule now takes on the appearance shown in Figure 8.

Figure 8
Facility Capacity Fee Escalated



The slope of the line takes into consideration inflation and the cost of money. The amplitude represents the magnitude or the total volume of dollars required. Each time the program is analyzed and the calculations re-run, the magnitude (the distance from the X axis) can vary as well as the slope of the line. Performing the calculations on a periodic basis minimizes changes in the rate, which could have adverse impacts on those paying the fees.

Likewise, the anticipated water demands and the facilities planned in the Capital Improvement Program are reexamined each year to determine whether changes are necessary.

Sales of Acre Feet of Capacity

The projected sale of acre feet of capacity is critical to the Agency's cash flow. The Agency has based its financial capacity to repay debt based on the revenue derived from the sale of capacity in the Agency's system, i.e. collection of facility capacity fees. Facility capacity fees are not considered by the municipal bond market to be a stable source of revenue to support bond payments, because they depend upon the progress of the housing market. It is necessary to use conservative projections of sales and demonstrate a conservative and responsible finance plan, in order to obtain a favorable bond rating. Over the past 17 years of the program the model has used 55% of projected capacity sales to calculate the capacity fee for purposes of providing sufficient revenues to support bond payments. Thus far this projection has proven to be satisfactory to the bond rating agencies as the Agency has an "A" rating. If this ever results in a potential of excess revenues, the ratio will be adjusted accordingly.

In addition to the foregoing discussion on sales it is important to point out that not all of the projected demands will be provided by the Agency. For example: there are golf courses and agricultural activities that may develop their own wells and do not require a connection to a purveyor's water system and thus are not subject to the fee. In addition there are developments that are not required to obtain building permits such as hospitals and schools. Thus, the Agency may not collect fees from these uses.

Since the fees are evaluated on a yearly basis, the Agency can adjust its sales as a percentage of demand if it is determined that more money will be collected than necessary; thus avoiding over collection.

Past Debt Allocation

As projects are built, they are removed from the CIP. However, the capital cost now has been replaced with debt. The engineers track the actual use of the proceeds of the various bond issues and allocate the debt service for each bond issue among the appropriate benefiting cost centers such as Treatment facilities which are allocated to all WSAs , or to transmission facilities which are allocated only to the WSA(s) served by those facilities.

Unspent Bond Proceeds

If there are unspent bond proceeds, these likewise are attributed to the appropriate cost centers such as Treatment and WSA1 through WSA8. These unspent funds are an offset to projects scheduled in the program that are not yet built. The Agency currently has unspent bond proceeds because of delays in its construction program. These delays are a result of litigation and the need to prepare more environmental documentation before construction can proceed.

Allocation of 1% Property Tax

The Agency receives a portion of the 1% property tax revenue and allocates the proceeds to the future users and existing property owners based on the ratio of the assessed value of developed vs. undeveloped property. The calculation of the Facility Capacity Fee takes into account revenues available from the increment of the basic 1% property tax levy derived from undeveloped property. However, not all of the property tax revenue from undeveloped property is used to reduce the Facility Capacity Fee. Certain activities of the Agency funded with property taxes are deemed to benefit future users as well as existing users of the Agency's water system. Therefore, a portion of the property taxes on undeveloped property is used for the Agency's non-capital activities. The allocation of the Agency's tax revenue from the basic 1% levy between current uses and the CIP is based on the ratio between developed projects' assessed values (95%) and undeveloped properties' assessed values (5%). The model takes into consideration the effect of the changing ratio of developed to undeveloped property in calculating the funds available for the facility capacity program over time.

Calculation

In order to start the calculation, the model requires an initial facility capacity rate. This number is calculated by dividing the total CIP, plus financing cost including past debt, less cash sources, by the total anticipated water demand for the study period. Based on the initial rate, the model then generates a preliminary total cash revenue over the study period. If the cash falls short, it begins a series of successive iterations until it achieves a matching of cumulative costs and revenues.

What makes this calculation complicated is that it considers cash needs on an annual basis and, if there is a cash shortfall, it takes into consideration costs attributable to borrowing this money. Each WSA effectively borrows and repays money to the Agency. The result of these borrowings and payments dictates the amount of cash required at the Agency. The Agency in turn borrows money when there is insufficient cash to cover the needs of the various WSAs.

Thus, the Facility Capacity Fee takes into account all the foregoing parameters and the cost of borrowing when it is necessary. It truly reflects the entire cost that is involved in developing and paying for a Capital Improvement Program in each WSA.

Facility Capacity Fee Calculation

A more detailed explanation of the calculation to derive the capacity fee is as follows:

A percentage of each element of the Facility Capacity Program benefiting future demand in the subject WSA is adjusted to reflect the expected change in the Construction Cost Index between now and the time of expected construction, plus the expected financing costs over the life of the financing, plus the actual cost of that percentage of facilities in place which will benefit future demand in the subject WSA, including financing costs, less estimated revenues available from property taxes collected on undeveloped property, less estimated revenues from interest on Facility Capacity Fees and tax revenues, until they are expended.

The sum of the total costs as calculated above is divided by the projected future sales in the WSA (expressed in acre feet) which will be met by the capacity of facilities planned under the CIP, and facilities currently in existence, which are of benefit to the WSA. The basic Facility Capacity Fee amount for the WSA is then adjusted to take into consideration the time value of money by reducing the fee in earlier years and increasing the fee expected to be levied in later years so that the present value of the fee in each year is equal based upon a discount rate of 4.42%.

The initial Facility Capacity Fee projected for each year is multiplied by the estimated sales of capacity (i.e. estimated facility capacity fee revenues) for each year in the future. This creates a Facility Capacity trial cash flow. This initial cash flow is then accumulated and is reduced by the accumulated annual CIP costs. The result will indicate years where there is not enough cash and other years where there is an excess. Borrowing must occur in the deficit years and the excess revenues over capital outlays may be invested to generate interest income in the surplus years. The initial Facility Capacity Fee calculation will typically result in a situation where, at the end of the build out, a WSA will either have excess cash or remaining debt. In order to minimize the projected difference between total revenues and expenses over the time period addressed in the CIP, a series of iterations must be run to adjust the initial Facility Capacity Fee either lower or higher incrementally in all time periods until a state of no excess cash and no remaining debt is reached at build out. Hundreds of iterations may occur to end up with an acceptable closing tolerance of less than 1%. Because many of the factors which go into the calculation are based on projections, estimates and assumptions regarding future growth patterns and economic conditions, the results are not guaranteed to be exact reflections of future costs and revenues. The calculations represent the Agency's best effort to set facility capacity fees based on information available today. Annual review of the capacity fees will be conducted to determine whether adjustments are necessary.

WSAs versus Agency – Model View

The Agency is the legal entity that has the authority to collect funds, spend and borrow money, and thus, for the purpose of the model, it is a "central bank". Each WSA functions as a sub-account; each has a CIP, estimated service requirements, anticipated growth and sales. Those elements that are considered Agency-wide are calculated at the Agency-wide level. The Agency-wide elements include the treatment plant, purchased water and storage. Elements which are WSA-specific (i.e., the Pipeline Capital Program), are distributed to each affected WSA. The logic previously described is also used to calculate the pipeline portion of the Facility Capacity Fee.

The very nature of the calculation is self-adjusting. As parameters change -- inflation, interest, time, sales, borrowing, value of money, amount of borrowing, increase or decrease in CIP -- the model automatically shifts the Facility Capacity Fee projection line up or down, flatter or steeper.

Summary

The model is extremely dynamic and attempts to reflect real world conditions. It allows the Agency to make annual adjustments after reviewing past history and expected financial impacts. Further, it results in a smooth increase in connection fees that is relatively predictable over the foreseeable future.

The ultimate goal is to collect sufficient money to fund the Agency's Capital Improvement Program as well as to minimize borrowings attributable to that program in a manner that is fair, equitable and in compliance with law and Board policy.

Appendix F
Assumptions

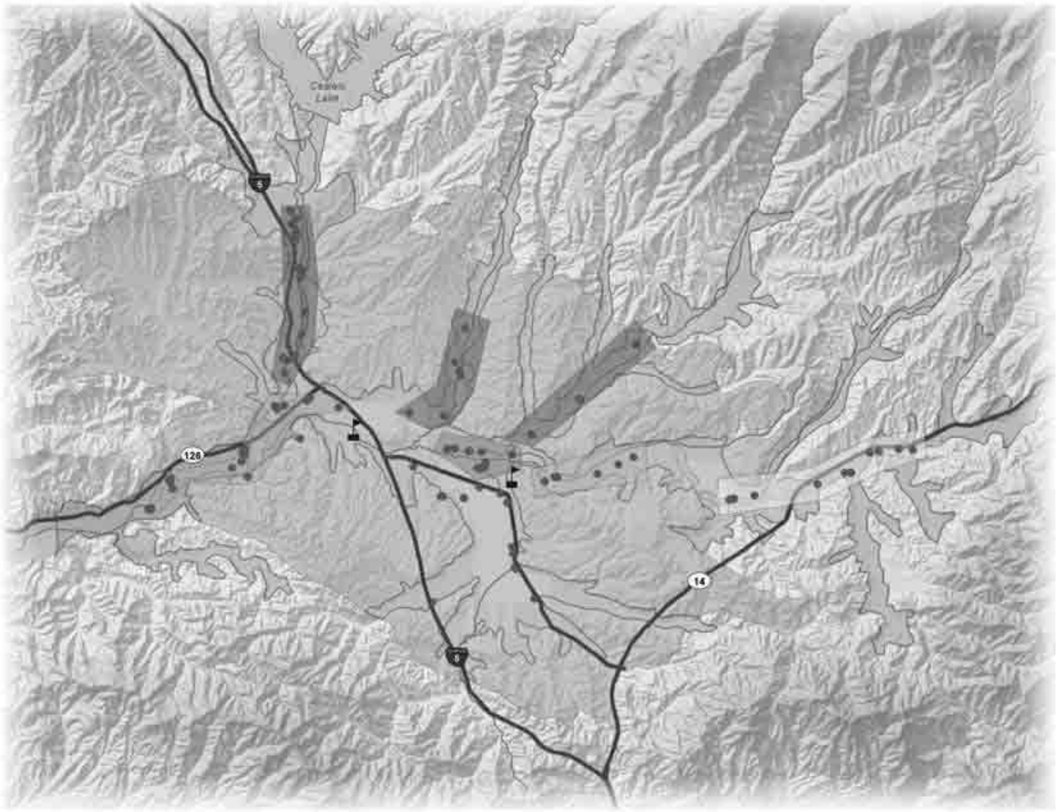
Inflation:

Construction Cost Index	Since 1913	4.82%
Consumer Price Index	Since 1960	4.42%

Interest:

Interest Income	1962 – 2002	5.99%
3-Year Treasury less 100 Basis Points		
Interest Expense	1962 – 2002	6.49%
3-Year Treasury less 50 Basis Points		

2004
Santa Clarita Valley Water Report



Castaic Lake Water Agency (CLWA)
CLWA Santa Clarita Water Division
Los Angeles County Waterworks District 36
Newhall County Water District
Valencia Water Company

May, 2005

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

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Figures, continued

(all figures following their respective sections)

Tables

Executive Summary

This annual report, which is the seventh in a series that began in 1998, provides current information about the water requirements and water supplies of the Santa Clarita Valley. The report was prepared by Castaic Lake Water Agency (CLWA) and its Santa Clarita Water Division, Los Angeles County Waterworks District 36, Newhall County Water District, and Valencia Water Company.

The Santa Clarita Valley is served by four local retail water Purveyors: Castaic Lake Water Agency's Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LA36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). The CLWA provides water from California's State Water Project (SWP) to the water Purveyors for distribution. Management from these entities and representatives from the City of Santa Clarita and the County of Los Angeles meet as required to coordinate the management of imported SWP water with local groundwater to meet water requirements in the Valley.

This report provides information about local groundwater resources, SWP water supplies, water conservation, and recycled water. The report also reviews the sufficiency and reliability of supplies in the context of existing water demand, as well as an overall outlook of water supply and demand.

In 2004, total water demands in the Santa Clarita Valley were about 87,900 acre-feet (af), of which about 82 percent (72,300 af) was for municipal use and the remaining 18 percent (15,600 af) was for agricultural and other (miscellaneous) uses. These total water demands were met by a combination of about 40,300 af from local groundwater resources (nearly 24,700 af for municipal and about 15,600 af for agricultural and other uses), about 47,200 af of SWP water, and about 450 af of recycled water.

Of the 40,300 af of total groundwater pumpage in the Valley in 2004, about 33,800 af were pumped from the Alluvium and about 6,500 af were pumped from the underlying, deeper Saugus Formation. Alluvial pumpage represented about a 200 af increase from 2003, and Saugus pumpage increased by about 2,300 af from 2003. Neither pumping volume resulted in any overall change in ongoing groundwater conditions (water levels, water quality, etc.) in either aquifer system. SWP deliveries to the Purveyors increased by 2,800 af over 2003, to 47,205 af in 2004. Water uses and supplies in 2004 are summarized in the following Table ES-1.

As discussed in the 2000 Water Report, a notable accomplishment in that year was the preparation of the Urban Water Management Plan (UWMP) for the Santa Clarita Valley. The UWMP, which is more technical and longer term in focus than this annual report, and which does not focus on recent or other historical water requirements and supplies, provides a projection of water demands through 2020. Among other details, it delineates a number of local and other groundwater supplies in conjunction with SWP water to meet those projected water demands over that time frame. It also identifies operating plans for dry periods of up to three consecutive dry years. This operating plan proposes using alternate supplies and/or development

Table ES-1
Santa Clarita Valley
Summary of 2004 Water Uses
(acre-feet)

Municipal		
State Water Project		47,205
Groundwater (Total)		24,671
Alluvium	*18,970*	
Saugus	*5,701*	
Recycled Water		448
Subtotal		**72,324**
Agriculture/Miscellaneous		
State Water Project		-
Groundwater (Total)		15,590
Alluvium	*14,787*	
Saugus	*803*	
Subtotal		**15,590**
Total		***87,914***

of future supplies from groundwater storage projects, short-term transfers, local groundwater and other supplies to offset potentially reduced deliveries of SWP water. Conjunctively, these supplies can meet demands without exceeding the operational yield of the aquifer system on a long-term basis. In litigation filed by Ventura County, The Sierra Club, and Friends of the Santa Clara River, the UWMP was upheld in April 2003 by the Kern County Superior Court as a fully legal and complete document. Notably, the Court rejected claims that population projections and associated water demand projections were underestimated, and that available water supplies were overestimated. Subsequently, however, in September 2004, the Appellate Court found that the 2000 UWMP should have addressed the time needed to implement available methodology for treatment of perchlorate contaminated groundwater, and should have described the reliability of groundwater supplies during the treatment implementation period.

As a result, the Purveyors prepared and adopted an amended 2000 Urban Water Management Plan to address three general topics: updated requirements of urban water management plans related to groundwater, as added to the Water Code since 2000; the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand without perchlorate-impacted wells; and detailed plans for the integrated control of perchlorate migration and full restoration of perchlorate-impacted water supply, scheduled for implementation by 2006. The 2000 Urban Water Management Plan **Groundwater Perchlorate Contamination Amendment and Other Amendments** was completed in January 2005 and formally submitted to the State Department of Water Resources in February 2005.

As introduced in the 2001 Water Report, a significant accomplishment in that year was the preparation and execution of a Memorandum of Understanding (MOU) between the Santa

Clarita Valley water Purveyors and the United Water Conservation District (United). United manages surface and groundwater resources in seven groundwater basins in the Lower Santa Clara River Valley Area, downstream of the Santa Clarita Valley. This regional MOU effort was born out of a willingness among the involved agencies to seek opportunities to work together and develop programs that mutually benefit the region and the communities they serve.

The MOU has initiated a collaborative and integrated approach to the following: data collection; database management; groundwater flow modeling; assessment of groundwater basin conditions, including determination of basin yield amounts; and preparation and presentation of reports, including continued annual reports such as this Water Report for current planning and consideration of development proposals, and also including less frequent but more technically detailed reports on geologic and hydrologic aspects of the overall stream-aquifer system. Integration of the Upper (Santa Clarita Valley) and Lower (United WCD) Santa Clara River databases was accomplished in 2003. Work was subsequently completed on the development and calibration of a numerical groundwater flow model of the entire Santa Clarita groundwater basin. That model will be further utilized in 2005 for evaluation of basin yield under varying management actions and hydrologic conditions.

In August 2002, the Department of Water Resources (DWR) released its Draft State Water Project Delivery Reliability Report. The report was finalized in May 2003. The report is intended to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies. The analyses contained in the report conclude that the SWP, using existing facilities and operated under current regulations, can deliver a long-term average of 76 percent of the primary contractual supply (defined as the Table A Amount) at the 2021 level of development described in the report. During infrequent dry periods deliveries are projected to be less than 50 percent, and possibly as low as 19 percent during an unusual single dry year condition that has historically occurred about once every 70 years. During very wet years, full contract amounts are available.

Significant accomplishments in 2002 and 2003 were the storing of 24,000 af of 2002 available SWP Table A water and 32,522 af of available SWP Table A water by CLWA in the Semitropic Water Storage District’s groundwater banking program in Kern County. Over the subsequent ten years, this groundwater bank account will be used as an additional supply for the Santa Clarita Valley during a dry period. In accordance with the provisions of the banking agreements, CLWA can withdraw up to 50,870 af of the stored water to meet valley demands when needed.

Another notable accomplishment in water resource management in 2003 was the completion and adoption of a formal groundwater management plan. In 2001, as part of legislation authorizing CLWA to provide retail water service to individual municipal customers in addition to its ongoing wholesale water supply, Assembly Bill 134 included a requirement that CLWA prepare a groundwater management plan in accordance with the provisions of Water Code Section 10753, which was originally enacted by, and is commonly known as, Assembly Bill 3030. The general contents of that groundwater management plan were outlined in 2002, and a detailed plan was drafted in 2003 to satisfy the requirements of AB 134 and to both complement and formalize a number of existing water supply and water resource planning and management activities in the CLWA service area. Among the elements of the adopted Plan is the preparation of groundwater management reports. The annual Water Reports, like this one, were envisioned in that Plan to continue to provide regular reporting on many of the aspects of the groundwater management plan. Other more detailed technical reports were also envisioned in the Plan to address specific aspects of basin management. The first of these technical reports, on the development and calibration of a numerical groundwater flow model, was drafted in 2003.

Due to the nature of the above-noted issues with perchlorate contamination in the basin, the primary focus of efforts in 2004 centered around those issues. Significant accomplishments included the completion of an integrated plan for restoration of impacted groundwater supply wells, treatment of groundwater for removal of perchlorate, and containment of perchlorate contamination in order to protect other wells in the basin. Closely related to the completion of that plan was the utilization of the recently developed groundwater model, after approval of the model for that purpose by the State Department of Toxic Substance Control, for analysis of the required pumping rates and resultant containment of perchlorate contamination. Embedded in the latter analysis was the basin-wide utilization of groundwater for water supply as planned in the UWMP; the resultant analysis showed, over a long-term period of typical wet/normal/dry hydrologic conditions, that both aquifer systems responded in a sustainable manner, with no depletion or degradation of the basin.

As introduced above, water supplies to meet existing water demands in the Santa Clarita Valley include groundwater from the shallow Alluvial Aquifer and from the underlying deeper Saugus Formation, SWP water, and recycled water. The following summarizes the use and condition of those water resources in the Valley in 2004.

ES.1 Alluvial Aquifer

In light of Alluvial aquifer conditions over the last 10 to 20 years, during which Alluvial pumpage has increased without long-term adverse effects on water levels or quality, the UWMP includes Alluvial pumpage in the range of 30,000 to 40,000 acre-feet per year (afy) in average/normal years, and slightly reduced pumpage (30,000 to 35,000 afy) in dry years. Pumpage from the Alluvium in 2004 was 33,800 af, and remained in the overall UWMP range as it has over the last ten years.

On a long-term basis, there is no evidence of any historic or recent trend toward permanent water level or storage decline. In general, throughout a large part of the basin, Alluvial groundwater levels have generally remained near historic highs during the last 30 years. Higher than average precipitation in late 2004 and early 2005 resulted in significant water level recovery in the eastern part of the basin, continuing the overall trend of fluctuating groundwater levels within a generally constant range over the last 30 years. These ongoing data indicate that the Alluvium is in good operating condition and can continue to support pumpage in the range included in the UWMP, as has been the case for the last decade, without adverse results (e.g., long-term water level decline or degradation of groundwater quality.)

Based on an integration of water quality records from multiple wells completed in the Alluvium, there have been historical fluctuations in groundwater quality, typically associated with variations in precipitation and streamflow. However, like groundwater levels, there has been no long-term trend toward groundwater quality degradation; groundwater produced from the Alluvial aquifer is a viable municipal and agricultural water supply.

In 2002, as part of ongoing monitoring of wells for perchlorate contamination, perchlorate was detected in one Alluvial well located near the former Whittaker-Bermite facility. The detected concentration was slightly below the Notification Level for perchlorate (6 ug/l), and the well has been inactivated for municipal water supply. In early 2005, perchlorate was detected in a second Alluvial well, VWC's Well Q2. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. The Q2 Report (Luhdorff and Scalmanini, 2005) documents that the perchlorate detected in Well Q2 will not significantly impact the water supplies used to meet demand in the Santa Clarita Valley for the period of time required to respond to the contamination. The results of the Q2 analysis and Report are consistent with the analysis and conclusions in the Amended 2000 UWMP. Valencia's response plan for Well Q2 is to pursue permitting and installation of wellhead treatment by the fall of 2005, which will return the well to water supply service. All other Alluvial wells operated by the Purveyors continue to be used for municipal water supply service; those wells near the Whittaker-Bermite property are routinely sampled and perchlorate has not been detected. As detailed in the Amended 2000 UWMP and the Q2 Report, the inactivation of two Alluvial wells due to perchlorate contamination does not limit the Purveyors' ability to produce groundwater from the Alluvium in accordance with the capacities delineated in the UWMP.

The ongoing characterization and plan for control and cleanup of perchlorate initially focused on the Saugus Formation as previously reported and discussed herein. However, as a result of the detection of perchlorate in one Alluvial municipal supply well, control and cleanup actions are also being planned for the Northern Alluvium.

ES.2 Saugus Formation

For long term planning purposes, the UWMP includes pumping from the Saugus in the range of 7,500 to 15,000 afy in average/normal years; it also includes planned dry-year pumping from the Saugus of 21,000 to 35,000 afy for one to three consecutive dry years. The UWMP recognizes that such short-term pumping can be recharged during subsequent wet/normal years to allow groundwater levels and storage to recover, as it has in historical periods.

Pumpage from the Saugus Formation was about 6,500 af in 2004; on average, Saugus pumpage has been about 7,000 afy since 1980. Both rates are near the lower end of the range included in the UWMP. Detailed records are not available prior to 1980, but historical pumpage from the Saugus was quite small prior to 1960 (100 to 200 afy) and was still small in the 1960's (peak pumpage of about 3,000 afy through the mid-1960's). Historical pumpage has been as high as nearly 15,000 af in 1991, and about 12,000 afy over a four-year period in the early 1990's. These amounts are near the upper end of the range included in the UWMP. As a result of long-term relatively low pumpage from the Saugus Formation, groundwater levels in that aquifer have remained essentially constant over the last 35 to 40 years; that trend continued in 2004.

In 1997, ammonium perchlorate was discovered in four wells completed in the Saugus

Formation in the vicinity of the former Whittaker-Bermite facility located generally on the east side of the basin. All four of those impacted wells exceed the current Notification Level of 6 parts per billion set by the California Department of Health Services (DHS) and have been taken out of active water supply service (water levels in the wells continue to be monitored). All other Saugus wells owned and operated by the Purveyors are available for municipal water supply service. As part of regular operation, those wells are sampled on a routine basis and perchlorate has not been detected. However, the Purveyors have taken a cautious and prudent approach in utilizing Saugus groundwater, pending the installation of treatment facilities as part of control and cleanup of perchlorate contamination that will also restore the pumping capacity of the inactive wells. Ultimately, despite the inactivated Saugus wells, the Purveyors still have sufficient pumping capacity in other wells to meet the planned normal range of Saugus pumping in the UWMP.

Work toward the ultimate remediation of perchlorate contamination, including the restoration of impacted groundwater supply continued to progress on several integrated tracks in 2004. In February 2003, the Purveyors entered into a voluntary cleanup agreement with the State Department of Toxic Substances Control (DTSC) whereby DTSC is providing review and oversight of the activities by the Purveyors in response to the detection of perchlorate in the five impacted wells. In accordance with that agreement, the Purveyors have prepared a Work Plan for sampling of production wells, prepared a report on the results and findings of the production well sampling, prepared a draft Human Health Risk Assessment, prepared a draft Remedial Action Workplan, completed the evaluation of treatment technologies, and completed the development of the groundwater model described above. The Purveyors have also initiated a process for approval by DHS in accordance with its Policy 97-005 for restoration of water supply from “severely impaired” water sources such as the perchlorate-impacted wells. The evaluation of treatment technologies and development of the groundwater model noted above were key activities completed in 2003 and reported in 2004 for inclusion in the application for approval by DHS for the restoration of perchlorate-impacted water supply. CLWA, the Purveyors and Whittaker entered into an Interim Settlement Agreement (ISA) in 2003, wherein the parties agreed to work cooperatively for a minimum of a one-year period to further define long-term costs and reach a long-term settlement. The ISA expired in September 2004 but was extended by mutual consent of all parties until the end of January 2005. The ISA specifies that Whittaker and its insurers would reimburse certain past costs as well as ongoing costs incurred by CLWA and the Purveyors in responding to perchlorate contamination. Activities since execution of the ISA have continued on developing the elements of a remedial strategy that will entail, among other details, the pumping of two impacted wells for containment of perchlorate migration, utilization of the pumped water, after treatment, for water supply, and installation of replacement wells in non-impacted portions of the basin to restore the remainder of groundwater supply impacted by perchlorate. Activities since execution of the ISA have also involved negotiation of a long-term Settlement Agreement.

ES.3 Imported Water

CLWA’s contractual Table A Amount is 95,200 af of water from the SWP. CLWA operates two water filtration plants and has a current total treatment capacity of 63.5 million gallons per day of capacity where the water is treated, filtered, and disinfected prior to being delivered to Purveyors for distribution. CLWA has nearly completed construction that will expand the Earl Schmidt Filtration Plant from its existing rated capacity of 33.5 million gallons per day to 56 million gallons per day. Plant expansion is scheduled to come on line in mid-2005. Upon completion, CLWA will have combined treatment capacity of 86 million gallons per day.

CLWA's final allocation of Table A for 2004 was 65 percent, or 61,880 af. On December 1, 2003, the initial allocation for 2004 was announced as 35 percent. On March 1, 2004, it was raised to the final allocation of 65 percent. Utilizing SWP contract provisions, CLWA elected to "carry over" unused remaining Table A Amount into 2005.

The total available SWP supply in 2004 was 99,283 af, including 35,785 af of 2003 carryover delivered in early 2004, and 1,618 af of Article 21 water. CLWA deliveries were 47,205 af to the Purveyors and 3,776 af to the Devil's Den Ranch, with 15,522 af of the 2004 Table A Amount for potential carryover to 2005.

Late in 2003, CLWA negotiated a second groundwater banking agreement with the Semitropic Water Storage District in Kern County. CLWA delivered 32,522 af of 2003 carryover water for storage in Semitropic's program; actual delivery took place in January, February and March 2004. Over a ten-year period (until 2013), CLWA can withdraw up to 29,270 af of that stored water to meet valley demands when needed. Combined with its storage of water in 2002, CLWA now can withdraw up to 50,870 af from Semitropic to meet water demands in the Valley when needed.

SWP water deliveries are subject to reduction when dry conditions occur in Northern California. The UWMP addresses programs for enhancing water supply reliability during such occurrences. A capital improvement program funded by CLWA has been established to provide facilities and additional water supplies needed to firm up SWP water supplies during times of drought.

ES.4 Recycled Water

Recycled water service was initiated in July 2003 in accordance with CLWA's Draft Reclaimed Water System Master Plan (2002). The amount of recycled water used for irrigation purposes, at a golf course and in roadway median strips, was approximately 448 af in 2004.

ES.5 Reliability Goal

Water consumers expect that their needs are going to be met with a high degree of quality and reliability of service. To that end, CLWA and the Purveyors are in the process of establishing a water reliability policy for planning purposes sufficient to meet projected demands 95 percent of the time over each 20-year period. In the remaining 5 percent of the time, it is planned that the maximum supply shortage will be 10 percent of demand. This level is being planned based on past experience that a 10 percent water demand reduction is feasible during a drought. When a shortage occurs, water consumers typically increase their awareness of water usage and voluntarily reduce water demands. During the last drought, in the early 1990's, voluntary conservation efforts by area residents resulted in a decrease in water demand of about 20 percent per year.

For planning purposes, water supplies and facilities are added on an incremental basis and ahead of need because it would be economically imprudent to immediately, or in the short term, acquire and/or construct all the facilities and water supplies needed for the next twenty to thirty years. This would represent an unfair shift of costs from future customers to existing customers.

ES.6 Water Supply Outlook

Total demand in 2004 was consistent with the year-to-year fluctuations in demand, taking into account increases in service connections. In 2005, total water demands are expected to be about 89,000 af, generally consistent with the growth rate in the UWMP while also recognizing the cool and wet early months of the year. Of the total, municipal demand is expected to be about 73,000 af. However, record rainfall in early 2005 has depressed demand, so total annual demand may be lower. Agricultural water demands are expected to be essentially unchanged. It is expected that water demands in 2005 will continue to be met with a generally similar mix of water supplies comprised of imported SWP water, local groundwater, and recycled water.

Recycled water will continue to supply a small portion of total water demand in 2005. CLWA anticipates continuing Phase 1 of its recycled water program in 2005 to provide delivery of up to 1,700 afy of recycled water for use on large landscape areas, roadway medians and other acceptable non-potable uses. In addition, surveys conducted by CLWA indicate an interest for recycled water by existing water users as well as future development when it becomes available.

Each year, DWR determines SWP deliveries. As of April 21, 2005, the allocation of water from the SWP is 80 percent of CLWA's Table A Amount, representing 76,160 af. Combined with local groundwater from the two aquifer systems (47,500 af), small additional surface water supplies (Article 21 and Flexible Storage Account, which represent about 6,200 af combined), net carryover SWP water from 2004 (1,657 af), and recycled water (up to 1,700 af), the total available water supplies for 2005 are slightly more than 133,000 af. As a result, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2005.

In any given year, SWP supplies may be reduced due to dry weather conditions or regulatory factors. During such an occurrence, the remaining water demands are planned to be met by a combination of alternate supplies such as returning water from CLWA's accounts in the Semitropic Groundwater Storage Program, deliveries from CLWA's flexible storage account in Castaic Lake Reservoir, local groundwater pumping, short-term water exchanges, and participation in DWR dry-year water purchase programs in accordance with the Urban Water Management Plan. Due to the banking of excess 2002 and 2003 SWP water in the Semitropic Groundwater Storage Program, CLWA can draw upon its account as needed, pursuant to the terms of the banking agreement with Semitropic. The banked excess 2002 and 2003 SWP water now represents nearly 51,000 af of recoverable water for drought water supply.

Drought periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and the reverse situation can also occur (as it did in 2002 and 2003). For this reason, CLWA and the

Purveyors have emphasized developing water supplies that add diversity in water supply options, especially in dry years. Diversity of supply is considered a key element of reliability, giving Valley water Purveyors the ability to draw on multiple sources of supply during dry year conditions and thereby making the Purveyors less dependent upon direct deliveries from the SWP water supplies.

I. Introduction

1.1 Background

For most residents of the Santa Clarita Valley (Valley), domestic water service is provided by four water Purveyors. They are the Castaic Lake Water Agency Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LA36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). Together, the Purveyors provide water to approximately 65,000 service connections. Castaic Lake Water Agency (CLWA) draws water from Castaic Lake where it is treated, filtered, and disinfected at two treatment plants before distribution to the Purveyors. The staff of these entities meet regularly to coordinate the supply of water in the Valley. Their respective service areas are shown in Figure I-1.

Water supply for a small percentage of Valley residents is provided by individual private water supply wells. The location, construction, annual pumpage and other information about these private wells are not currently available. CLWA is currently working with private well owners to receive information about their wells for incorporation in future reports and for planning purposes. Pumping as reported herein includes an estimate of groundwater pumped from private wells; it is expected that this estimate will be refined in future reports as more information about the private wells is obtained.

Over the years, CLWA and the Purveyors have reviewed and documented the availability of water resources in the region. Past studies have assessed the condition of the local groundwater aquifers, their hydrogeologic character, aquifer storage capacity, operational yield and recharge rate, and the potential for conjunctive use of groundwater and imported water resources.

Other efforts have included developing drought contingency plans, evaluating the impact of landfills on the groundwater basin, coordinating emergency response procedures and implementing Valley-wide conservation programs. In 1985, the Purveyors prepared the area’s first Urban Water Management Plan (UWMP.) Information in the plan had been coordinated among CLWA and the Purveyors so that there was general agreement about water supply and demand information for long term planning purposes. In December 2000, CLWA and the Purveyors updated the valley-wide UWMP, and that current UWMP remains the reference for projected water requirements and for municipal and agricultural water supplies in the Valley. The 2000 UWMP was amended in 2005 to specifically address the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand; the Amended 2000 UWMP also addressed the plans for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply, scheduled to be implemented by 2006. The UWMP is being updated in 2005 in accordance with the California Urban Water Management Planning Act.

1.2 Purpose and Scope of the Report

The purpose of this report, which is the seventh in a series of annual water reports that began in 1998, is to provide current information about the available water supplies and demands of the Santa Clarita Valley. CLWA and the Purveyors have prepared this series of reports in response to a request made by the Los Angeles County Board of Supervisors in 1998. This report was prepared by Castaic Lake Water Agency (CLWA) and its Santa Clarita Water Division, by Los Angeles County Waterworks District 36, by Newhall County Water District, and by Valencia Water Company. It establishes a format for providing information regarding the availability of water on an annual basis. It is intended to be a helpful resource for use by water planners and local planning agencies. This report is complemented by the more detailed UWMP for the area, which provides longer-term water supply planning over a 20-year period.

1.3 Santa Clarita Valley Water Purveyors

Castaic Lake Water Agency Santa Clarita Water Division has a service area that includes a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Saugus, Canyon Country, and Newhall. Water is supplied from both groundwater and CLWA turnouts to 26,161 service connections.

Los Angeles County Waterworks District 36 has a service area that encompasses approximately 7,635 acres in the Hasley Canyon area and the unincorporated community of Val Verde. LACWWD 36 has 1,308 service connections. The District has traditionally obtained its full water supply from a connection to the CLWA’s Castaic Conduit. In 2004, the District supplemented its surface water supply with groundwater purchased from the Los Angeles County Peter J. Pitchess Detention Center.

Newhall County Water District’s service areas lie in four distinct geographical areas of the Santa Clarita Valley, designated as the service areas of Newhall, Pinetree, Castaic, and Tesoro. NCWD supplies water from both groundwater and CLWA turnouts to approximately 9,010 service connections.

Valencia Water Company’s service area serves 28,296 service connections in a portion of the City of Santa Clarita and in the unincorporated communities of Castaic, Newhall, Saugus, Stevenson Ranch, and Valencia. VWC supplies water from both groundwater and CLWA turnouts; VWC also delivers recycled water for some non-potable uses.

1.4 The Upper Santa Clara River Hydrologic Area

The Upper Santa Clara River Hydrologic Area (HA), as defined by the California Department of Water Resources (DWR), is located almost entirely in northwestern Los Angeles County (Figure I-2). The area encompasses about 654 square miles comprised of flat valley land (about 6 percent of the total area) and hills and mountains (about 94 percent of the total area) that border the valley area. The mountains include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from about 800 feet on the valley floor to about 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of about 3,200 feet at the divide separating this hydrologic area from the Mojave Desert.

The Santa Clara River and its tributaries flow intermittently from Lang Station westward about 35 miles to Blue Cut, just west of the Los Angeles-Ventura County line, where it forms the outlet for the Upper Santa Clara River Hydrologic Area. The principal tributaries of the upper river are Castaic Creek, San Francisquito Creek, Bouquet Creek, and the South Fork of the Santa Clara River. Additionally, the Santa Clara River receives treated wastewater discharge from the Saugus and Valencia Water Reclamation Plants, which are operated by the Sanitation Districts of Los Angeles County (Figure I-2).

The Santa Clara River traverses the Santa Clarita Valley. The mountainous area to the north of the river is dissected by long southwest draining canyons - San Francisquito, Bouquet and Mint Canyons. Castaic Lake and Lagoon are within this Sub-Area. The South Fork of the Santa Clara River, draining the mountains along the southern boundary, traverses the valley floor where it joins with the main stem of the Santa Clara River.

Beneath the Santa Clarita Valley, there are two aquifer systems that comprise the Santa Clara River Valley East Groundwater Subbasin. This groundwater basin is the source of all local groundwater used for water supply in the Santa Clarita Valley. Below Blue Cut, the Santa Clara River continues westward through Ventura County to its mouth near Oxnard. Along that route, the River traverses all or parts of six groundwater basins in Ventura County (Piru, Fillmore, Santa Paula, Oxnard Forebay, Oxnard Plain and Mound) as shown in Figure I-3.

There are two primary precipitation gages in the Santa Clarita Valley, the Newhall-Soledad 32c gage and the Newhall County Water District gage (shown in Figure I-4). The National Climatic Data Center (NCDC) and Los Angeles County Department of Public Works (LADPW) have maintained records for the Newhall-Soledad 32c gage since 1931. Newhall County Water District has maintained records for the NCWD gage since 1979. The cumulative records from these two gages correlate very closely, with the NCWD gage recording approximately 25 percent more precipitation than the Newhall-Soledad 32c gage. This is likely due to the location of the NCWD gage, which is at the base of the mountains rimming the southern edge of the Santa Clarita Valley.

The Santa Clarita Valley is characterized as having an arid climate. Intermittent periods of less-than-average precipitation are typically followed by periods of greater-than-average precipitation in a cyclical pattern, with each wetter or drier period typically lasting from one to five years. Long-term precipitation records for the Newhall-Soledad 32c gage are illustrated in Figure I-5. The long-term average precipitation is 17.90 inches (1931-2004). Figure I-5 also shows the yearly departure from mean annual precipitation. In general, periods of less-than-average precipitation are longer and more moderate than periods of greater-than-average precipitation. Recently, the periods from 1971 to 1976, 1984 to 1991 and 1999 to 2003 have been drier than average; the periods from 1977 to 1983 and 1992 to 1996 have been wetter than average. 2004 was a slightly wet year, with total precipitation of approximately 23 inches, about 5 inches above average. Wet conditions continued into early 2005; significant storm events in January 2005 produced over 13 inches of measured precipitation, or more than 70 percent of average annual precipitation in the first month of the year.

II. 2004 Water Demands and Supplies

In 2004, total water demands in the Santa Clarita Valley were 87,900 af, an increase of about 5,000 af from the previous year. Of that amount, 82 percent (72,300 af) was for municipal use and the remaining 18 percent (15,600 af) was for agricultural and other (miscellaneous) uses. These total water demands were met by a combination of 40,300 af from local groundwater resources (nearly 24,700 af for municipal and about 15,600 af for agricultural and other uses), about 47,200 af of SWP water, and 448 af of recycled water.

In 2004, the total water demand in the Santa Clarita Valley increased by slightly more than five percent from the previous year, and was approximately six percent higher than the short-term projected water demand of 83,000 af presented in last year's water report. This increase in water usage is related to an increase in the number of municipal connections served, from approximately 61,400 in 2003 to 64,800 in 2004. As presented in the 2000 UWMP, historical water use from 1985 to 1998 fluctuated notably, increasing up to 10.2 percent in hot dry years and declining by up to 3.7 percent in cool wet years. Although 2004 was a wetter-than-average year, demand per service connection remained the same as in the previous (slightly dry) year.

Tables II-1 through II-4 summarize the use of available water sources by each Purveyor to meet water demands since the importation of SWP water began in 1980. The historical distribution of water supply sources to meet cumulative municipal water demands is summarized in Table II-5; the trends in use of local groundwater and imported SWP water to meet total demand are illustrated in Figure II-1. Tables II-6 and II-7 summarize historical agricultural and miscellaneous water requirements and supplies. Finally, total water demands and supplies since 1980 are summarized in Table II-8.

Table II-1
Water Supplies for Los Angeles County Waterworks District 36
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	-	-	**0**
1981	0	-	-	**0**
1982	145	-	-	**145**
1983	207	-	-	**207**
1984	240	-	-	**240**
1985	272	-	-	**272**
1986	342	-	-	**342**
1987	361	-	-	**361**
1988	434	-	-	**434**
1989	457	-	-	**457**
1990	513	-	-	**513**
1991	435	-	-	**435**
1992	421	-	-	**421**
1993	465	-	-	**465**
1994	453	-	-	**453**
1995	477	-	-	**477**
1996	533	-	-	**533**
1997	785	-	-	**785**
1998	578	-	-	**578**
1999	654	-	-	**654**
2000	800	-	-	**800**
2001	907	-	-	**907**
2002	1,069	-	-	**1,069**
2003	1,175	-	-	**1,175**
2004	854	380	-	**1,234**

Groundwater purchased from Los Angeles County Honor Farm

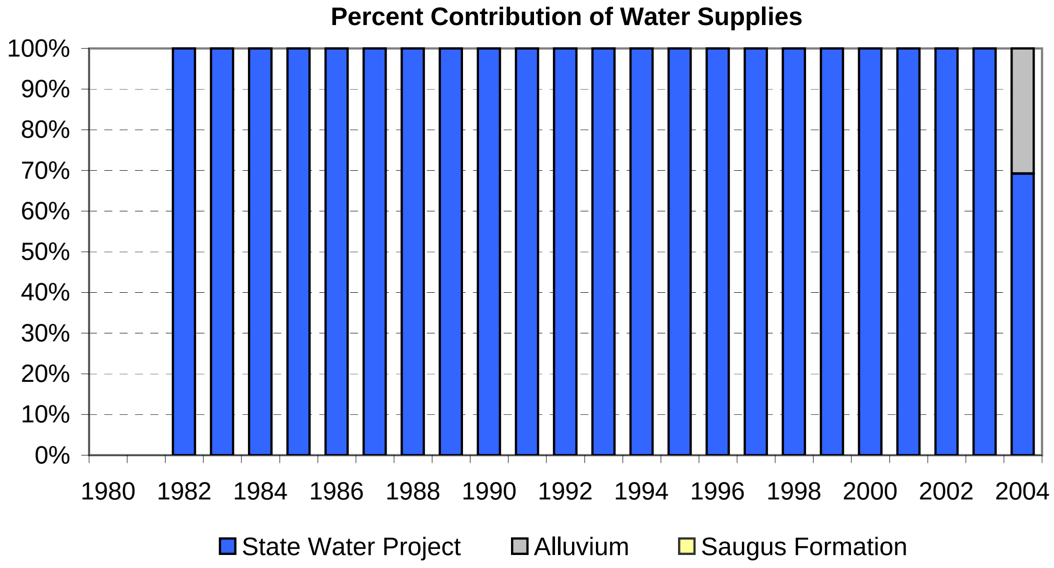


Table II-2
Water Supplies for Newhall County Water District
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	1,170	2,363	**3,533**
1981	0	1,350	2,621	**3,971**
1982	0	1,178	2,672	**3,850**
1983	0	1,147	2,787	**3,934**
1984	0	1,549	2,955	**4,504**
1985	0	1,644	3,255	**4,899**
1986	0	1,842	3,548	**5,390**
1987	22	2,127	3,657	**5,806**
1988	142	2,283	4,041	**6,466**
1989	428	2,367	4,688	**7,483**
1990	796	1,936	4,746	**7,478**
1991	675	1,864	4,994	**7,533**
1992	802	1,994	5,160	**7,956**
1993	1,075	1,977	5,068	**8,120**
1994	906	2,225	5,103	**8,234**
1995	1,305	1,675	4,775	**7,755**
1996	1,213	1,803	4,871	**7,887**
1997	1,324	2,309	5,168	**8,801**
1998	1,769	1,761	4,557	**8,087**
1999	5,050	1,676	2,622	**9,348**
2000	6,024	1,508	2,186	**9,718**
2001	5,452	1,641	2,432	**9,525**
2002	5,986	981	3,395	**10,362**
2003	6,572	1,266	2,513	**10,351**
2004	5,896	1,582	3,739	**11,217**

Percent Contribution of Water Supplies

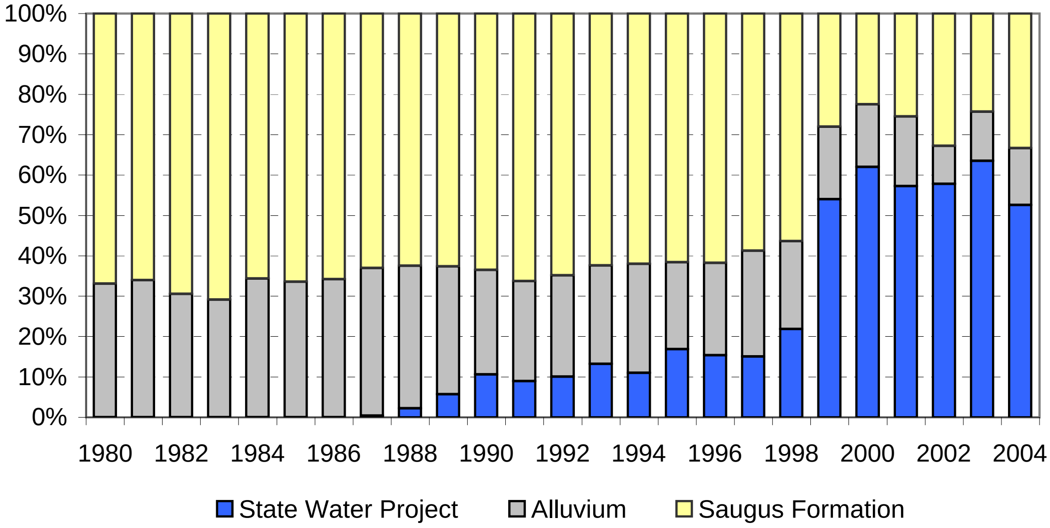


Table II-3
Water Supplies for CLWA Santa Clarita Water Division
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	1,125	9,460	0	**10,585**
1981	4,602	7,109	0	**11,711**
1982	6,454	4,091	0	**10,545**
1983	5,214	4,269	0	**9,483**
1984	6,616	6,057	0	**12,673**
1985	6,910	6,242	0	**13,152**
1986	8,366	5,409	0	**13,775**
1987	9,712	5,582	0	**15,294**
1988	11,430	5,079	63	**16,572**
1989	12,790	5,785	0	**18,575**
1990	12,480	5,983	40	**18,503**
1991	6,158	5,593	4,781	**16,532**
1992	6,350	8,288	2,913	**17,551**
1993	3,429	12,016	2,901	**18,346**
1994	5,052	10,996	3,863	**19,911**
1995	7,955	10,217	1,726	**19,898**
1996	9,385	10,445	2,176	**22,006**
1997	10,120	11,268	1,068	**22,456**
1998	8,893	11,426	0	**20,319**
1999	10,772	13,741	0	**24,513**
2000	13,751	11,529	0	**25,280**
2001	15,648	9,896	0	**25,544**
2002	18,921	9,513	0	**28,434**
2003	20,668	6,424	0	**27,092**
2004	22,045	7,146	0	**29,191**

Percent Contribution of Water Supplies

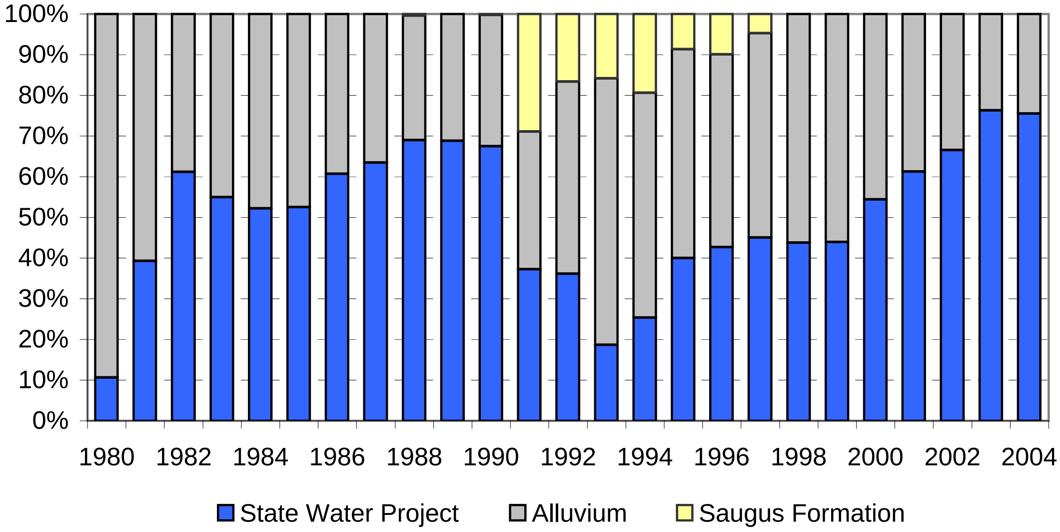


Table II-4
Water Supplies for Valencia Water Company
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	0	5,995	2,206	-	**8,201**
1981	1,214	5,597	2,329	-	**9,140**
1982	3,060	3,415	897	-	**7,372**
1983	3,764	3,387	611	-	**7,762**
1984	4,140	4,975	854	-	**9,969**
1985	4,641	4,633	885	-	**10,159**
1986	5,051	5,167	1,427	-	**11,645**
1987	6,190	4,921	1,305	-	**12,416**
1988	7,027	4,835	2,300	-	**14,162**
1989	7,943	5,826	2,529	-	**16,298**
1990	7,824	5,232	3,516	-	**16,572**
1991	700	9,951	4,642	-	**15,293**
1992	6,338	6,615	2,385	-	**15,338**
1993	8,424	5,815	2,182	-	**16,421**
1994	7,978	6,847	2,565	-	**17,390**
1995	7,259	8,698	1,586	-	**17,543**
1996	6,962	12,433	326	-	**19,721**
1997	9,919	11,696	516	-	**22,131**
1998	9,014	10,711	149	-	**19,874**
1999	10,806	11,823	106	-	**22,735**
2000	12,004	12,179	1,007	-	**25,190**
2001	13,362	10,518	835	-	**24,715**
2002	15,792	11,603	965	-	**28,360**
2003	16,004	11,707	1,068	700	**29,479**
2004	18,410	9,862	1,962	448	**30,682**

Percent Contribution of Water Supplies

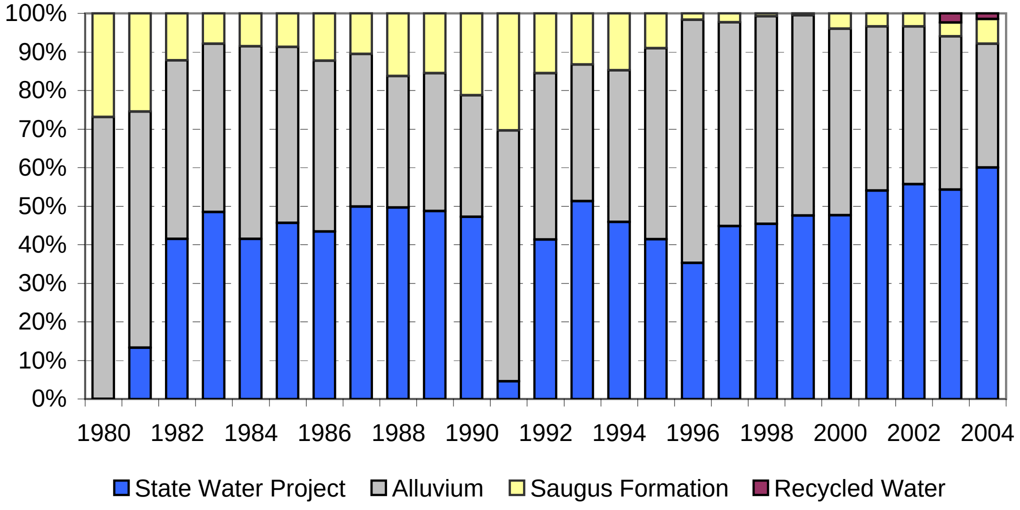


Table II-5
Total Water Supplies for Municipal Purveyors*
(Acre-Feet)

* includes LACWD 36, NCWD, SCWD and VWC

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	16,625	4,569	-	**22,319**
1981	5,816	14,056	4,950	-	**24,822**
1982	9,659	8,684	3,569	-	**21,912**
1983	9,185	8,803	3,398	-	**21,386**
1984	10,996	12,581	3,809	-	**27,386**
1985	11,823	12,519	4,140	-	**28,482**
1986	13,759	12,418	4,975	-	**31,152**
1987	16,285	12,630	4,962	-	**33,877**
1988	19,033	12,197	6,404	-	**37,634**
1989	21,618	13,978	7,217	-	**42,813**
1990	21,613	13,151	8,302	-	**43,066**
1991	7,968	17,408	14,417	-	**39,793**
1992	13,911	16,897	10,458	-	**41,266**
1993	13,393	19,808	10,151	-	**43,352**
1994	14,389	20,068	11,531	-	**45,988**
1995	16,996	20,590	8,087	-	**45,673**
1996	18,093	24,681	7,373	-	**50,147**
1997	22,148	25,273	6,752	-	**54,173**
1998	20,254	23,898	4,706	-	**48,858**
1999	27,282	27,240	2,728	-	**57,250**
2000	32,579	25,216	3,193	-	**60,988**
2001	35,369	22,055	3,267	-	**60,691**
2002	41,768	22,097	4,360	-	**68,225**
2003	44,419	19,397	3,581	700	**68,097**
2004	47,205	18,970	5,701	448	**72,324**

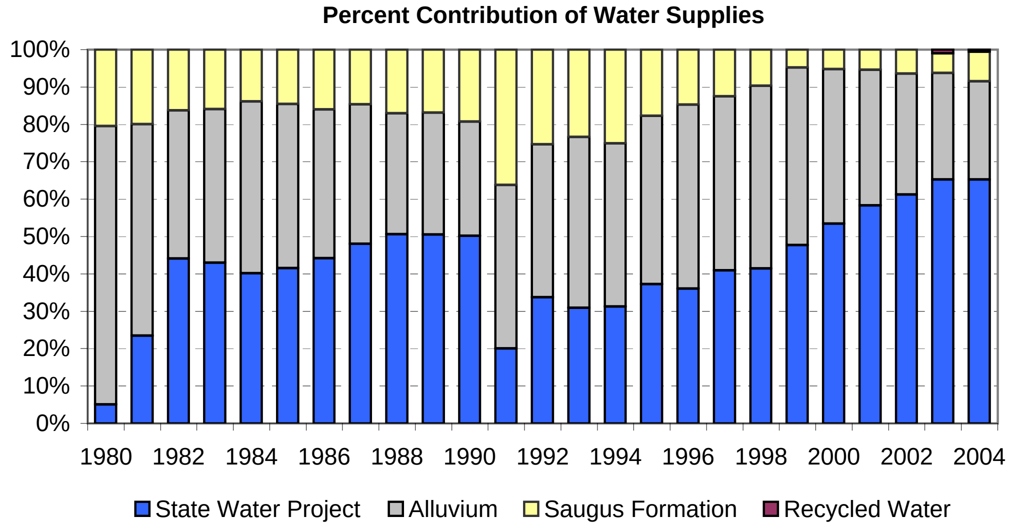


Table II-6
Water Supplies for Agriculture and Miscellaneous Uses
(Acre-Feet)

	Newhall Land and Farming			***Los Angeles County Honor Farm***			***Irrigation, Golf Courses and Miscellaneous Uses***		
Year	*Alluvium*	*Saugus Formation*	**Total**	*Alluvium*	*State Water Project*	**Total**	*Alluvium*[1]	*Saugus Formation*[2]	**Total**
1980	11,331	20	**11,351**	3,000	0	**3,000**	500	0	**500**
1981	13,237	20	**13,257**	3,000	0	**3,000**	500	0	**500**
1982	9,684	20	**9,704**	3,000	0	**3,000**	500	501	**1,001**
1983	7,983	20	**8,003**	3,000	0	**3,000**	500	434	**934**
1984	11,237	20	**11,257**	3,000	0	**3,000**	500	620	**1,120**
1985	9,328	20	**9,348**	3,000	0	**3,000**	500	555	**1,055**
1986	8,287	20	**8,307**	3,000	0	**3,000**	500	490	**990**
1987	6,512	20	**6,532**	3,000	0	**3,000**	500	579	**1,079**
1988	5,951	20	**5,971**	3,000	0	**3,000**	500	504	**1,004**
1989	6,243	20	**6,263**	3,000	0	**3,000**	500	522	**1,022**
1990	8,225	20	**8,245**	2,000	0	**2,000**	500	539	**1,039**
1991	7,039	20	**7,059**	2,240	0	**2,240**	500	480	**980**
1992	8,938	20	**8,958**	1,256	987	**2,243**	500	446	**946**
1993	8,020	20	**8,040**	1,798	443	**2,241**	500	439	**939**
1994	10,606	20	**10,626**	1,959	311	**2,270**	500	474	**974**
1995	11,174	20	**11,194**	2,200	6	**2,206**	500	453	**953**
1996	12,020	266	**12,286**	1,237	780	**2,017**	500	547	**1,047**
1997	12,826	445	**13,271**	1,000	1,067	**2,067**	500	548	**1,048**
1998	10,250	426	**10,676**	2,000	12	**2,012**	500	423	**923**
1999	13,824	479	**14,303**	1,842	20	**1,862**	500	509	**1,009**
2000	11,857	374	**12,231**	1,644	3	**1,647**	932	513	**1,445**
2001	12,661	300	**12,961**	1,604	0	**1,604**	953	573	**1,526**
2002	13,514	211	**13,725**	1,602	0	**1,602**	890	589	**1,479**
2003	10,999	122	**11,121**	2,273	0	**2,273**	909	504	**1,413**
2004	10,991	268	**11,259**	2,725	0	**2,725**	1,071	535	**1,606**

1. *Robinson Ranch Golf Course irrigation and estimated private pumping.*
2. *Valencia Country Club and Vista Valencia Golf Course irrigation.*

Table II-7
Total Water Supplies for Agriculture and Miscellaneous Uses
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	14,831	20	**14,851**
1981	0	16,737	20	**16,757**
1982	0	13,184	521	**13,705**
1983	0	11,483	454	**11,937**
1984	0	14,737	640	**15,377**
1985	0	12,828	575	**13,403**
1986	0	11,787	510	**12,297**
1987	0	10,012	599	**10,611**
1988	0	9,451	524	**9,975**
1989	0	9,743	542	**10,285**
1990	0	10,725	559	**11,284**
1991	0	9,779	500	**10,279**
1992	987	10,694	466	**12,147**
1993	443	10,318	459	**11,220**
1994	311	13,065	494	**13,870**
1995	6	13,874	473	**14,353**
1996	780	13,757	813	**15,350**
1997	1,067	14,326	993	**16,386**
1998	12	12,750	849	**13,611**
1999	20	16,166	988	**17,174**
2000	3	14,433	887	**15,323**
2001	0	15,218	873	**16,091**
2002	0	16,006	800	**16,806**
2003	0	14,181	626	**14,807**
2004	0	14,787	803	**15,590**

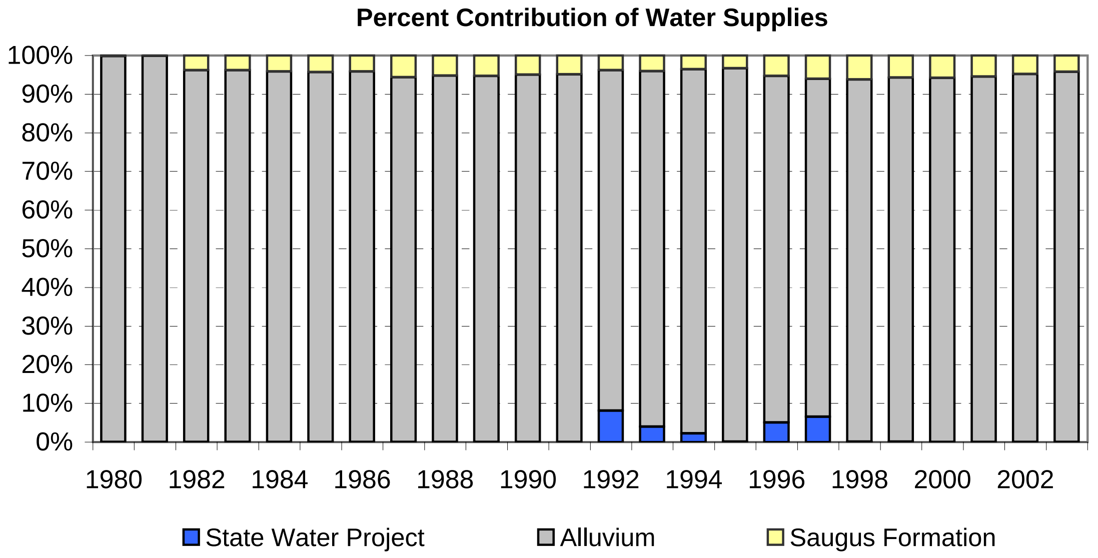
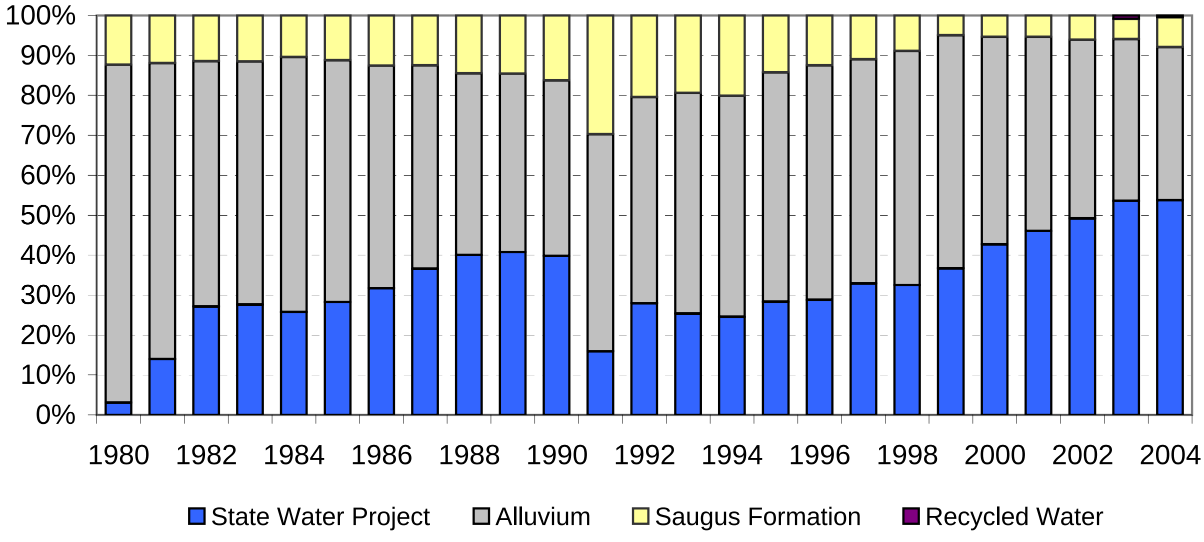


Table II-8
Total Water Supplies for Municipal, Agriculture and Miscellaneous
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	31,456	4,589	-	**37,170**
1981	5,816	30,793	4,970	-	**41,579**
1982	9,659	21,868	4,090	-	**35,617**
1983	9,185	20,286	3,852	-	**33,323**
1984	10,996	27,318	4,449	-	**42,763**
1985	11,823	25,347	4,715	-	**41,885**
1986	13,759	24,205	5,485	-	**43,449**
1987	16,285	22,642	5,561	-	**44,488**
1988	19,033	21,648	6,928	-	**47,609**
1989	21,618	23,721	7,759	-	**53,098**
1990	21,613	23,876	8,861	-	**54,350**
1991	7,968	27,187	14,917	-	**50,072**
1992	14,898	27,591	10,924	-	**53,413**
1993	13,836	30,126	10,610	-	**54,572**
1994	14,700	33,133	12,025	-	**59,858**
1995	17,002	34,464	8,560	-	**60,026**
1996	18,873	38,438	8,186	-	**65,497**
1997	23,215	39,599	7,745	-	**70,559**
1998	20,266	36,648	5,555	-	**62,469**
1999	27,302	43,406	3,716	-	**74,424**
2000	32,582	39,649	4,080	-	**76,311**
2001	35,369	37,273	4,140	-	**76,782**
2002	41,768	38,103	5,160	-	**85,031**
2003	44,419	33,577	4,207	700	**82,904**
2004	47,205	33,757	6,503	448	**87,914**

Percent Contribution of Water Supplies



III. Water Supplies

Prior to 1980, local groundwater extracted from the Alluvium and the Saugus Formation was the sole source of water supply in the Santa Clarita Valley. Since 1980, local groundwater supplies have been supplemented with imported SWP water supplies. In 2003, those water supplies began to be augmented by the initiation of deliveries from CLWA's recycled water program. Ongoing expansion of this program is anticipated to increase the recycled water supply. This section describes the groundwater resources of the Santa Clarita Valley, SWP water supplies, and CLWA's recycled water program.

3.1 Santa Clara River Valley Groundwater Basin – East Subbasin

The groundwater basin generally beneath the Santa Clarita Valley, identified in the State Department of Water Resources' Bulletin 118 as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), is comprised of two aquifer systems. The Alluvium generally underlies the Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. There are also some scattered outcrops of Terrace deposits in the basin that likely have the capacity to contain limited amounts of groundwater. However, since these deposits are located in limited areas that are situated at elevations above the regional water table and are also of limited thickness, they are of no practical significance as aquifers and have consequently not been developed for any significant water supply. The mapped extent of the Santa Clara River Valley East Subbasin in DWR Bulletin 118 and its relationship to the extent of the CLWA service area are illustrated in Figure III-1. The subbasin boundary approximately coincides with the outer extent of the Alluvium and Saugus Formation.

A 2001 Update Report on both the Alluvium and Saugus Formation Aquifers (Slade, 2002), which updated analyses and interpretation of hydrogeologic conditions from earlier reports (Slade, 1986 and 1988), included extensive detail on major aspects of the groundwater basin. Notable parts of the Update Report include:

- Description of the extensive additional data available since the original Alluvium and Saugus Formation reports were prepared in 1986 and 1988, respectively;
- Organization of historic data into a Geographic Information System (GIS) database;
- Description of the overall groundwater basin in conformance with that being mapped by the State Department of Water Resources;
- Analysis of historical groundwater levels and production, and conclusions that there have been no conditions that would be illustrative of groundwater overdraft;
- Suggestion that utilization of operational yield (as opposed to perennial yield) as a basis for managing groundwater production would be more applicable in this basin to reflect fluctuating utilization of groundwater in conjunction with imported SWP water;

- Conclusion that operational yield of the Alluvium would typically be as included in the UWMP: 30,000 to 40,000 afy for wet and normal rainfall years, with an expected reduction into the range of 30,000 to 35,000 afy in dry years;

- Conclusion that operational yield of the Saugus Formation could also be as included in the UWMP: in the range of 7,500 to 15,000 afy on a long-term basis, with short-term increases during dry periods into a range of 15,000 to 25,000 afy, and to 35,000 afy if dry conditions continue.

In 2004, as part of analyzing the restoration of perchlorate-impacted groundwater supply, a numerical groundwater flow model was utilized to analyze the response of the groundwater basin to long-term operation at the operational yields noted above. Resultant projections of groundwater levels, groundwater storage, and surface water flows showed the basin to respond in a long-term sustainable manner, with no chronic depletion of groundwater levels, storage, or stream flows (CH2M Hill, 2004).

3.2 Alluvium – General

The Alluvial aquifer system, of Quaternary to Holocene (Recent) geologic age, consists primarily of stream channel and flood plain deposits of the Santa Clara River and its tributaries. The Alluvium is deepest along the center of the present river channel, with a maximum thickness of about 200 feet near the area known as Saugus. It thins toward the flanks of the adjoining hills and toward the eastern and western boundaries of the basin and, in the tributaries, becomes a mere veneer in their upper reaches. The spatial extent of the Alluvium throughout the basin is illustrated in Figure III-1.

Groundwater generally moves toward the outlet of the basin, which is also the outlet of the Upper Santa Clara River HA. Thus, groundwater movement in the Alluvium beneath the tributaries is toward their confluence with the Santa Clara River and then westward in the Alluvium. From about Castaic Junction to Blue Cut, the Alluvium thins and narrows. This configuration forces groundwater to rise, keeping the depth to water at or close to the land surface. As discussed in more detail below, the general groundwater flow direction has remained unchanged whether groundwater levels are high or intermittently depressed. The San Gabriel and Holser faults traverse the basin but neither fault measurably affects groundwater levels or flows in the Alluvium.

Alluvial wells are distributed throughout the basin along the Santa Clara River and its southwest draining tributaries. Figure III-2 illustrates the location of the Purveyor-operated Alluvial wells and other Alluvial wells considered in this water report. The Alluvium is the most permeable of the local aquifer units. Based on well yields and aquifer testing, estimated transmissivity values of 50,000 to 500,000 gallons per day per foot have been reported for the Alluvium, with the higher values where the Alluvium is thickest in the center of the valley and generally west of Bouquet Canyon. The amount of groundwater in storage in the Alluvium can vary considerably because of the effects of recharge, discharge, and pumping from the aquifer. The maximum storage capacity of the Alluvium has been estimated to be 240,000 acre-feet (af).

Consistent with the 2001 Update Report and the UWMP, the current management practice of the Purveyors is to maximize use of the Alluvium because of the aquifer's ability to store and produce good quality water on a sustainable basis, and because the Alluvium is capable of rapid recovery of water levels and storage in wet periods. As with many groundwater basins, it is possible to intermittently exceed a long-term average yield for one or more years without long-term adverse effects. Higher pumpage for short periods may temporarily lower groundwater storage and related water levels, as has been the case in the Alluvium several times since the 1930's. However, subsequent decreases in pumpage limit the amount of water level decline, and normal to wet-period recharge result in a rapid return of groundwater levels to historic highs. Historical groundwater data collected from the Alluvium over many hydrologic cycles provide assurance that groundwater elevations, if locally lowered, recover in average or wet years following dry periods during which the groundwater elevations have declined. Such water level response to rainfall is a significant characteristic of permeable, porous, alluvial aquifer systems that occur within large watersheds. In light of these historical observations, complemented by the results of the recently developed groundwater flow model, there is ongoing confidence that groundwater can continue to be a sustainable source of water supply at the rates of pumping described in the 2001 Update Report and in the 2000 UWMP.

Long-term adverse impacts to the Alluvium could occur if the amount of water extracted from the aquifer exceeds the amount of water that recharges the aquifer over an extended period. However, the quantity and quality of water in the Alluvium and pumpage from the Alluvium are routinely monitored, and no long-term adverse impacts are evident. However, the Purveyors have identified cooperative measures to be taken if needed, to ensure sustained use of the aquifer. Such measures include but are not limited to the continuation of conjunctive use of imported SWP surface water with local groundwater, artificial recharge of the aquifer with local runoff or other surface water supplies, financial incentives discouraging extractions above a selected limit, and expanded use of other alternative supplies such as recycled water.

3.2.1 Alluvium – Historical and Current Conditions

Total pumpage from the Alluvium in 2004 was about 33,800 af, essentially the same as the preceding year with an increase of about 200 af. Of the total Alluvial pumpage in 2004, about 56 percent (19,000 af) was for municipal water supply, and the balance, about 44 percent (14,800 af), was for agriculture and other (minor) miscellaneous uses.

Alluvial pumpage has been recorded beginning in the mid-1940's, and consistently since 1980. When pumpage records are unavailable, data have been approximated to obtain a continuous historic record (Figure III-3). Alluvial pumpage from private wells, estimated to be at most 500 afy, has been included in the total Alluvial pumpage. Over the last two decades, since the inception of SWP deliveries in 1980, total pumpage from the Alluvium has ranged from a low of about 20,000 afy (in 1983) to slightly more than 43,000 afy (in 1999). Agricultural pumpage remained stable from the mid-1940's through about 1960, generally ranging from 33,000 to 37,000 afy, with annual pumpage as high as 41,000 af. From 1960 through the late 1970's, agricultural pumpage declined in a nearly linear trend, and has fluctuated slightly since then, between approximately 10,000 and 16,000 afy. As agricultural pumpage declined, municipal pumpage from the Alluvium increased from less than 4,000 afy in the 1950's to approximately 17,000 afy in 1980. Beginning in 1980 with the importation of SWP water, municipal pumpage from the Alluvium declined to about 12,500 afy and remained stable throughout the 1980's. Municipal pumpage has subsequently increased to the current range of approximately 20,000 to 25,000 afy. Overall, there has been a change in municipal/agricultural pumping distribution since 1980, toward a slightly higher fraction for municipal water supply (from about 50 percent to nearly 60 percent of Alluvial pumpage), which reflects the general land use changes in the area.

Historical estimates (Slade, 1986, 2002; Amended 2000 UWMP; CH2M Hill, 2004) have suggested and shown that the operational yield of the Alluvium is from 30,000 to 40,000 afy in average and wet years, and in the range of 30,000 to 35,000 afy in dry years. On a long-term basis since the importation of SWP water, total Alluvial pumpage has been about 30,500 afy (31,300 af in years with less-than-average precipitation, and 29,400 af in years with greater-than-average precipitation). These averages are at the lower end of the range of operational yield of the Alluvium.

Groundwater levels in various parts of the basin have historically exhibited different responses to both pumpage and climatic fluctuations. During the last 20 to 30 years, in essentially all the alluvial portions of the basin, groundwater levels have fluctuated from near the ground surface when the basin is full, to as much as 100 feet lower during intermittent dry periods of reduced recharge. Figure III-2 groups the Alluvial wells into areas with similar groundwater level fluctuations. Figures III-4 and III-5 present historical groundwater levels organized into hydrograph form (groundwater elevation vs. time) for four areas throughout the basin. The other areas shown in Figure III-2 exhibit groundwater level responses that are similar to those in these four areas.

The 'Mint Canyon' area is located at the far eastern end of the groundwater basin along the Santa Clara River. In this area, the Alluvium is shallower than in the westerly parts of the basin; consequently, the area has historically exhibited the most dramatic responses to climatic fluctuations. The 'Above Saugus WRP' and 'Bouquet Canyon' areas generally exhibit groundwater level responses that are similar to those in the 'Mint Canyon' area. As described and discussed above, the Alluvium has historically experienced a number of alternating wet and dry hydrologic conditions (Figures III-4 and III-5) during which groundwater level declines are followed by returns to historic highs. Since the Alluvium is thinner to the east, the resulting groundwater fluctuations are most dramatic in this area, up to 75 to 100 feet. When water levels are low, well yields and pumping capacities in this area can be impacted. The affected Purveyors respond by increasing use of Saugus Formation and imported (SWP) supplies, as shown in Table II-8. The Purveyors also shift a fraction of the Alluvial pumpage that would normally be supplied by 'Mint Canyon' area wells to areas further west, where well yields and pumping capacities remain fairly constant because of smaller groundwater level fluctuations. As shown in Figure III-6, the Purveyors decreased total Alluvial pumpage from the 'Mint Canyon' area steadily from 2000 through 2003, and offset these decreases by increasing pumpage in the 'Below Saugus WRP' and 'Below Valencia WRP' areas. This allowed the Purveyors to maximize the available supply from the Alluvium during dry periods to best meet demand. In spite of a continued period of below-average precipitation from 1999 to 2003, groundwater levels in the ‘Mint Canyon’ area ceased to decline in 2002 and 2003. This is illustrative of the Purveyor’s integrated use of surface water and groundwater to maintain local groundwater resources within their overall yield during dryer than average periods.

The ‘Below Saugus WRP’ area is located along the Santa Clara River immediately downstream of the Saugus Water Reclamation Plant. The ‘San Francisquito Canyon’ area generally exhibits groundwater level responses that are similar to those in the ‘Below Saugus WRP’ area. In this middle part of the basin, historical groundwater levels were lower in the 1950's and 60's than current levels. The historically lower groundwater levels were likely a result of the higher agricultural pumpage of the 1950's before the importation of SWP water. Increased return flows to the river from treated wastewater discharge have also more recently augmented groundwater recharge. Groundwater levels in this area notably recovered as pumpage declined through the 1960's and 1970's. They have subsequently sustained generally high levels for much of the last 30 years, with three dry-period exceptions: mid-1970's, late 1980's to early 1990's, and the late 1990’s to early 2000’s. Recoveries to previous high groundwater levels followed both of the short dry-period declines in the 1970's and 1990's. Most recently, groundwater levels have recovered significantly following a wetter-than-average year in 2004 and heavy precipitation in January 2005, indicating that the groundwater level decline that occurred from 1999-2004 also represented a temporary dry-period decline.

The ‘Castaic Valley’ area is located along Castaic Creek below Castaic Lake. In that area, groundwater levels have remained fairly constant, with slight responses to climatic fluctuations, since the 1950’s.

The ‘Below Valencia’ WRP area is located along the Santa Clara River downstream of the Valencia Water Reclamation Plant, and receives recharge from the treated wastewater discharged from the Valencia WRP to the Santa Clara River. Groundwater levels in this area exhibit slight, if any, response to climatic fluctuations, and have remained fairly constant since the 1950’s despite, over the last 20 years, a notable increase in pumping in that area.

As previously mentioned, it is possible to intermittently utilize some water from storage in the aquifer, such as has historically been the case in the eastern part of the basin. This results in temporarily lower groundwater levels, which subsequently recover during periods of reduced pumpage or higher than average precipitation. Records of groundwater levels, pumpage and precipitation suggest that declines and subsequent rises in groundwater levels are influenced more by fluctuations in the availability of water for recharge than by pumpage. When less water is available for recharge, during periods of lower-than-average precipitation and streamflow, groundwater levels decline even when pumpage remains constant. Conversely, when an abundance of water is available for recharge because of wet conditions, pumpage can increase significantly without affecting groundwater levels.

During the period from 1984 through 1991, which experienced eight consecutive years of lower than average precipitation (with one average year in the middle), pumpage from the Alluvium averaged 24,000 afy, well below the dry-year operational yield. During this same period, water levels declined over 80 feet in the eastern part of the basin. Subsequently, from 1992 to 1996, when precipitation was generally higher than average, groundwater levels recovered to and maintained historic highs, despite a steady increase in annual pumpage. From 1999 to 2003, precipitation was again generally lower than average but average pumping from the Alluvium had increased to about 38,400 afy; as a result, during that period, groundwater levels again declined in some areas. Annual pumpage from the Alluvium has now decreased from 2000 to present, and is currently within the operational yield. The previous annual report stated that it was likely that groundwater levels would not return to historic highs until a period of higher-than-average precipitation occurred. As mentioned above, early 2005 data indicates that groundwater levels have already recovered significantly (approaching historic highs) in response to very high precipitation and runoff in January.

In summary, depending on the period of available data, all the history of groundwater levels in the Alluvium show the same general picture: recent (last 30 years) groundwater levels have exhibited historic highs; in some locations, there are intermittent dry-period declines (and an associated use of some groundwater from storage) followed by wet-period recoveries (and associated refilling of storage space). On a long-term basis, whether over the last 23 years since importation of supplemental SWP water, or over the last 40 to 50 years (since the 1950's - 60's), the Alluvium shows no signs of water level-related overdraft, i.e., no trend toward decreasing water levels and storage. Consequently, pumpage from the Alluvium has been and continues to be within the operational yield of that aquifer.

3.3 Saugus Formation – General

Late Pleistocene older Alluvium, known as terrace deposits, is elevated along the Santa Clara River to form terraces and mesas. These terrace deposits define the extent of the Saugus Formation in the groundwater basin. Because they are elevated, they usually lie above the regional water table and act as areas of infiltration and percolation to the underlying formation.

The Saugus Formation, of Pliocene to Pleistocene geologic age, has traditionally been divided into two stratigraphic units: the lowermost, geologically older Sunshine Ranch member, which is of mixed marine to terrestrial (non-marine) origin; and the overlying, or upper, portion of the Formation which is entirely terrestrial in origin. The Sunshine Ranch Member of the Saugus Formation has a maximum thickness of about 3,000 to 3,500 feet in the central part of the valley; however, due to its marine origin and fine-grained nature, it is not considered to be a viable source of groundwater for municipal or other water supply. Above the Sunshine Ranch Member, the Saugus Formation is coarser grained, consisting mainly of lenticular beds of sandstone and conglomerate that are interbedded with lesser amounts of sandy mudstone, which were deposited in stream channels, flood plains, and alluvial fans by one or more ancestral drainage systems in the valley. The sand and gravel units that represent aquifer materials in the upper part of the Saugus Formation are generally located between depths of about 300 and 2,500 feet. The spatial extent of the Saugus Formation throughout the basin is illustrated in Figure III-1.

While much thicker and more spatially extensive throughout the basin when compared to the Alluvium, and while significant in terms of groundwater storage and individual well capacity, the Saugus Formation has typically lower values of transmissivity, in the range of 80,000 to 160,000 gpd/ft, with the higher values in the upper portions of the Formation. The storage capacity of the Saugus has most recently been estimated to be 1.65 million acre-feet between depths of 300 feet and approximately 2,500 feet (to the base of the Saugus, or to the base of fresh water if shallower than 2,500 feet). Groundwater in the Saugus Formation generally moves north along the South Fork of the Santa Clara River, towards the Santa Clara River and the outlet of the basin. Saugus wells operated by the Purveyors (shown in Figure III-7) are located in the southern portion of the basin, south of the Santa Clara River.

For long term planning purposes, the UWMP includes pumping from the Saugus in the range of 7,500 to 15,000 afy in average/normal years, a conservative estimate in light of historical estimates of potential recharge to the Saugus, complemented by observations of high groundwater levels in the overlying Alluvium over the last 30 years. The UWMP also includes planned dry-year pumping from the Saugus of 15,000 to 35,000 afy for one to three consecutive dry years, when shortages to CLWA's SWP water supplies could occur. Such high pumping would be followed by periods of lower pumpage (the 7,500 to 15,000 afy in average/normal years as noted above) in order to allow recharge to recover water levels and storage in the Saugus. Maintaining the substantial volume of water in the Saugus Formation is an important strategy to help maintain water supplies in the Santa Clarita Valley during drought periods.

3.3.1 Saugus Formation – Historical and Current Conditions

Total pumpage from the Saugus in 2004 was 6,500 af, an increase of about 2,300 af from the preceding year. Of the total Saugus pumpage in 2004, most (5,700 af) was for municipal water supply, and the balance (800 af) was for agricultural and other (minor) uses. The majority of pumpage from the Saugus (an average of about 90% of total Saugus pumpage) is for municipal supply. Groundwater pumpage from the Saugus peaked in the early 1990's and then steadily declined through the remainder of that decade. Saugus pumpage has subsequently increased gradually since 1999.

Historical pumpage records for the Saugus formation are limited prior to 1980, but suggest that pumpage from the Saugus was minimal at that time. When pumpage records are unavailable, data have been approximated to obtain a continuous historic record (Figure III-8). There was essentially no pumping from the Saugus prior to 1960 (on the order of about 100 af in most years, beginning in 1948). Some increased pumping for agricultural water supply (about 900 af) began in about 1962. The largest amount of agricultural pumping from the Saugus was during the mid-1960's, when annual pumpage was about 3,000 af. Agricultural pumping from the Saugus declined to near zero by the late 1970's, but has generally ranged from 500 to 1,000 afy since 1982. There was no Saugus pumpage for municipal supply in the early 1960's; post-1980 data suggests that municipal pumping from the Saugus began in the 1970's, and reached nearly 5,000 afy by 1980-81.

Historical estimates and recent analyses (Slade, 1988, 2002; Amended 2000 UWMP; CH2M Hill, 2004) have suggested and shown that the operational yield of the Saugus Formation is in the range of 7,500 to 15,000 afy in average years, with an increase to up to 35,000 afy in multiple dry-year periods. On a long-term average basis since the importation of SWP water, total pumpage from the Saugus Formation has ranged from a low of about 3,700 afy (in 1999) to a high of nearly 15,000 afy (in 1991); average pumpage from 1980 to present has been about 6,700 afy. These pumping rates are within, and generally at the lower end of the range of the operational yield of the Saugus Formation.

Unlike the Alluvium, which has an abundance of wells with extensive water level records, the water level data for the Saugus Formation are limited by the distribution of the wells in this Formation and the periods of record. The wells that do have water level records extending back to the mid-1960's indicate that groundwater levels in the Saugus Formation were highest in the mid-1980's and are currently higher than they were in the mid-1960's (Figure III-9). Based on these data, there is no evidence of any historic or recent trend toward permanent water level or storage decline.

Records of groundwater levels, pumpage and precipitation suggest that declines and subsequent rises in groundwater levels in the Saugus Formation are more influenced by pumpage than by climatic fluctuations. Water levels in wells in the Saugus Formation are highly dependent on pumping in the respective well. In contrast to the Alluvium, where pumpage is fairly evenly distributed among a number of wells in a given area, there are fewer active wells in the Saugus Formation, and pumping at one well can create a localized pumping depression that is evident in groundwater level hydrographs. Water levels in the Saugus Formation also exhibit stronger seasonal (pumping) fluctuations over a year than in the Alluvium (generally more than 20 feet in active Saugus wells, as opposed to generally less than ten feet in Alluvial wells). These responses to pumping are characteristic of the lower transmissivity of the Saugus Formation.

During the period from 1985 through 1991, which experienced consecutive years of lower-than-average precipitation (with one average year in the middle), pumpage from the Saugus increased from 4,700 afy to nearly 15,000 afy, and groundwater levels declined more than 100 feet in some cases. However, the subsequent rise in water levels at an individual well depended on pumping at that well. For example (as illustrated in Figure III-9), pumping of Saugus wells declined dramatically beginning between 1993 and 1995, and water levels in individual wells subsequently rose when pumping decreased. From 1999 to 2003, water levels in the Saugus were stable and exhibited very slight, if any, response to less-than-average precipitation. The amount of pumpage from Saugus wells in 2004 was about the same as in 1997 and 1998, and groundwater levels were also about the same as in those years. A slight pumping depression is evident around active wells. Water levels in the Saugus remain at or above historic averages, and there is no trend toward a sustained decline in Saugus water levels or storage that would be indicative of overdraft.

Consistent with the 2001 Update Report and the UWMP, and consistent with the recently modeled basin response to UWMP pumping, the current management practice of the Purveyors is to maintain water levels in the Saugus Formation so this supply is available during drought periods, when available Alluvial groundwater and SWP supplies are anticipated to decrease. The period of increased pumpage during the late 1980's and early 1990's is a good example of this management strategy. Most notably, in 1991, when SWP deliveries were substantially reduced, increased pumpage from the Saugus made up almost half of the decrease in SWP deliveries. This increased Saugus pumpage resulted in short-term declining water levels reflecting the use of stored water. However, the water levels subsequently rose when pumpage declined, reflecting recovery of storage capacity of the Saugus Formation.

3.4 Imported Water

CLWA obtains water supplies from the SWP, which is managed by DWR. CLWA is one of 29 contractors holding long-term SWP contracts with the State of California DWR. SWP water originates from rainfall and snowmelt in northern and central California. Runoff is stored in Lake Oroville, which is the project's largest storage facility. The water is then released from Lake Oroville down the Feather River to the Sacramento River and the Sacramento-San Joaquin Delta. Water is diverted from the Delta into the Clifton Court Forebay, and then pumped into the 444-mile long California Aqueduct. SWP water is temporarily stored in San Luis Reservoir, which is jointly operated by DWR and the U.S. Bureau of Reclamation. Prior to delivery to CLWA, SWP supplies are stored in Castaic Lake, located at the end of the West Branch of the California Aqueduct.

CLWA's service area covers approximately 195 square miles (124,800 acres), including the entire City of Santa Clarita and the surrounding unincorporated communities. CLWA obtains SWP water from the upper reservoir at Castaic Lake. The water is treated, filtered and disinfected at CLWA's Earl Schmidt Filtration Plant and Rio Vista Water Treatment Plant. CLWA has a current capacity to treat a total of 63.5 million gallons per day. CLWA has nearly completed construction that will expand the Earl Schmidt Filtration Plant from its existing rated capacity of 33.5 million gallons per day to 56 million gallons per day. Plant expansion is scheduled to come on line in mid-2005. CLWA will then have combined treatment capacity of 86 million gallons per day. Treated water is delivered from the treatment plants by gravity flow to each of the four Purveyors through a distribution network of pipelines and turnouts. At present, CLWA delivers water to the four Purveyors through 11 turnouts.

In 2004, CLWA fulfilled the following major accomplishments in order to enhance, preserve, and strengthen the quality and reliability of existing and future supplies:

- Delivered approximately 32,000 af of SWP water to be banked in the Semitropic groundwater banking program;
- Continued construction for expansion of the Earl Schmidt Filtration Plant from 33.5 mgd to 56 mgd;
- Continued implementation of various water supply programs recommended in the Amended 2000 UWMP;
- Amended the 2000 UWMP to reflect updated information about perchlorate contamination;
- Continued implementation of the water conservation Best Management Practices, as recommended in the UWMP;
- Continued work under the Interim Settlement Agreement toward a possible long-term settlement that will accomplish containment of perchlorate and restoration of perchlorate-impacted water supply wells and associated cost recovery;
- Continued cooperative effort with the U.S. Army Corps of Engineers for characterization studies of the former Whittaker-Bermite site and in a task force effort with the City of Santa Clarita, local legislators, and state agencies to affect the cleanup and remediation of all aspects of the former Whittaker-Bermite site, including the perchlorate groundwater contamination;

- Obtained $700,000 in Federal funding for continued analysis of perchlorate contamination and $500,000 for expansion of recycled water system;
- Continued recycled water service.

3.4.1 State Water Project Table A Supplies

Each SWP contractor has a specified water supply amount shown in Table A of its contract that currently totals approximately 4.1 million af. The term of the contract is through 2035 and is renewable after that year. Although the SWP has not been fully completed, the SWP can deliver all of the 4.1 million af of Table A Amounts during very wet years.

CLWA has a contractual Table A Amount of 95,200 af per year of water from SWP. The original contract for 23,000 af was signed in 1960 and the Table A Amount was later increased to 41,500 af. CLWA increased its Table A Amount to its current level of 95,200 af by purchasing 12,700 af from Devil's Den Water District in 1988 and acquiring 41,000 af in 1999 from Kern County Water Agency and its member district, the Wheeler Ridge-Maricopa Water Storage District (WRMWSD).

CLWA acquired the 41,000 af from WRMWSD by way of a Table A water transfer agreement executed in March 1999. CLWA prepared an environmental impact report (EIR) to address the environmental consequences of the transfer agreement. The environmental review for the project by CLWA was the subject of litigation in Los Angeles Superior Court. CLWA prevailed in the EIR litigation at the trial court; however, the project opponents (Friends of the Santa Clara River) filed an appeal.

In January 2002, the Court of Appeal issued a decision ordering the Superior Court to decertify the EIR for the transfer agreement on the grounds that it had tiered off of another EIR that had been subsequently decertified in other litigation. In doing so, however, the Court of Appeal also examined all of the plantiffs' other arguments, found them to be without merit, and held that, if the tiering problem had not arisen, it would have affirmed the earlier trial court judgment upholding the EIR.

The Court of Appeal did not invalidate any portion of the completed 41,000 afy transfer agreement. Instead, the Court directed the trial court to vacate certification of the EIR, and to retain jurisdiction until CLWA corrects the tiering technicality by preparing a new EIR. In September 2002, the Los Angeles Superior Court refused to prohibit CLWA from using the 41,000 af of Table A water while a new EIR is being prepared. The Superior Court decision on remand was appealed by Friends of the Santa Clara River to the appellate court in January 2003. In December 2003, the appellate court denied any relief to Friends and affirmed the trial court's ruling.

The new EIR was released for public review and comment in April 2004. It was subsequently certified by the CLWA Board of Directors on December 23, 2004. On January 24, 2005, separate lawsuits challenging the environmental review for this same project were filed by California Water Impact Network and Planning and Conservation League in the Ventura County

Superior Court. Hearings on motions to transfer the cases to the Los Angeles Superior Court are pending.

CLWA's final allocation of Table A for 2004 was 65 percent, or 61,880 af. On December 1, 2003, the initial allocation for 2004 was announced as 35 percent. On March 1, 2004, it was raised to the final allocation of 65 percent. Utilizing SWP contract provisions, CLWA elected to "carry over" unused remaining Table A Amount into 2005. As of April 21, 2005, CLWA's allocation of Table A for 2005 is 80 percent, or 76,160 af.

As shown in Table III-1, due to the 65 percent allocation, CLWA had excess SWP water in 2004. As DWR increased the allocation through the year, and due to a total of 35,785 af of carryover from 2003 and 1,618 af of Article 21 water, the total available SWP supply in 2004 was 99,283 af. CLWA deliveries were 47,205 af to the Purveyors and 3,776 af to Devil's Den Ranch, with 15,522 af of the 2004 Table A Amount for potential carryover to 2005.

As noted above, CLWA had slightly more than 35,000 af of excess Table A water in 2003, which it elected to carry over to 2004. The CLWA Board of Directors instructed staff to search out possibilities for storing the excess water in a groundwater banking program. An agreement was reached with the Semitropic Water Storage District in Kern County, and 32,522 af were banked in Semitropic's 2003 groundwater bank account. Of that amount, CLWA can withdraw up to 29,270 af as a short-term dry year supply over the next ten years (until 2013). Combined with 24,000 af banked in Semitropic's 2002 account, of which 21,600 af can be withdrawn, CLWA now has a total of 50,870 af of short-term dry year supply available for extraction from groundwater storage in Kern County.

3.4.2 Imported Water Supply Reliability

In May 2003 the Department of Water Resources finalized its State Water Project Delivery Reliability Report. This report is intended to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies.

The Reliability Report is based on a computer model commonly known as CALSIM II, which calculates SWP delivery probabilities under different hydrologic year types, based on long-term historical data and a variety of operating parameters. The analyses contained in the report conclude the SWP, using existing facilities and operated under current regulations, can deliver an average of 76 percent of the primary contractual supply (defined as the Table A Amount) at the 2021B level of development described in the report. During infrequent dry periods, deliveries are projected to be less than 50 percent, and possibly as low as 19 percent during an unusual single dry year condition that historically occurs about once every 70 years. During very wet years, full contract amounts are available.

The report will be updated with new information and calculations of delivery reliability every two years. The report is available on-line at *http://swpdelivery.water.ca.gov/*.

Some of the most significant opportunities for meeting the future water supply needs of the Santa Clarita Valley are from supplies available from the SWP. In the resource planning process of the

Table III-1
2004 CLWA State Water Project Supply and Demand Schedule
(acre-feet)

Supply		
Net 2003 Carryover to 2004 [1]		3,263
CLWA 2004 Final Allocation [2]		61,880
Article 21 Water		1,618
Total 2004 SWP Supply [1]		**66,761**
Demand		
Purveyor Deliveries (Total)		47,205
CLWA SCWD	*22,045*	
Valencia Water Company	*18,410*	
Newhall County Water District	*5,896*	
Los Angeles County WWD 36	*854*	
CLWA/ Purveyor Metering		258
Devils Den Ranch		3,776
2004 Table A Carryover to 2005 [3]		15,522
Total 2004 SWP Demand [4]		**66,761**

1. Total Carryover from 2003 was 35,785 af, resulting in a total 2004 SWP supply of 99,283 af; of that amount, 32,522 af were banked in Semitropic WSD, leaving a net carryover of 3,263 af.

2. Final 2004 allocation was 65% of contractual Table A amount of 95,200 acre-feet, which progressed as follows:

Initial allocation (Dec. 1, 2003)	35%
Allocation increase (Jan. 15, 2004)	50%
Final allocation (March 1, 2004)	65%

3. Total excess 2004 SWP supply; of that amount, 13,865 af spilled in early 2005 at San Luis Reservoir, leaving a net carryover of 1,657 af.

4. Includes total 2004 Table A carryover.

SWP, there are a number of complex issues facing delivery of CLWA's Table A Amount of 95,200 af. These factors include annual hydrologic conditions, environmental requirements, and evolving policies in the Bay-Delta. However, there are a number of programs and approaches that improve reliability of SWP water supplies.

Groundwater banking and conjunctive use offer significant opportunities to improve water supply reliability for CLWA. Groundwater banking is the process of storing available supplies of water during wet years in groundwater basins. Conjunctive use is the coordinated operation of multiple water supplies to achieve improved supply reliability. During wet periods, additional surface water supplies from the SWP can be used to recharge a local groundwater basin and then recovered for delivery during dry periods. In 2002 and 2003 CLWA took advantage of such a program on a short-term basis (10 years or less) by placing 24,000 af of available 2002 Table A water and 32,522 af of 2003 Table A water in the Semitropic Water Storage District's Groundwater Banking Program. Over the next ten years, CLWA can withdraw up to 50,870 af of that stored water to meet valley demands when needed. The Amended 2000 UWMP Supplement includes additional information about these and other programs.

3.5 Water Quality – General

Water delivered by the Purveyors consistently meets drinking water standards set by the Environmental Protection Agency (EPA) and the California Department of Health Services (DHS). The Purveyors in turn supply this safe and potable water to their customers. An annual Consumer Confidence Report is provided to all Santa Clarita Valley residents who receive water from one of the four water retailers. In that report, there is detailed information about the results of quality testing of the groundwater and treated SWP water supplied to the residents of the Santa Clarita Valley during 2004.

Water quality regulations are constantly changing as contaminants that are typically not found in drinking water are being discovered, and new standards are adopted. In addition, existing water quality standards are becoming more stringent in terms of allowable levels in drinking water. In light of these changes, several constituents of particular interest are discussed in more detail below.

Total Trihalomethanes

In 2002, the United States Environmental Protection Agency implemented the new Disinfectants and Disinfection Byproducts Rule. In part, this rule establishes a new MCL of 80 ug/L (based on an annual running average) for Total Trihalomethanes (TTHM). TTHMs are a byproduct that is created when free chlorine is used as a means for disinfection. In December 2004, as part of regular quarterly TTHM monitoring, Newhall CWD detected TTHM concentrations that resulted in the running annual average TTHM concentrations to slightly exceed the MCL of 80 parts per billion (ppb) in its Pinetree and Tesoro service areas. The respective running average annual TTHM concentrations for the fourth quarter 2004 were 82.6 ppb and 80.8 ppb. In August 2004, Los Angeles County WWD 36 reported its running annual average TTHM concentration to also exceed the MCL, in that case at 88 ppb. To address potential TTHM formation in the future, CLWA and the Purveyors are implementing an alternative method of disinfection (i.e., chloramination) to be able to maintain compliance with the new rule and future regulations relating to disinfection byproducts.

Arsenic

The United States Environmental Protection Agency has revised the Federal MCL for arsenic from 50 ug/L to 10 ug/L. Compliance with the Federal standard is not required until 2006. In April 2004, the Office of Environmental and Health Hazard Assessment (OEHHA) finalized a new Public Health Goal (PHG) for arsenic at 4 parts per trillion (ppt). State Health and Safety Code required DHS to establish a new MCL for arsenic by June 30, 2004. Because the PHG was not available until April of that year, the process for establishing the new arsenic MCL has been delayed. DHS has not made public a revised schedule for the MCL process. Historically, naturally occurring arsenic has been detected at concentrations of less than 5 ug/L in a few local groundwater supplies, and at concentrations of less than 3 ug/L in SWP water supplies. Most groundwater wells in the valley have non-detectable (less than 2 ug/L) concentrations of arsenic.

Perchlorate

Perchlorate has been a water quality concern in the Valley since 1997 when it was originally detected in four Saugus wells operated by the Purveyors in the eastern part of the Saugus Formation, near the former Whittaker-Bermite facility. In late 2002, perchlorate was detected in a fifth municipal well, in this case an Alluvial well also located near the former Whittaker-Bermite site. In early 2005, perchlorate was detected in a second Alluvial well near the former Whittaker-Bermite site. The six perchlorate-impacted wells have been removed from active water supply service. The Purveyors are continuing to test for perchlorate in all of their active Alluvial and Saugus wells. The current DHS Notification Level for perchlorate is 6 micrograms per liter (ug/l). DHS currently anticipates proposing a Maximum Contaminant Level (MCL) for perchlorate in 2005.

In the meantime, the impacted Purveyors (CLWA, SCWD, NCWD, and VWC) and CLWA are developing a plan for a water treatment process to restore the impacted pumping capacity as soon as possible. The plan for restoring “severely impaired” water sources such as the perchlorate-impacted wells must comply with the provisions of the State Department of Health Services’ (DHS) Policy Memo 97-005. Work on the documentation required by Policy Memo 97-005 continued in 2004 on interrelated fronts: 1) development of a pumping plan for restoration of some perchlorate-impacted groundwater supply by installing treatment at two impacted wells, together with a plan for construction of replacement wells to restore the balance of impacted groundwater supply; 2) analysis of the capture zones around wells to contain further migration of perchlorate and protect non-impacted wells; 3) analysis of overall groundwater reliability during the period before restoration of impacted supply, currently scheduled for 2006; and 4) analysis of overall groundwater resource sustainability under long-term pumping that would both contain perchlorate migration and meet municipal and agricultural water requirements in accordance with the UWMP.

Pilot studies of an ion exchange treatment system and two biological treatment systems were completed in 2003; the results of those studies were the basis for selection of ion exchange as the treatment process for removal of perchlorate from groundwater pumped for control of perchlorate migration in the aquifer system.

The numerical groundwater flow model was originally envisioned as a tool for analysis of basin-wide water supply and management issues. In addition to that use, which is ongoing, the model was initially approved by regulatory agencies in 2003 and formally approved in 2004 for use in evaluating the effectiveness of pumping on the extraction of contaminants and the control of contaminant migration in the affected aquifers. The initial use of the model in 2003 was to evaluate the effectiveness of pumping at capacities equivalent to replacement of the perchlorate-impacted wells. In 2004, the model was used to simulate long-term aquifer response to basin-wide pumping in accordance with the operational plans in the UWMP; included in that analysis was the selective pumping of impacted wells, with treatment, for a combination of restoring some impacted water supply and controlling perchlorate migration. The results, derived from simulation over a 78-year period that includes a range of wet/normal/dry hydrologic conditions, showed the aquifer system to be sustained with no long-term adverse conditions such as groundwater level decline, groundwater storage depletion, or depletion of surface stream flows. The modeled results also showed that the pumping of selected impacted wells for water supply, with treatment, will contain the migration of perchlorate and thus provide a level of protection against contamination of additional downgradient wells. The modeling results and the evaluation of treatment alternatives are being submitted to DHS for its approval of a program to restore the impacted water supply in accordance with its Policy Memo 97-005.

The development and implementation of a cleanup plan for the Whittaker-Bermite site and the impacted groundwater is being coordinated among CLWA, the impacted Purveyors, the State Department of Toxic Substance Control (DTSC), and U.S. Army Corps of Engineers. DTSC is the lead agency responsible for regulatory oversight of the Whittaker-Bermite site. In February 2003, DTSC and the impacted Purveyors entered into a voluntary cleanup agreement entitled *Environmental Oversight Agreement*. Under the Agreement, DTSC is providing review and oversight of the response activities being undertaken by the impacted Purveyors related to the detection of perchlorate in the five impacted wells. Under the Agreement’s Scope of Work, the impacted Purveyors have prepared a Work Plan for sampling the production wells, prepared a report in the results and findings of the production well sampling, prepared a draft Human Health Risk Assessment, prepared a draft Remedial Action Workplan, completed the evaluation of treatment technologies, and completed the development of the groundwater model described above.

In 2000, CLWA and the impacted Purveyors had filed a lawsuit against Whittaker Corporation (the former owner of the contaminated property) and Santa Clarita LLC and Remediation Financial, Inc. (the current owners). The lawsuit seeks to have the defendants pay all necessary costs of response, removal of the contaminant, remedial action costs, and any liabilities or damages associated with the contamination. In late summer 2003, CLWA, the Purveyors and Whittaker entered into an Interim Settlement Agreement (ISA) wherein the parties agreed to work cooperatively for a minimum of a one-year period to further define long-term costs and reach a long-term settlement. The ISA expired in September 2004 but was extended by mutual consent of all parties until the end of January 2005. The ISA specifies that Whittaker and its insurers would reimburse certain past costs as well as ongoing costs incurred by CLWA and the Purveyors in responding to perchlorate contamination. Activities since execution of the ISA have continued on developing the elements of a remedial strategy that will entail, among other details, the pumping of two impacted wells for containment of perchlorate migration, utilization of the pumped water, after treatment, for water supply, and installation of replacement wells in non-impacted portions of the basin to restore the remainder of groundwater supply impacted by perchlorate. Activities since execution of the ISA have also involved negotiation of a long-term Settlement Agreement.

3.5.1 Groundwater Quality – Alluvium

Groundwater quality is, of course, a key factor in assessing the Alluvial aquifer as a municipal and agricultural water supply. Groundwater quality details related to drinking water standards are discussed below. In terms of the aquifer system, however, there is no convenient long-term record of water quality, i.e. water quality data in one or more single wells that span several decades and continue to the present. Thus, in order to examine a long-term record of water quality in the Alluvium, one approach is to integrate individual records from several wells completed in the same aquifer materials and in close proximity to each other. Several such integrated records are illustrated in Figures III-10 and III-11, which show trends in groundwater quality for the ‘Above Saugus WRP’, ‘Below Saugus WRP’, ‘Bouquet Canyon’ and ‘Castaic Creek’ areas. Specific conductance (or Electrical Conductivity, EC) was chosen to represent water quality because it is generally a good indicator of overall trends in water quality, and because the records for this parameter are the most comprehensive. Based on these records of groundwater quality, wells within the Alluvium have experienced historical fluctuations in EC, which correlate with fluctuations of individual constituents that contribute to EC. The limited historic water quality data indicate that on a long-term basis, there has not been a notable trend and specifically, there has not been a decline in water quality within the Alluvium.

Specific conductance within the Alluvium exhibits a westward gradient, corresponding with the direction of groundwater flow in the Alluvium, which is also westward. EC is lowest in the easternmost portion of the basin, and highest in the west. Water quality in the Alluvium generally exhibits an inverse correlation with precipitation and streamflow, with a stronger correlation in the easternmost portion of the basin where groundwater levels fluctuate the most. Wet periods have produced substantial recharge of higher quality (low EC) water and dry periods have resulted in the notable declines in water levels described above, with a corresponding increase in EC (and individual contributing constituents) in the deeper parts of the Alluvium.

In the ‘Above Saugus WRP’ area, EC correlates strongly and inversely with precipitation and streamflow, showing an increase during periods of lower-than-average precipitation and a decrease during periods of higher-than-average precipitation. There is inadequate data for this area to determine the relationship of current levels of EC with long-term historic trends. The limited historic data from other areas indicate that, despite the recent increase, overall levels of EC around 1960 were higher than current levels. Water quality in the ‘Mint Canyon’ area is similar to that in the ‘Above Saugus WRP’ area.

Water quality in the ‘Below Saugus WRP’ area has also historically exhibited noticeable inverse fluctuations with precipitation and streamflow. Limited data from the early 1960’s indicates that the recent increases (since 2001) in levels of EC in this area have not resulted in measured historic highs. EC in this area has experienced similar increases to those in the ‘Above Saugus WRP’ area, and is currently within the same range. This is an indication that the recent increase in EC in the 'Below Saugus WRP' area may not be a result of salt loading from recharge of treated wastewater discharged to the Santa Clara River from the Saugus Water Reclamation Plant.

In the 'Bouquet Canyon' area, water quality appears to have generally improved since the 1950's and 1960's, and has remained fairly stable for the last thirty years. The 'San Francisquito Canyon' area has exhibited similarly consistent water quality.

Fluctuations in water quality in the 'Castaic Creek' area have been recorded since the 1950's, but there has been no long-term change in overall level of EC. Levels of EC generally declined in the 1990's, and limited recent data indicates that levels may be increasing, but are still below historic highs. Water quality in the 'Below Valencia WRP' area is similar to that in the 'Castaic Creek' area; however, no water quality data within the last 25 years is available for this area.

Throughout the Alluvium, measurements of EC have generally been made about every three years, as is typically required for public water supply wells. While this frequency is adequate to determine long-term trends and fluctuations in EC, it is not sufficient to identify the timing of the water quality response to wet or dry conditions. Occasional more frequent measurements of EC indicate that in the central to eastern portions of the basin there is a lag time in water quality response to precipitation, and levels of EC do not appear to decline substantially until there are at least two consecutive years of higher-than-average precipitation. The last such instance was in 1992 to 1993, which corresponded to the last significant decline in EC. It is likely that levels of EC will not decline substantially until a period of consecutive years of higher-than-average precipitation occurs. Monthly data collected by VWC in 2004 show that EC levels declined gradually during the year. Analysis of water quality data to be collected in 2005 may provide a better understanding of the correlation between groundwater levels and water quality within the Alluvium, and allow for better characterization of the Alluvial water quality response to precipitation.

Specific conductance throughout the Alluvium is currently below the Secondary (aesthetic) Upper Maximum Contaminant Level of 1600 µmhos/cm. The presence of long-term consistent water quality patterns, although intermittently affected by wet and dry cycles, supports the conclusion that the Alluvial aquifer is a viable ongoing water supply source in terms of groundwater quality.

As discussed above, in 2002, one Alluvial well located near the former Whittaker-Bermite facility was inactivated for municipal water supply due to detection of perchlorate slightly below the Notification Level. In early 2005, perchlorate was detected in a second Alluvial well, VWC's Well Q2. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. The Q2 Report (Luhdorff and Scalmanini, 2005) documents that the perchlorate detected in Well Q2 will not significantly impact the water supplies used to meet demand in the Santa Clarita Valley for the period of time required to respond to the contamination. The results of the Q2 analysis and Report are consistent with the analysis and conclusions in the Amended 2000 UWMP. Valencia's response plan for Well Q2 is to pursue permitting and installation of wellhead treatment by the fall of 2005, which will return the well to water supply service. All other Alluvial wells operated by the Purveyors continue to be used for municipal water supply service. Those Alluvial wells near the Whittaker-Bermite property are routinely sampled and perchlorate has not been detected. As detailed in the Amended 2000 UWMP and the Q2 Report, the inactivation of two Alluvial wells due to perchlorate contamination does not limit the Purveyors' ability to produce groundwater from the Alluvium in accordance with the capacities delineated in the UWMP. The characterization and plan for control and cleanup of perchlorate, initially focused on the Saugus Formation due to the contamination and resultant inactivation of four Saugus wells in 1997, includes the Alluvial aquifer as well.

3.5.2 Groundwater Quality – Saugus Formation

As discussed above for the Alluvium, groundwater quality in the Saugus Formation is a key factor in assessing that aquifer as a municipal and agricultural water supply. As with groundwater level data, long-term Saugus groundwater quality data are not sufficiently extensive (few wells) to permit any sort of basin-wide analysis or assessment of pumping-related impacts on quality. As with the Alluvium, specific conductance (EC) has been chosen as an indicator of overall water quality, and records have been combined to produce a long-term depiction of water quality within the Saugus Formation (Figure III-12). Water quality in the Saugus Formation has not historically exhibited the precipitation-related fluctuations seen in the Alluvium. Based on the historical record over the last 50 years, groundwater quality in the Saugus has exhibited a slight overall increase in EC. More recently, several wells within the Saugus Formation have exhibited an additional increase in EC similar to that seen in the Alluvium. This is possibly a result of recharge to the Saugus Formation from the Alluvium. In 2004, monthly data collected by VWC for two Saugus wells shows that the overall level of EC remained fairly stable during the year. Levels of EC in the Saugus Formation remain below the Secondary (aesthetic) Upper Maximum Contaminant Level for EC. Groundwater quality within the Saugus will continue to be monitored to ensure that degradation that presents concern relative to the long-term viability of the Saugus as an agricultural or municipal water supply does not occur.

As previously noted, in 1997, ammonium perchlorate was discovered in four Saugus wells located generally on the east side of the basin in the vicinity of the former Whittaker-Bermite facility. All four impacted wells were removed from active water supply service, and are expected to remain inactive until the extent of contamination is fully characterized and appropriate treatment facilities are installed for contaminant control and removal. The other Saugus wells owned and operated by the Purveyors continue to be sampled on a routine basis and have not detected perchlorate.

The Amended 2000 UWMP specifically addressed the adequacy of groundwater supply in light of the inactivation of the four impacted Saugus wells; and it addressed the plan and schedule for restoration of perchlorate-impacted wells, including the protection of existing non-impacted wells. The Amended 2000 UWMP analysis showed that the inactivation of the impacted wells does not constrain the ability to meet the groundwater component of water supply through the scheduled period for restoration, through 2006. The same analysis showed that the restoration of pumping capacity, with treatment to meet drinking water standards, will effectively contain perchlorate migration and protect downgradient wells from perchlorate impacts.

3.5.3 Imported Water Quality

CLWA operates two water treatment plants, the Earl Schmidt Filtration Plant located near Castaic Lake and the Rio Vista Water Treatment Plant located in Saugus. CLWA produces water that meets drinking water standards set by EPA and DHS. SWP water has different aesthetic characteristics than groundwater with hardness (as $CaCO_3$) ranging from 130 to 170 milligrams per liter (mg/L) and TDS of approximately 280 to 314 mg/L.

3.6 Recycled Water

Recycled water is available from two existing water reclamation plants operated by the Sanitation Districts of Los Angeles County. In 1993, CLWA prepared a draft Reclaimed Water System Master Plan that outlined a multi-phase program to deliver recycled water in the Valley. CLWA has completed environmental review on the construction of Phase I of the project, which will deliver 1,700 afy of water. Deliveries of recycled water began in 2003 for irrigation water supply at a golf course and in roadway median strips. In 2004, recycled water deliveries were 448 af.

Surveys conducted by CLWA indicate an interest for recycled water by existing water users as well as future development when it becomes available. The Purveyors encourage and support the use of recycled water to help augment and drought proof existing supplies. Overall, the program is expected to ultimately reclaim up to 17,000 af of treated (tertiary) wastewater suitable for reuse on golf courses, landscaping and other non-potable uses, as set forth in the UWMP.

In October 2004, CLWA began California Environmental Quality Act (CEQA) analysis of the Recycled Water Master Plan (2002). This analysis will result in a Program Environmental Impact Report covering the various options for a recycled water system outlined in the Master Plan. A Notice of Preparation was released for public review in April 2005.

3.7 Santa Clara River

As noted above, a significant accomplishment in 2001 was the preparation and execution of a Memorandum of Understanding (MOU) between the Santa Clarita Valley Purveyors and the United Water Conservation District, which manages surface and groundwater resources in seven groundwater basins in the Lower Santa Clara River Valley Area. The MOU initiates a collaborative and integrated approach to data collection; database management; groundwater flow modeling; assessment of groundwater basin conditions, including determination of basin yield amounts; and preparation and presentation of reports, including continued annual reports such as this one for current planning and consideration of development proposals, and also including more technically detailed reports on geologic and hydrologic aspects of the overall stream-aquifer system. Meetings of the MOU participants have continued, and integration of the Upper (Santa Clarita Valley) and Lower (United WCD) Santa Clara River databases has been accomplished. In 2002, work commenced on the development and calibration of a numerical groundwater flow model of the entire Santa Clarita groundwater basin; model development and calibration was completed in 2003 and reported in early 2004. The model has been used as described above for assessing the effectiveness of various scenarios to restore pumping capacity impacted by perchlorate contamination by pumping and treating groundwater for water supply while simultaneously controlling the migration of contaminated groundwater. In 2005, it is planned to utilize the model for ongoing evaluation of basin yield under varying management actions and hydrologic conditions.

On occasion, issues have been raised about whether use and management of groundwater in the Santa Clarita Valley have adversely impacted surface water flows into Ventura County. The long-term history of groundwater levels in the western and central part of the basin, as illustrated in Figures III-4 and III-5, suggests that groundwater has not been lowered in such a way as to induce infiltration from the river. Long-term stream flow data gauged near the County line shows notably higher flows from the Santa Clarita Valley into the uppermost downstream basin, the Piru Basin, over the last 30 to 35 years, as illustrated in Figure III-13.

IV. Summary of 2004 Water Supply and 2005 Outlook

As reported herein, total water demands in the Santa Clarita Valley were 87,900 af in 2004. This represented an increase of slightly more than five percent from total demand in 2003. Of the total demand, about 72,300 af was for municipal water supply, and the balance (15,600 af) was for agricultural and other minor uses. As also discussed herein, the total demand in 2004 was met by a combination of local groundwater and imported SWP water, both within their respective operational yields and contractual Table A Amounts respectively, and by a small amount of recycled water.

The demand in 2004 was greater than the short-term projected demand that was estimated in the 2003 Water Report and it was also greater than the demand estimated in the UWMP. For illustration, historical water use from 1980 through 2003 is plotted in Figure IV-1; also shown with that historical record are the projected total water demands in the UWMP through 2020. As discussed in the 2000 UWMP, the year-to-year fluctuations in historical water demand range from about three percent below to about ten percent above the projection, primarily related to growth, that would describe the long-term historical trend in the Valley's total water demand. The primary factor causing the year-to-year fluctuations is weather. In the short term, drier years result in higher water demand. Extended drier periods, however, have resulted in decreased demand due to conservation and water shortage awareness. The decline in water demand at the end of the 1987-92 drought is a good example of such reduced demand. Ultimately, however, it would appear that the growth rate in the Santa Clarita Valley over the last three years has exceeded the rate estimated in the 2000 UWMP. Over the same time, the average rate of water use per service has remained nearly constant. The combination of a nearly constant unit water demand and a greater number of services has resulted in municipal water demand increasing over the last five years at a slightly higher rate than was estimated in the UWMP in 2000. Projected water demands will be updated in the 2005 UWMP currently in preparation.

For short-term planning, recognizing the continuation of recent higher-than-originally-estimated growth, and significantly above-normal precipitation in early 2005, water demand in 2005 is projected to be about 89,000 af. It is expected that both municipal and agricultural water demands in 2005 will be met with a generally similar mix of water supplies as in previous years, notably local groundwater and imported SWP water, complemented by recycled water that will continue to supply a small fraction of total water demand.

As of April 21, 2005, the allocation of water from the SWP is 80 percent of CLWA's Table A Amount, or 76,160 af. Combined with local groundwater from the two aquifer systems (47,500 af), small additional surface water supplies (Article 21 and Flexible Storage Account, which represent about 6,200 af combined), net carryover SWP water from 2004 (1,657 af), and recycled water (up to 1,700 af), the total available water supplies for 2005 are slightly more than 133,000. Consequently, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2005. A summary of projected 2005 water supply and demands is presented in Table IV-1.

Table IV-1
2005 Water Supply and Demand
(acre-feet)

Projected 2005 Demand [1]		**89,000**
Available Water Supplies		
Local Groundwater		47,500
Alluvial Aquifer [2]	*40,000*	
Saugus Formation [3]	*7,500*	
Imported Water		84,101
Table A Amount [4]	*76,160*	
Article 21 Water Program for 2005 [5]	*1,600*	
Net Carryover from 2004 [6]	*1,657*	
CLWA Flexible Storage Account [7]	*4,684*	
Recycled Water		1,700
Total Available 2005 Supplies		**133,301**
Dry Year Supplies **[8]**		
Semitropic Groundwater Storage Bank		50,870
2002 Account	*21,600*	
2003 Account	*29,270*	
Total Supplemental Dry Year Supplies		**50,870**

1. Refer to the Amended 2000 UWMP for long-term projections of supply and demand. The projected 2005 water demand is based on recent actual water demands, with adjustment for significantly wet conditions in early 2005.

2. The Alluvium represents 30,000 – 40,000 afy of available supply under wet-normal conditions, and 30,000 – 35,000 afy under dry conditions. Available supply in 2005 is shown to be the average/wet range due to significantly above-average precipitation in late 2004 and early 2005.

3. The Saugus represents 7,500 – 15,000 afy of available water supply under non-drought conditions, and up to 35,000 afy under increasingly dry conditions. Available supply in 2005 is shown to be limited to very wet conditions; no short-term increase in Saugus pumping is required or shown for 2005 water supply.

4. CLWA's SWP Table A amount is 95,200 af. The 2005 allocation, as of April 21, 2005, is 80 percent (76,160 af).

5. Through March 2005. Article 21 Water Program refers to a provision in the SWP contract for delivering water that is available in addition to CLWA's Table A allocation. This water is typically available only for a limited time from January through March, as hydrologic and SWP storage conditions allow.

6. Total excess 2004 SWP supply was 15,522 af; of that amount, 13,865 af spilled in early 2005 at San Luis Reservoir, leaving a net carryover delivery of 1,657 af.

7. CLWA can directly utilize up to 4,684 af of storage capacity in Castaic Lake.

8. Recoverable portion of 24,000 af and 32,522 af of excess in 2002 and 2003 Table A water banked in Semitropic WSD, respectively. Does not include other reliability measures available to CLWA and the retail water Purveyors. These measures include short-term exchanges, participation in DWR's dry-year water purchase programs, local dry-year supply programs and other planned groundwater storage programs. Refer to the Amended 2000 UWMP for more information on these and other programs.

In addition to the preceding, it is noteworthy that, while not required to meet projected demand in 2005, a total of nearly 51,000 af of recoverable water has been stored in a Kern County groundwater storage bank account for dry-year deliveries.

A significant number of local projects are part of an overall program currently funded by CLWA to provide facilities needed to firm up imported water supplies during times of drought. These involve water conservation, surface and groundwater storage, water transfers and exchanges, water recycling, additional short-term pumping from the Saugus Formation, and increasing CLWA's imported supply. This overall strategy is designed to meet increasing water demands while assuring a reasonable degree of supply reliability.

The Purveyors strive to provide a blend of groundwater and imported water to area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and location in the valley is an operational decision and varies over time due to source availability and operational capacity of Purveyor and CLWA facilities. The goal is to conjunctively use the available water resources so that the overall reliability of water supply is maximized.

Dry-year periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and vice versa.

For this reason, CLWA and the Purveyors have emphasized developing water supplies that add diversity allowing water supply options especially in dry years. Diversity of supply is considered a key element of reliability, giving the Purveyors the ability to draw on multiple sources of supply during dry-year conditions and thereby making the Purveyors' water deliveries more reliable. As a result of this advance planning, no water shortages are anticipated in CLWA's service area for the foreseeable future.

For long-term planning purposes, water supplies and facilities are added on an incremental basis and ahead of need. It would be economically to immediately, or in the short term, acquire all the facilities and water supplies needed for the next twenty to thirty years. This would represent an unfair shift of costs from future customers to existing customers.

There are many ongoing efforts to produce an adequate and reliable supply of good quality water for Valley residents. Water consumers expect that their needs are going to be met with a high degree of reliability and quality of service. To that end, CLWA and the Purveyors are in the process of establishing a water reliability policy for planning purposes sufficient to meet projected demands 95 percent of the time over each 20-year period. In the remaining 5 percent of the time, it is assumed that the maximum allowable supply shortage will be 10 percent of overall demand.

This shortage level is being recommended because a 10 percent water demand reduction is feasible during a drought based on past experience. When a shortage occurs, water consumers typically increase their awareness of water usage and voluntarily reduce water demands. During the 1987–1992 drought, voluntary conservation efforts by area residents resulted in a decrease in water demand of about 20 percent per year.

V. Water Conservation

The California Urban Water Conservation Council (CUWCC) was formed in 1991 through the Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California. The urban water conservation BMPs included in the MOU are intended to reduce California's long-term urban water demands. The BMPs are currently implemented by the signatories to the MOU on a voluntary basis. However, the CalFed Bay-Delta Program has included mandatory implementation of the BMPs and certification of water use efficiency programs in its final Environmental Impact Statement/Report and Record of Decision. This certification requirement would take effect after enabling legislation is passed and would apply to any agency subject to the Urban Water Management Planning Act that is located in the CalFed solution area. In addition, the BMPs are specified as part of the Urban Water Management Planning Act.

CLWA signed the urban MOU in 2001 on behalf of its wholesale service area. Since then, CLWA has instituted implementation of BMP 2 (Residential Plumbing Retrofits) and BMP 14 (Residential ULFT Replacement Programs). NCWD signed the MOU in 2002 on behalf of its own retail service area. As a separate MOU signer and due to its role as a retailer, NCWD is committed to implementing additional BMPs that are feasible and applicable in its service area. Efforts are made to coordinate with CLWA and the other purveyors wherever possible to maximize efficiency and ensure the cost effectiveness of NCWD's conservation program.

Water conservation can achieve a number of goals, such as:

- Meeting legal mandates
- Reducing average annual potable water demands
- Reducing sewer flows
- Reducing demands during peak sessions
- Meeting drought restrictions

In coordination with the Purveyors in its service area, CLWA has been implementing the following urban water conservation Best Management Practices (BMPs) (which pertain to wholesalers) for several years:

BMP 3	System Water Audits, Leak Detection and Repair
BMP 7	Public Information Programs
BMP 8	School Education
BMP 10	Wholesale Agency Programs
BMP 11	Conservation Pricing
BMP 12	Water Conservation Coordinator
BMP 13	Water Waste Prohibition (Implementation during last drought)

CLWA and the Purveyors have been implementing the listed BMPs valley-wide since 2002. In addition, interior plumbing code changes that have been in effect since 1992, as well as changes in lot size and reduction in exterior square footage of new housing and commercial developments, have begun to impact overall demand in the Valley. The valley's water suppliers will continue to monitor water demand trends through time to assess which factors are accounting for the reduction, and to attempt to quantify them.

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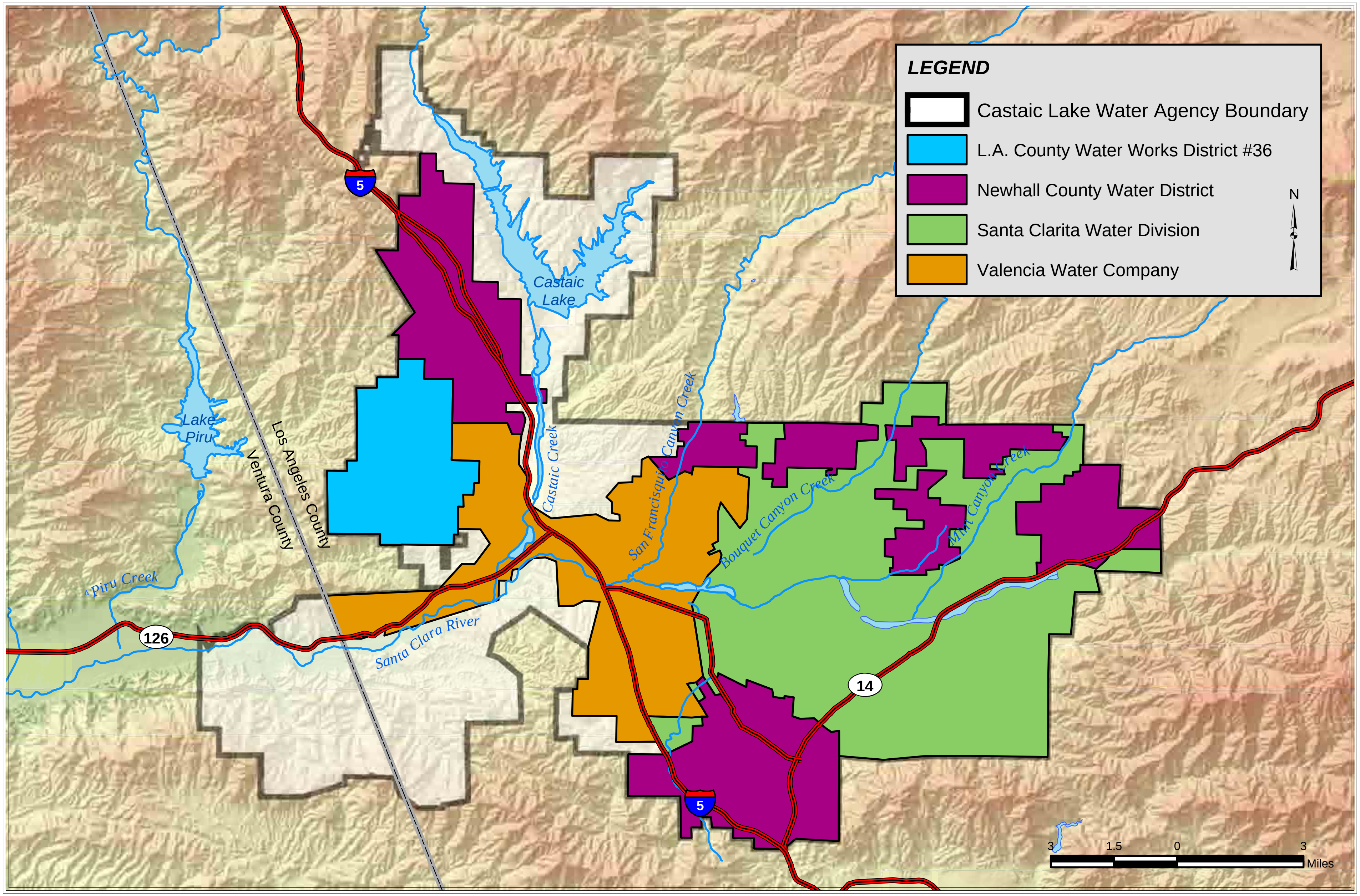

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Figure I-1
CLWA and Purveyor Service Areas

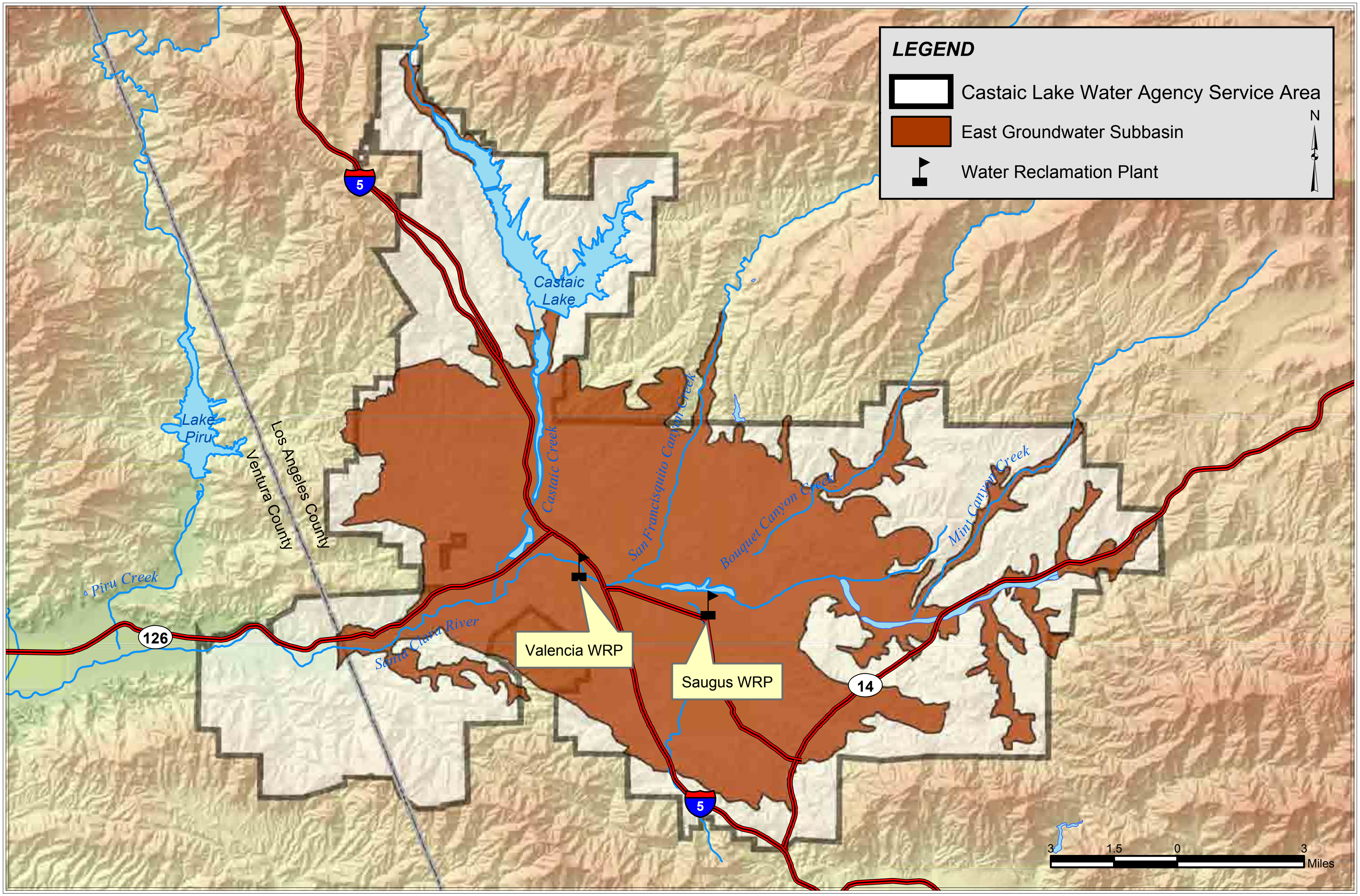

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Figure I-2
Santa Clara River Valley
East Groundwater Subbasin

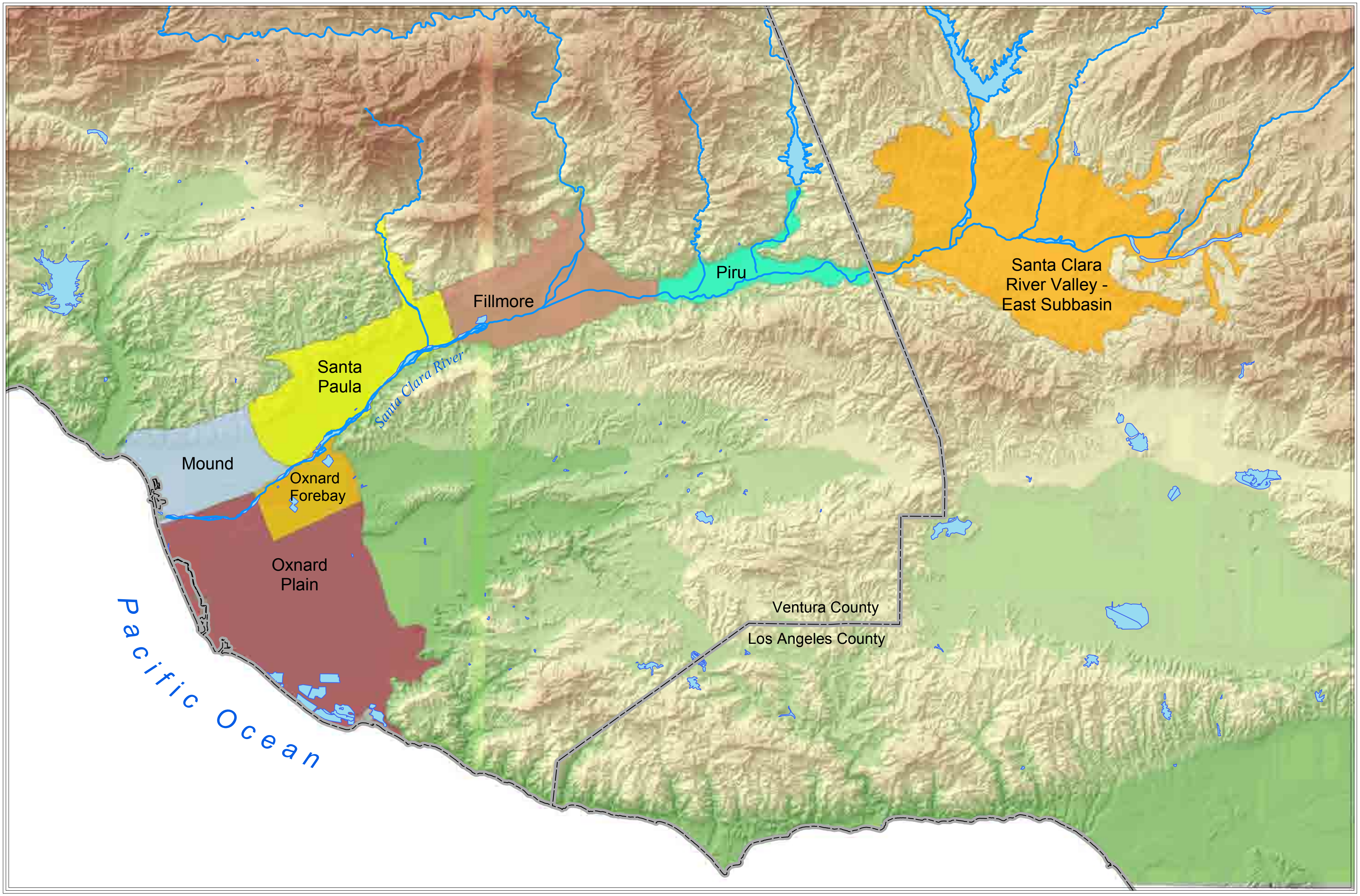

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Figure I-3
Upper and Lower Santa Clara River Basins

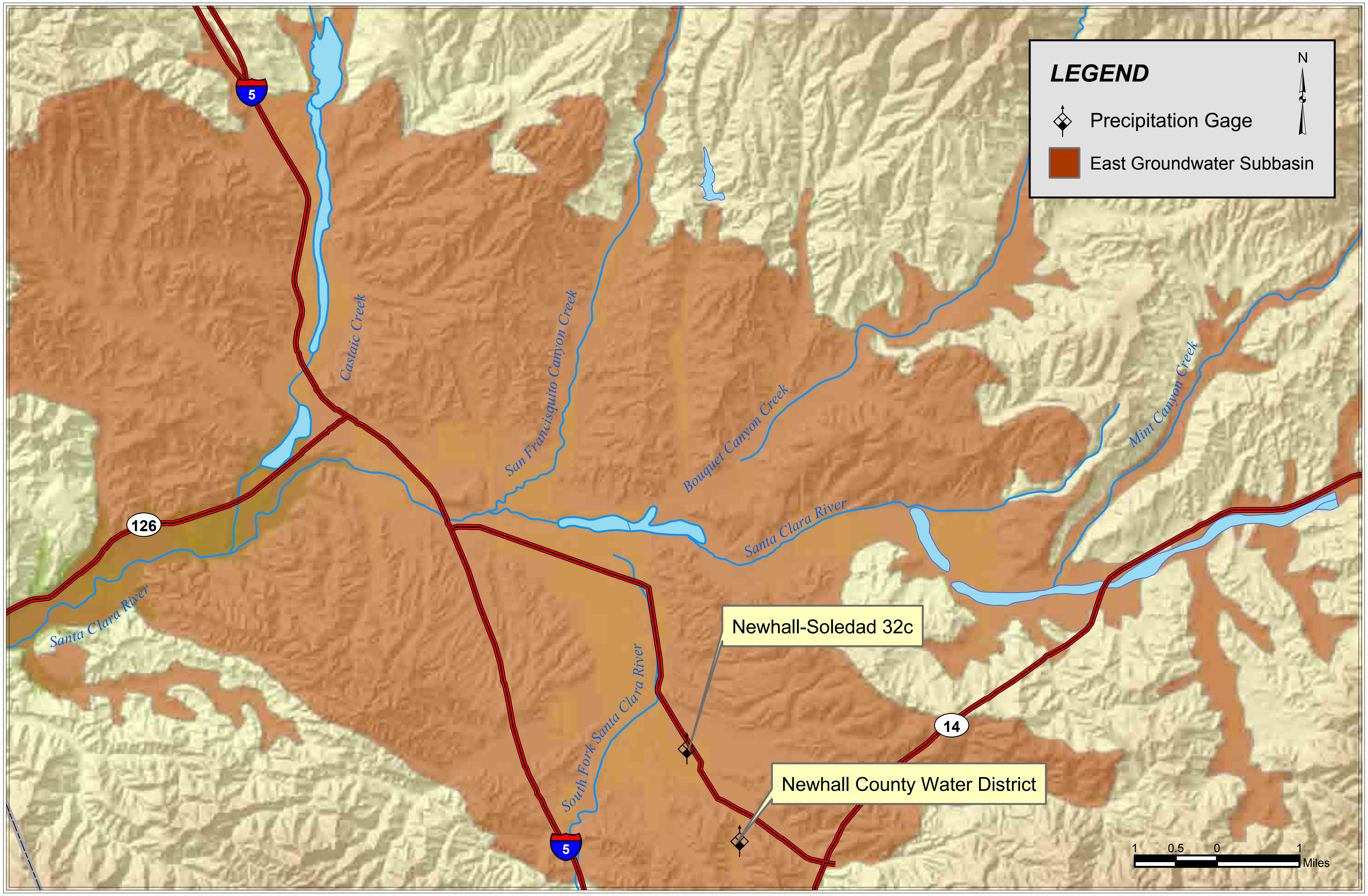

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Figure I-4
Precipitation Gage Locations
Santa Clara River Valley, East Groundwater Subbasin

Annual Precipitation and Departure from Mean Annual Precipitation

Santa Clara River Valley, East Groundwater Subbasin

(Newhall-Soledad 32c Gage)

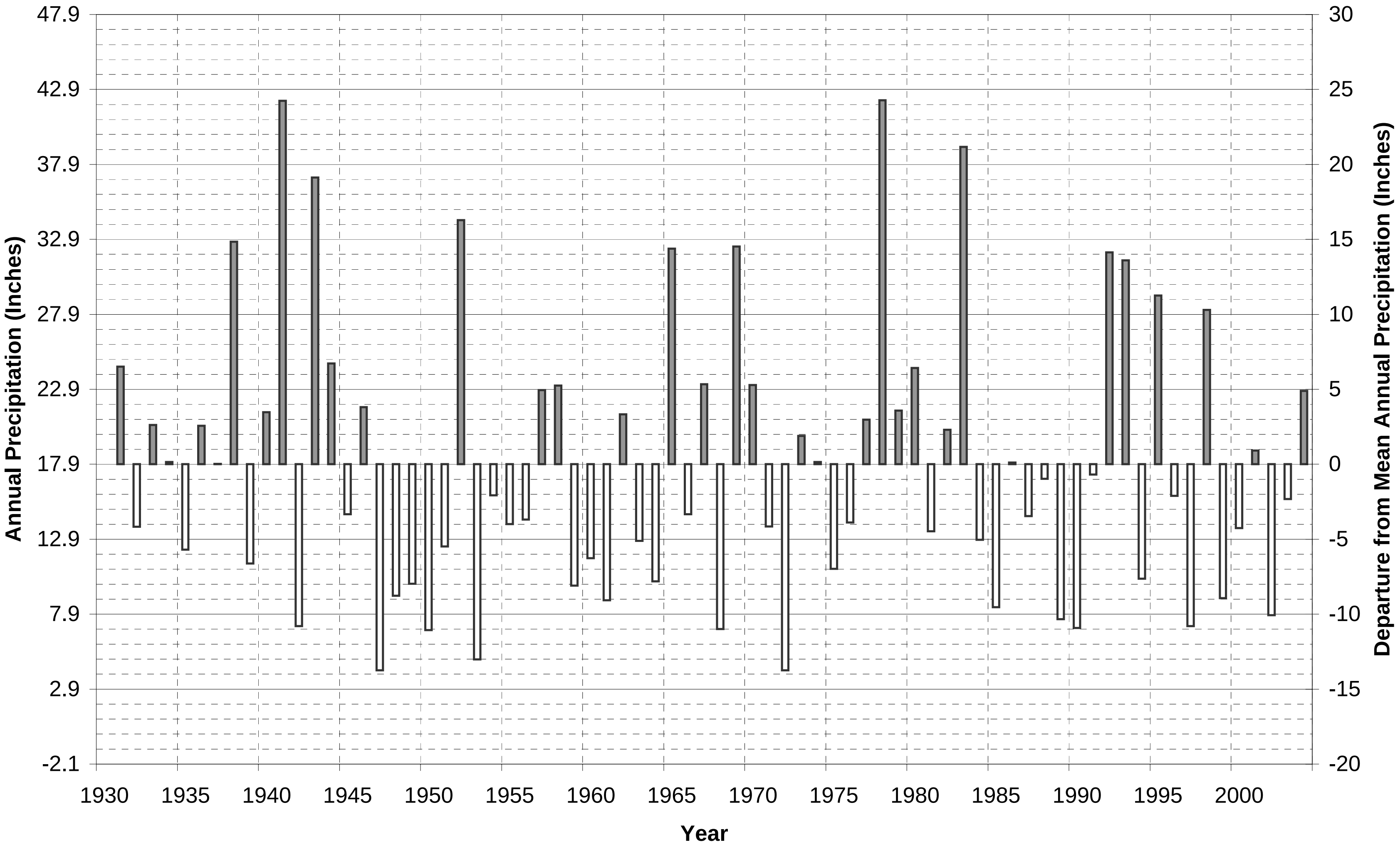

Figure I-5

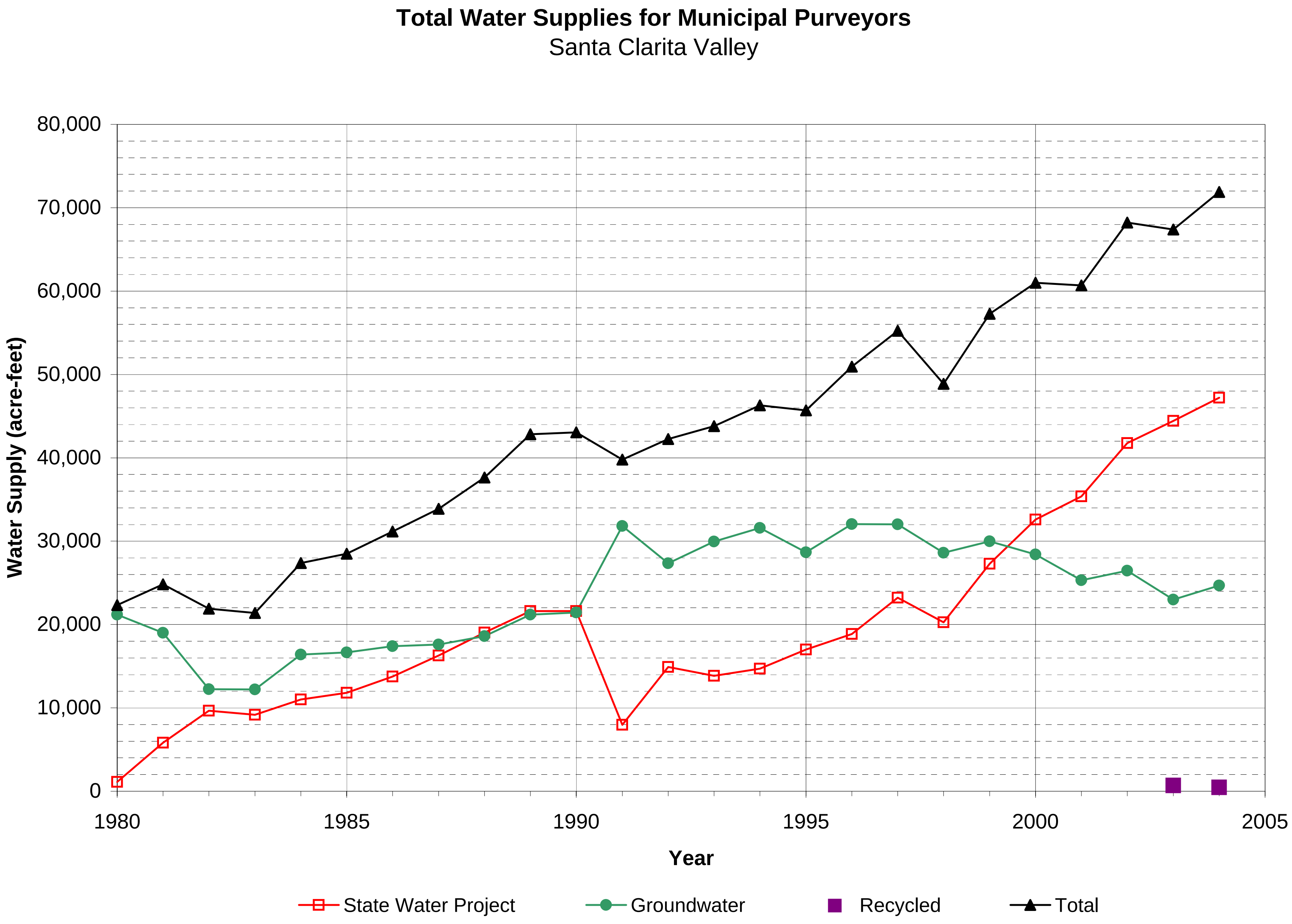
Total Water Supplies for Municipal Purveyors
Santa Clarita Valley
Water Supply (acre-feet)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1980
1985
1990
1995
2000
2005
Year
State Water Project
Groundwater
Recycled
Total

Figure II-1

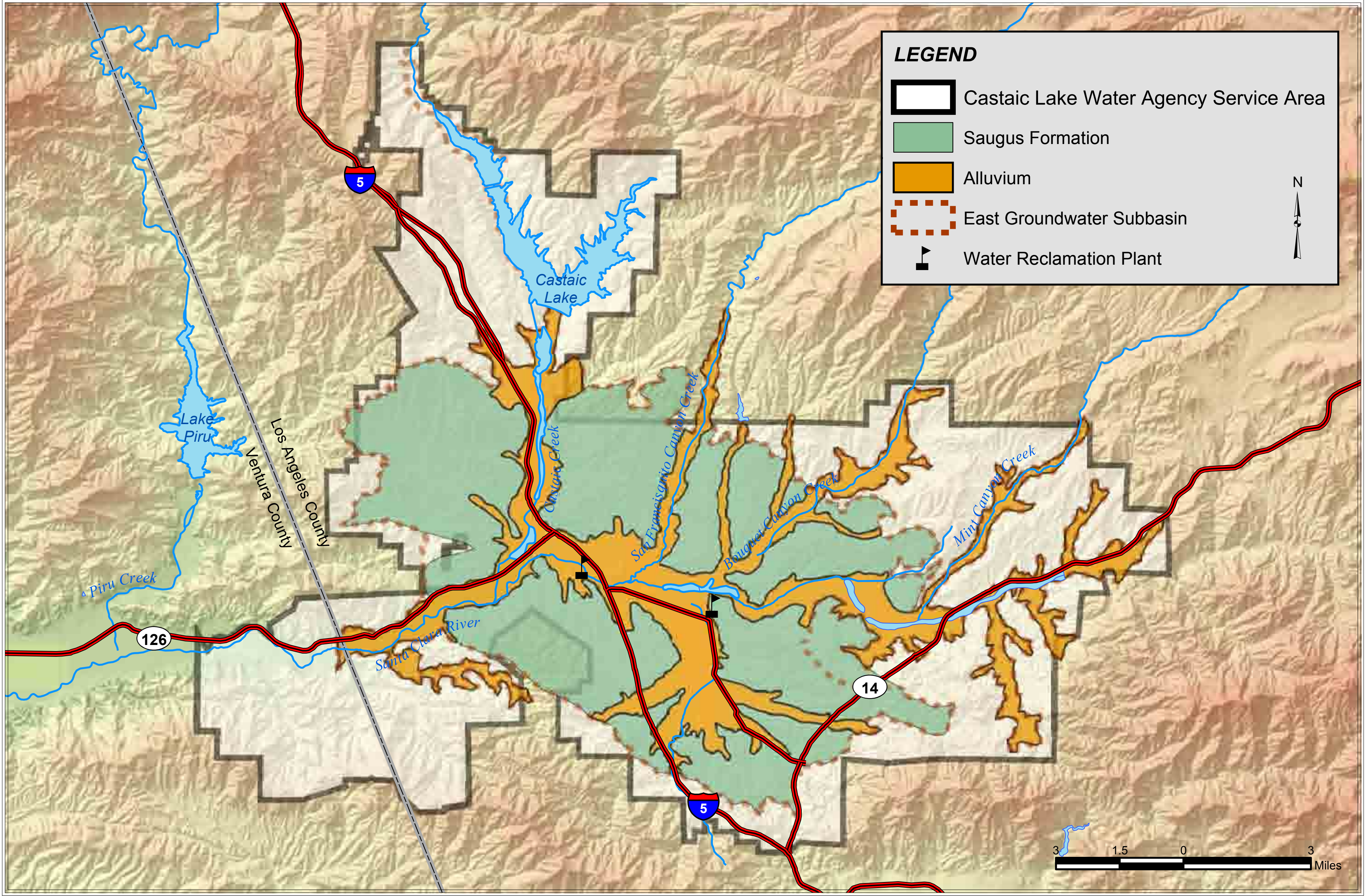

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Figure III-1
Alluvium and Saugus Formation
Santa Clara River Valley East Groundwater Subbasin

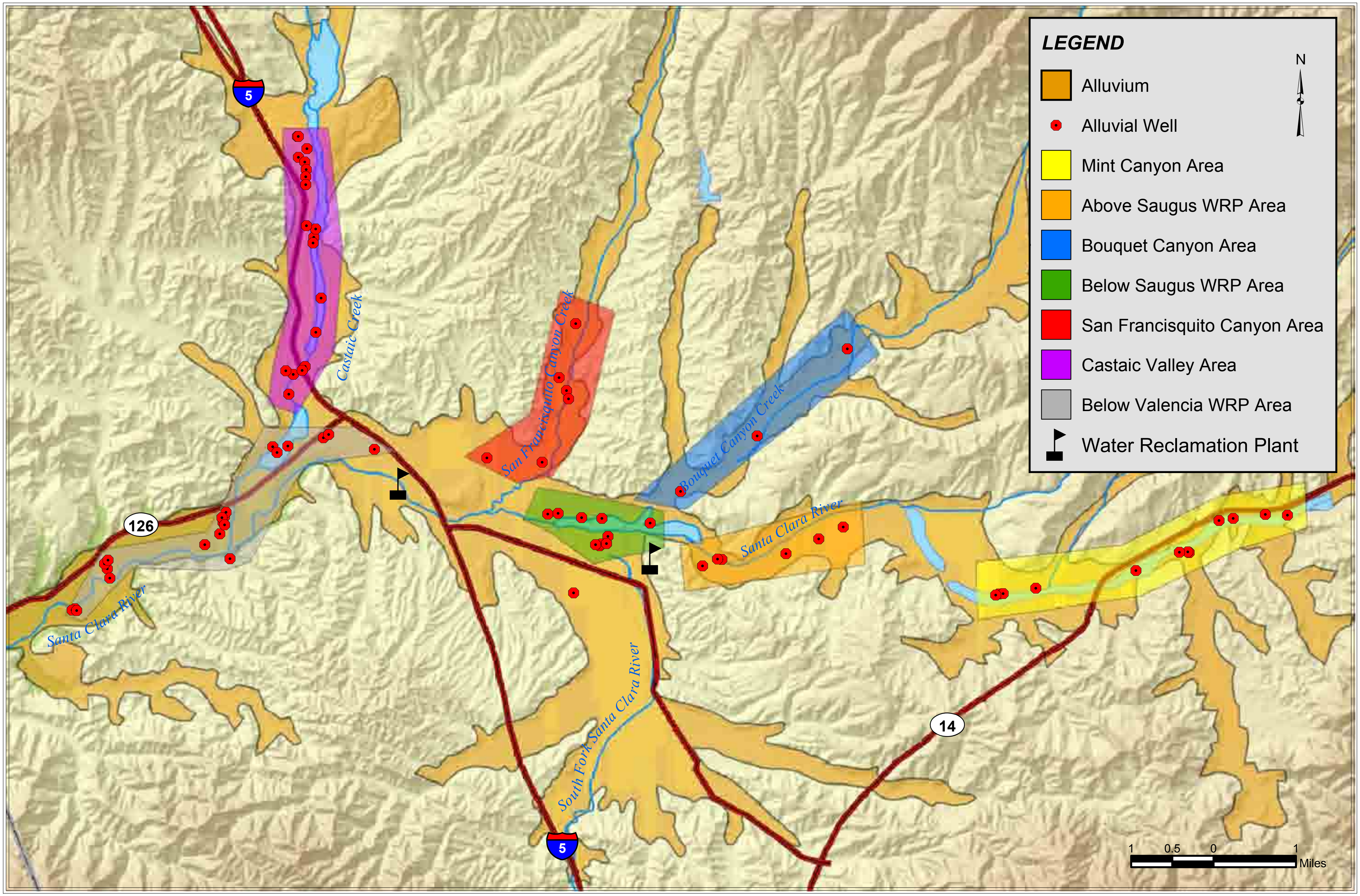

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Figure III-2
Alluvial Well Locations By Area
Santa Clara River Valley, East Groundwater Subbasin

Groundwater Production - Alluvium

Santa Clara River Valley, East Groundwater Subbasin

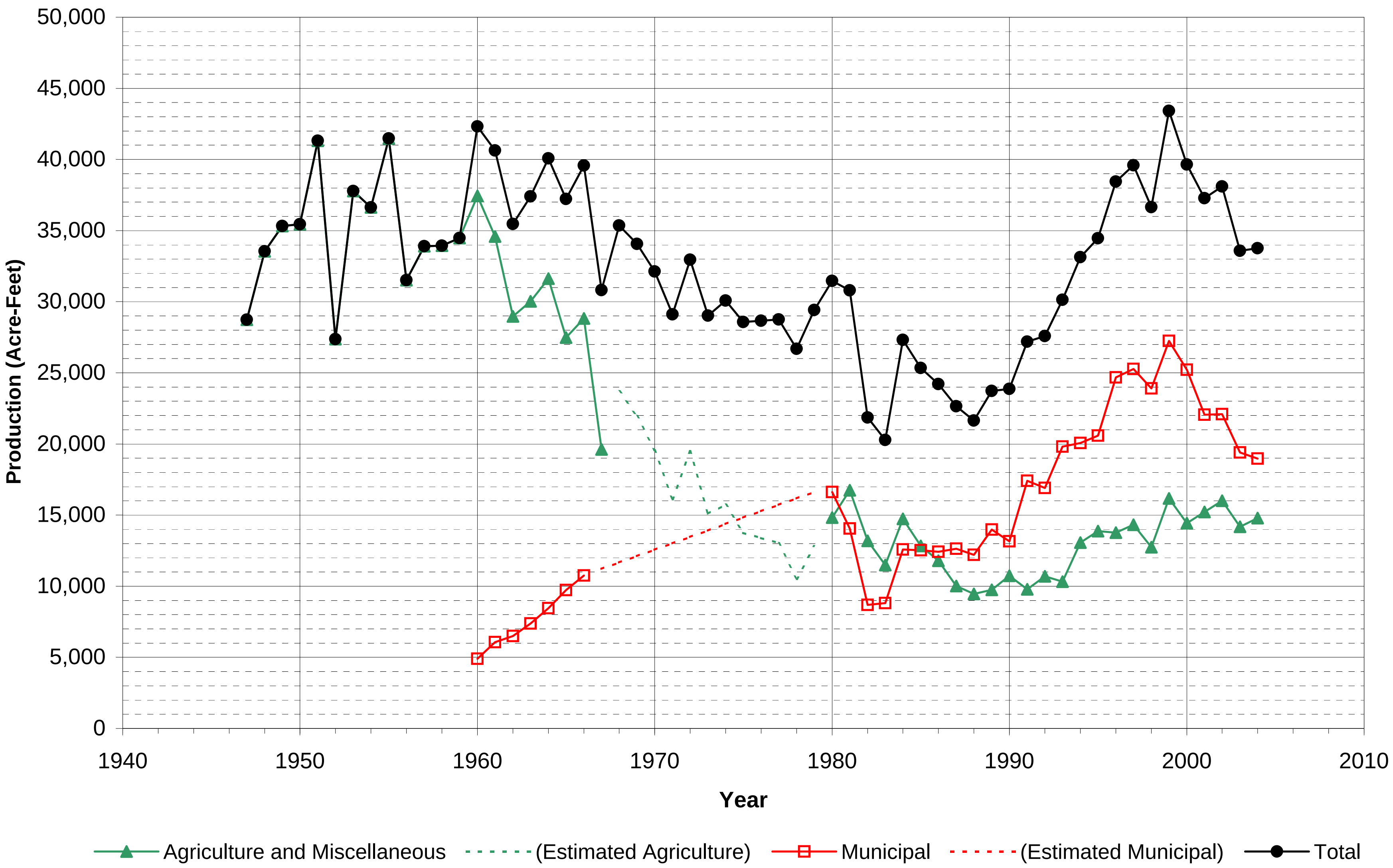
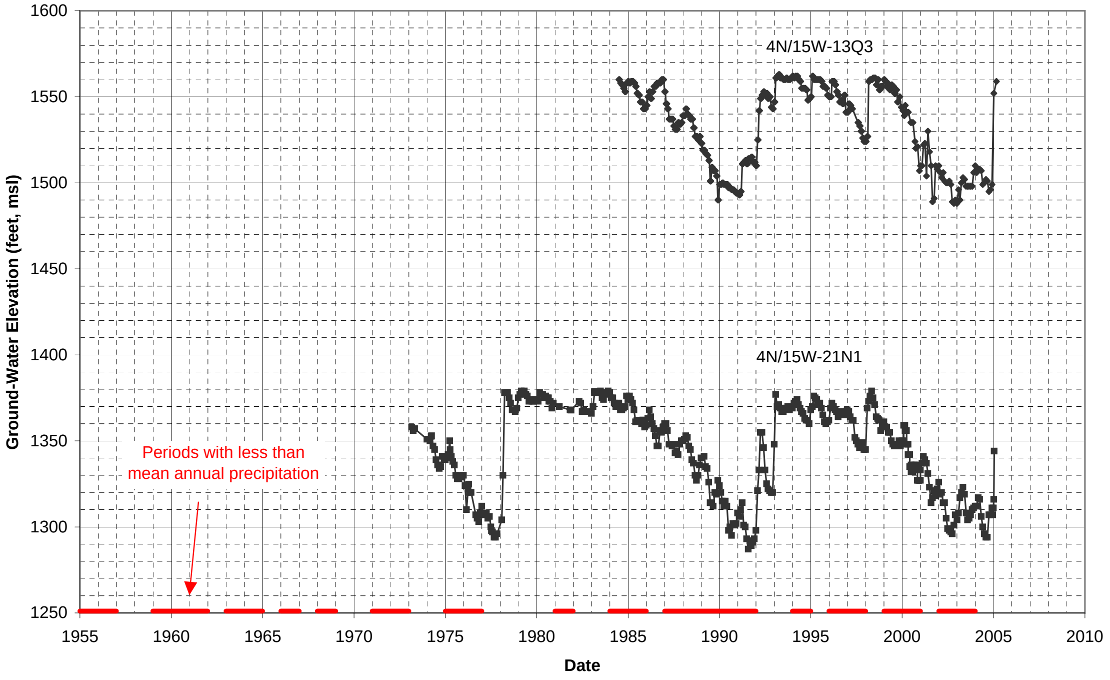


Figure III-3

Groundwater Elevation for 'Mint Canyon' Area Alluvial Wells
(lowest and highest for area shown)



Groundwater Elevation for 'Below Saugus WRP' Area Alluvial Wells
(lowest and highest for area shown)

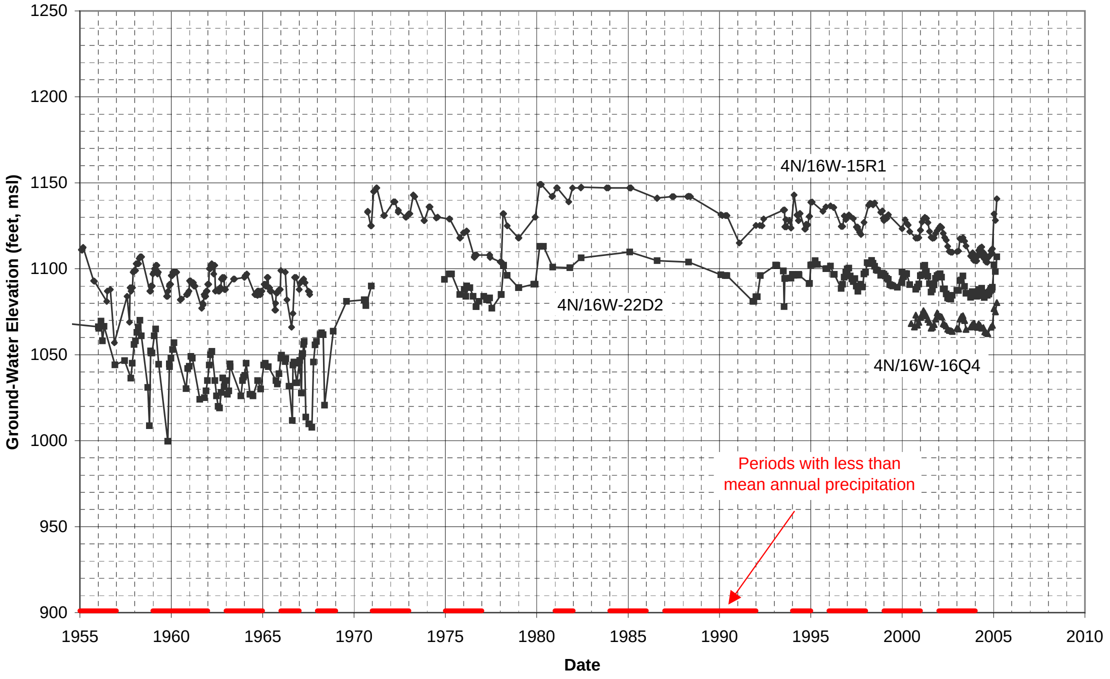
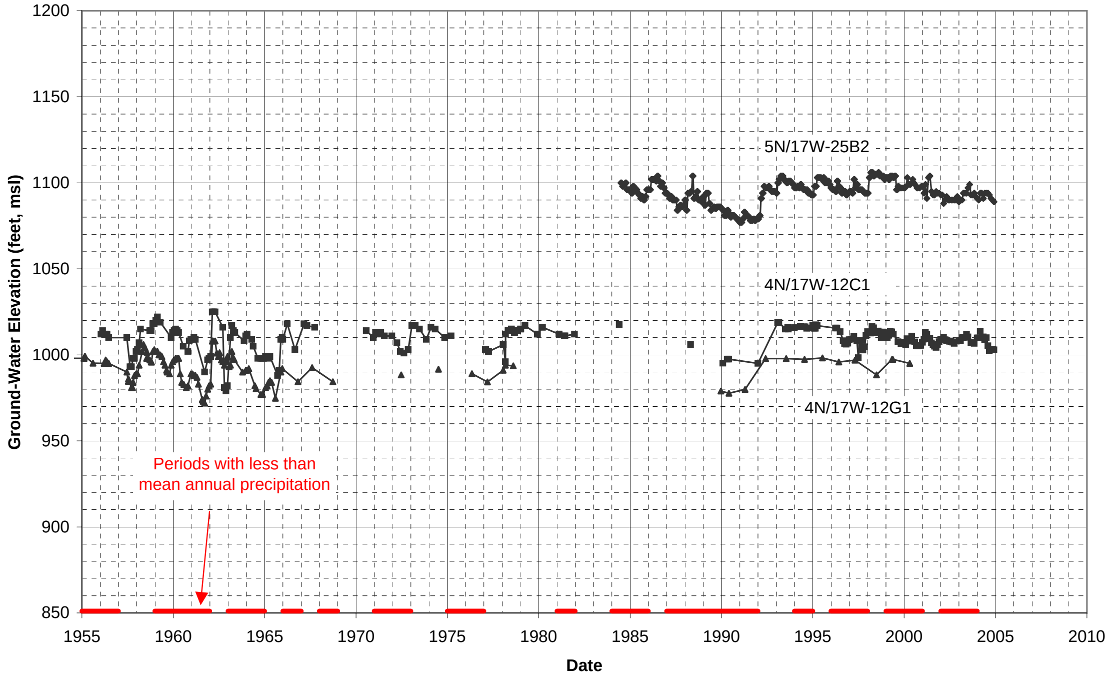


Figure III-4

Groundwater Elevation for 'Castaic Valley' Area Alluvial Wells
(lowest and highest for area shown)



Groundwater Elevation for 'Below Valencia WRP' Area Alluvial Wells
(lowest and highest for area shown)

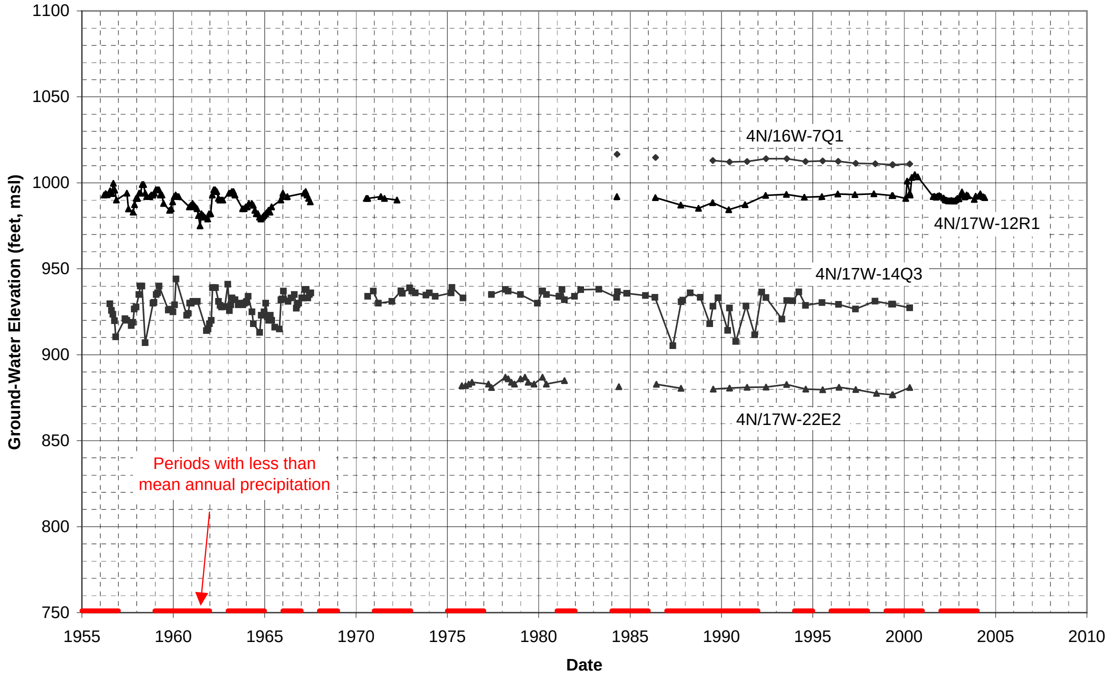


Figure III-5

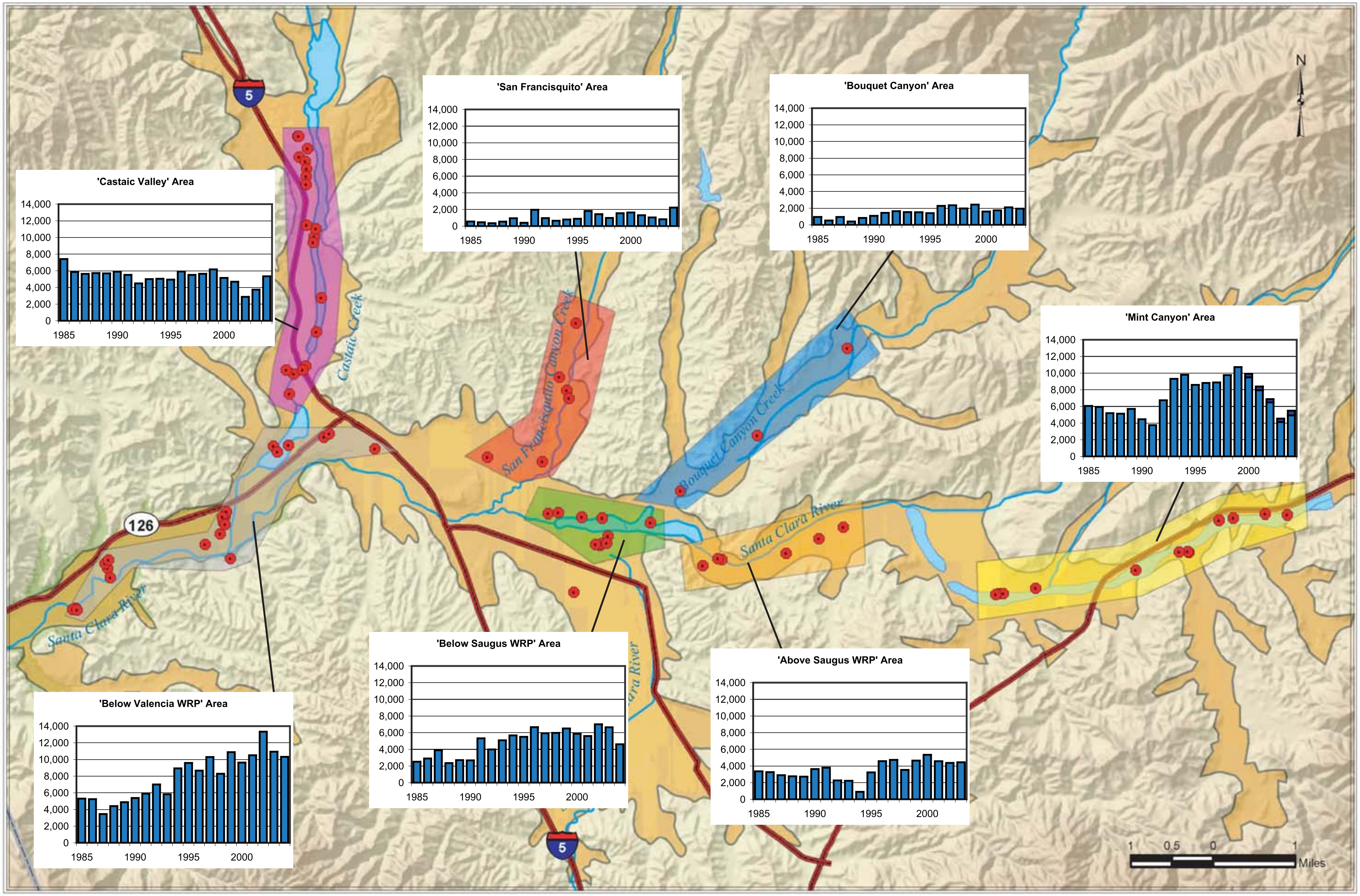


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Figure III-6
Annual Groundwater Production from Alluvium by Area (Acre-feet)
Santa Clara River Valley, East Groundwater Subbasin

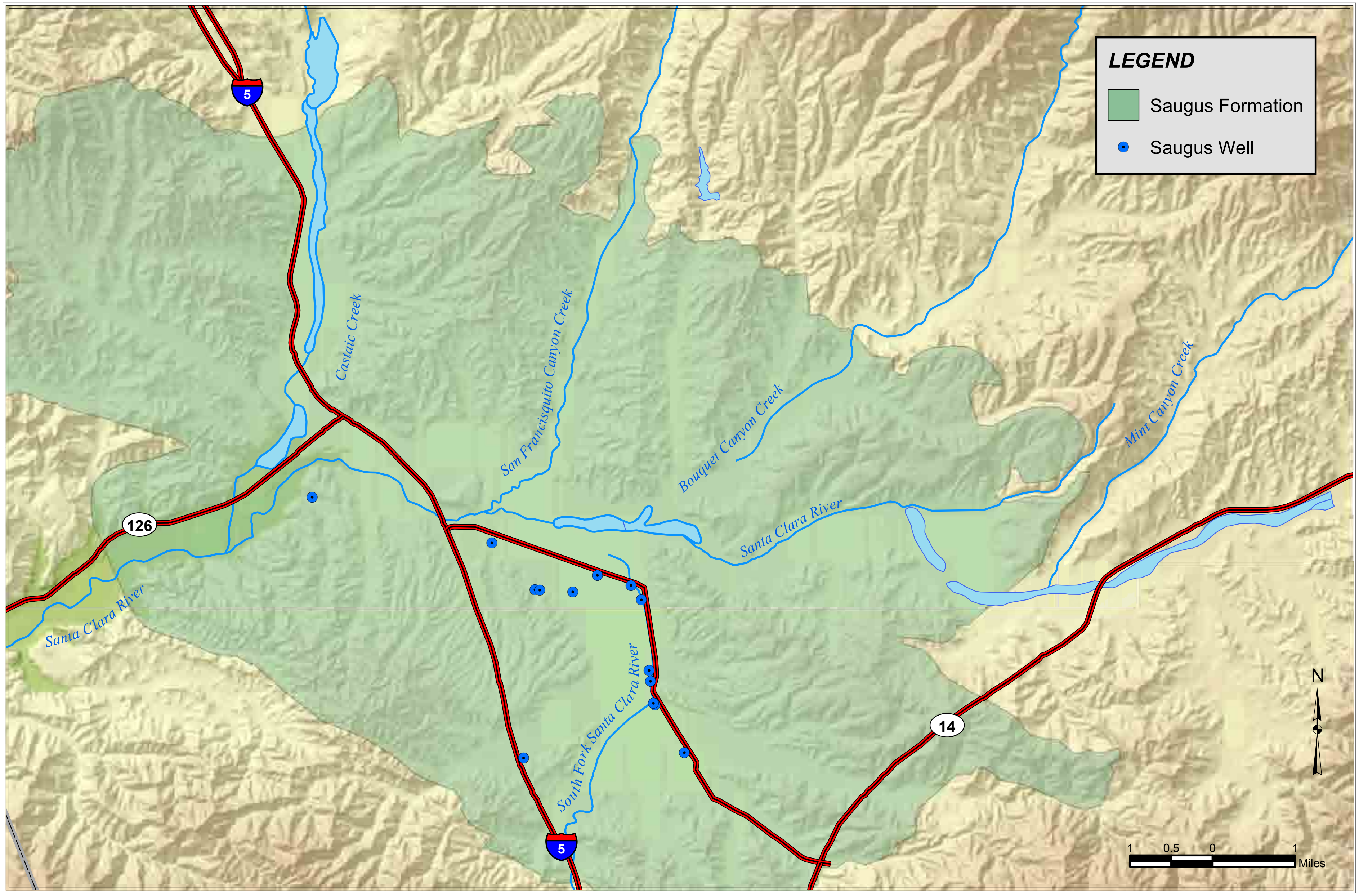

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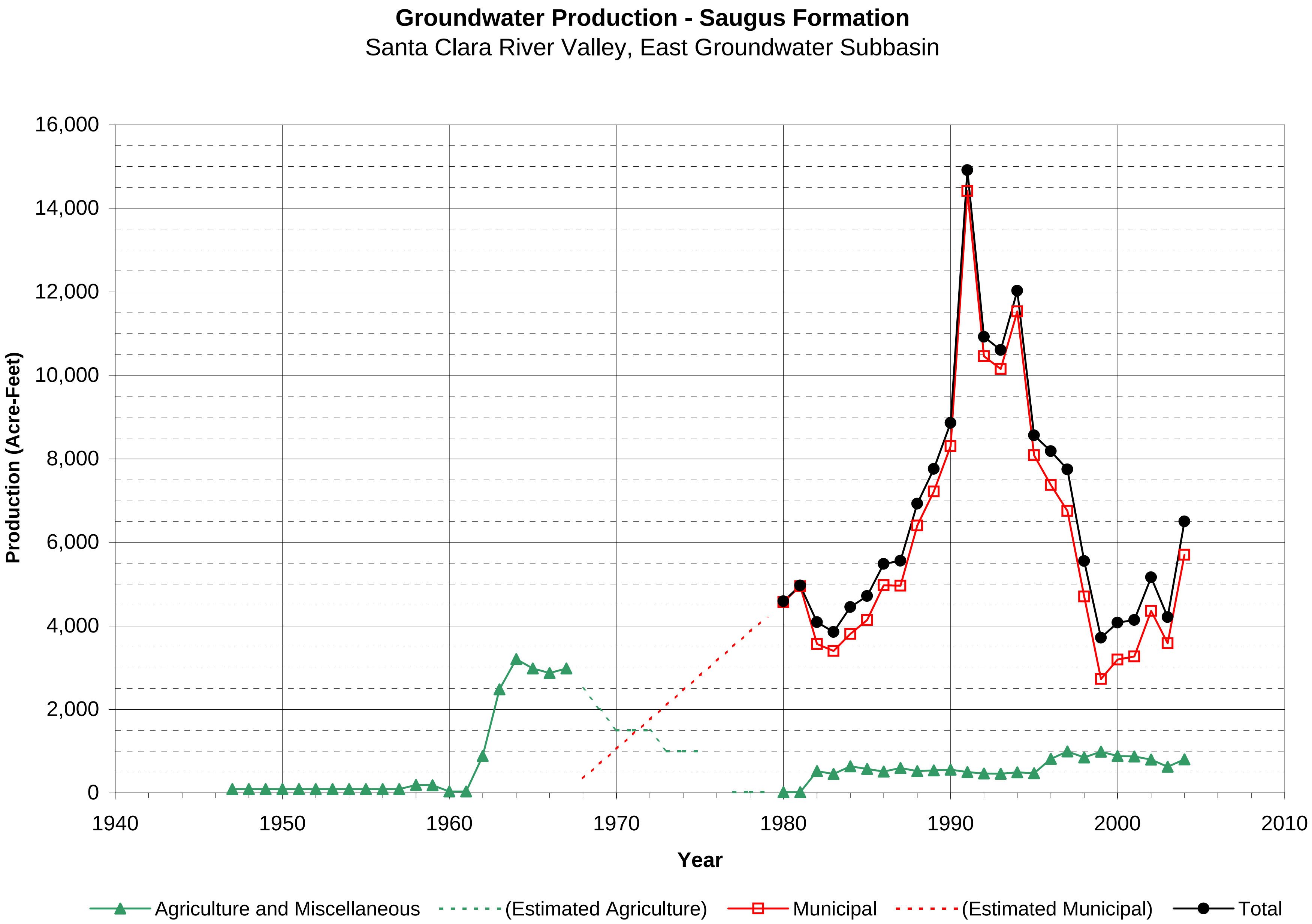
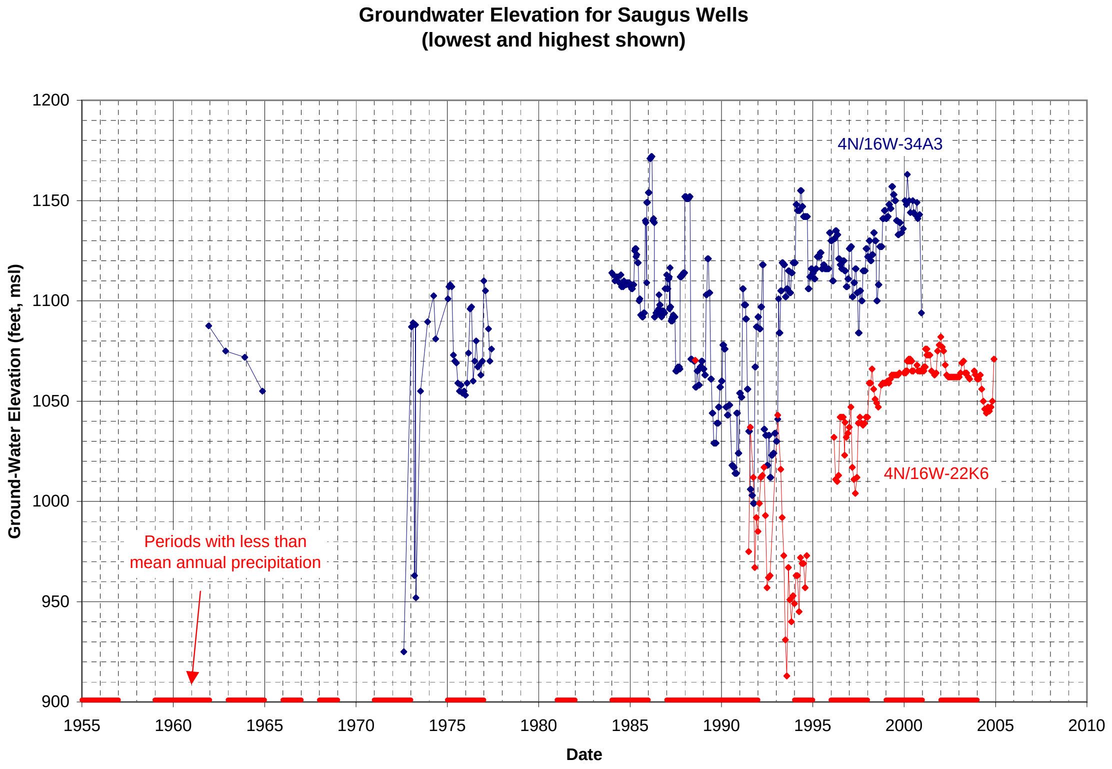
Figure III-7
Saugus Well Locations
Santa Clara River Valley, East Groundwater Subbasin

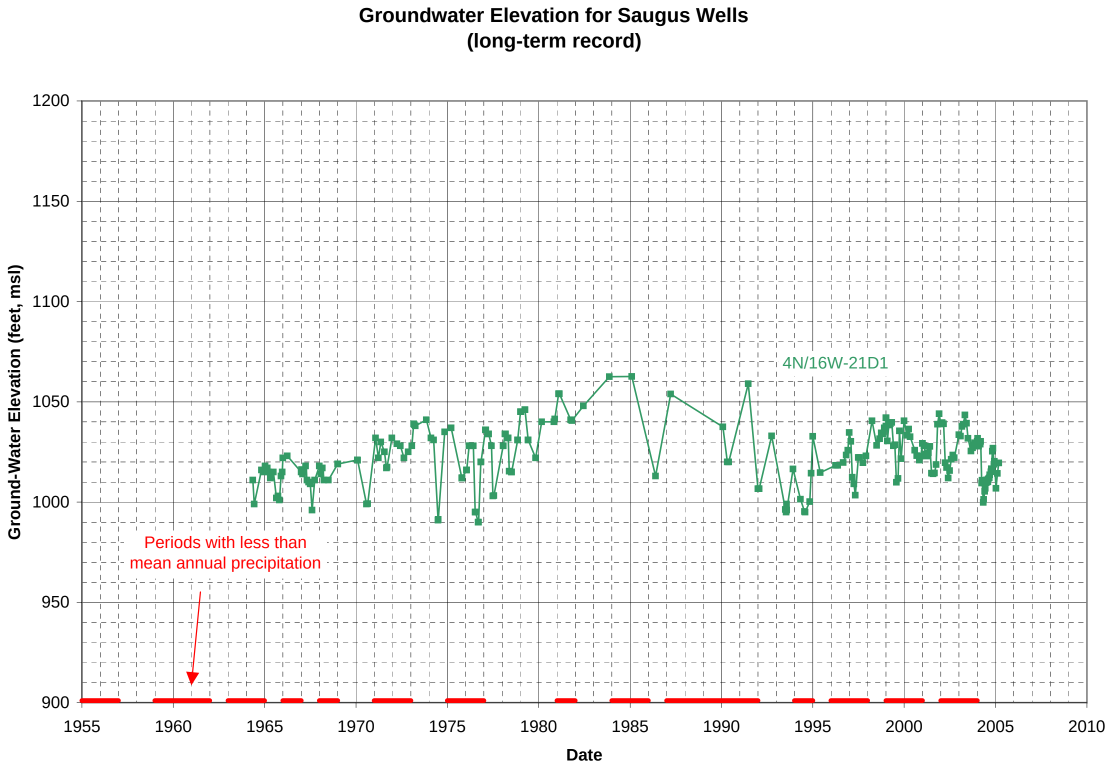


Groundwater Production - Saugus Formation
Santa Clara River Valley, East Groundwater Subbasin
Production (Acre-Feet)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1940
1950
1960
1970
1980
1990
2000
2010
Year
Agriculture and Miscellaneous
(Estimated Agriculture)
Municipal
(Estimated Municipal)
Total

Figure III-8



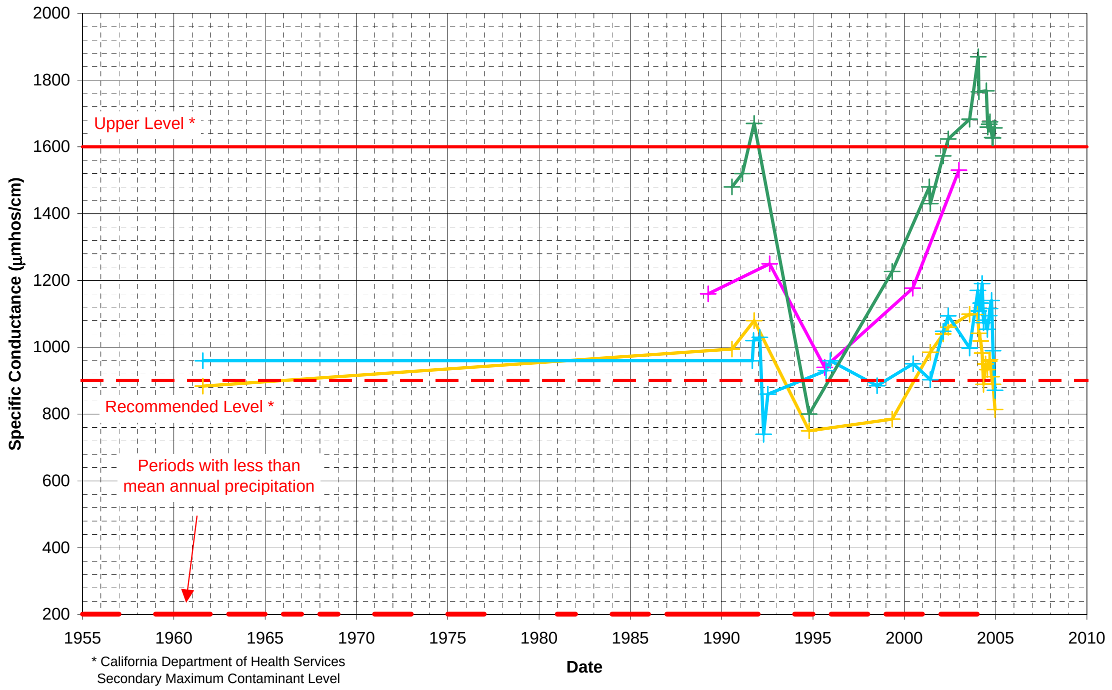
Groundwater Elevation for Saugus Wells
(lowest and highest shown)



Groundwater Elevation for Saugus Wells
(long-term record)

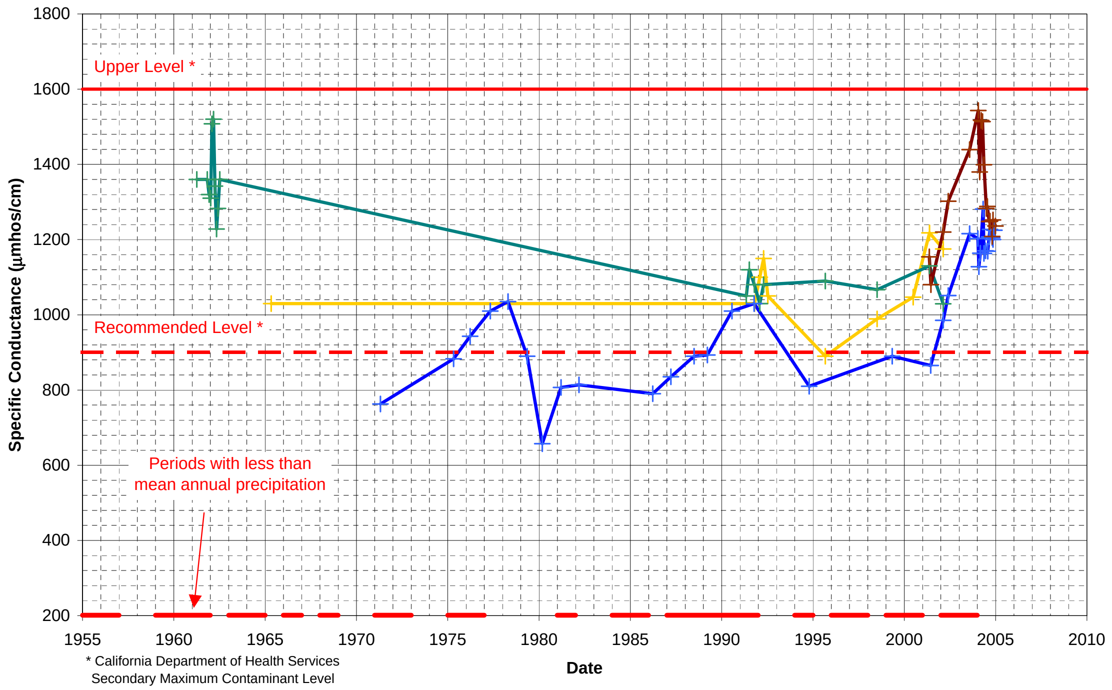
Figure III-9

Water Quality for 'Above Saugus WRP' Area Alluvial Wells
(representative selection for area shown)



* California Department of Health Services
Secondary Maximum Contaminant Level

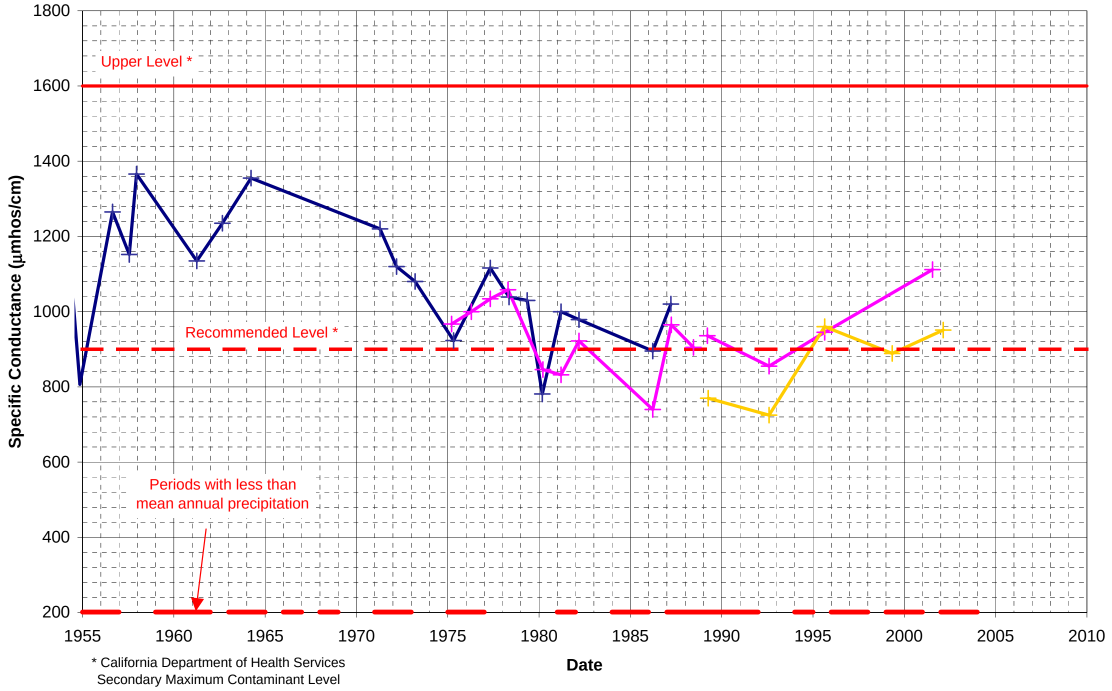
Water Quality for 'Below Saugus WRP' Area Alluvial Wells
(representative selection for area shown)



* California Department of Health Services
Secondary Maximum Contaminant Level

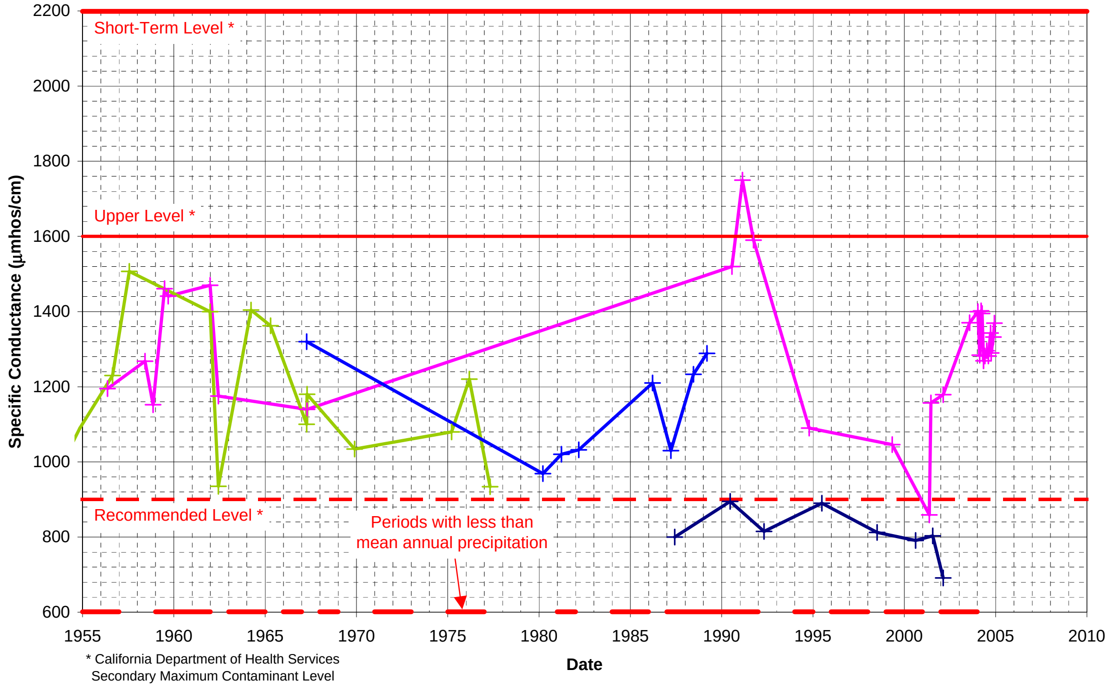
Figure III-10

Water Quality for 'Bouquet Canyon' Area Alluvial Wells
(representative selection for area shown)



* California Department of Health Services Secondary Maximum Contaminant Level

Water Quality for 'Castaic Creek' Area Alluvial Wells
(representative selection for area shown)



* California Department of Health Services Secondary Maximum Contaminant Level

Figure III-11

Water Quality for Saugus Wells
(representative selection shown)

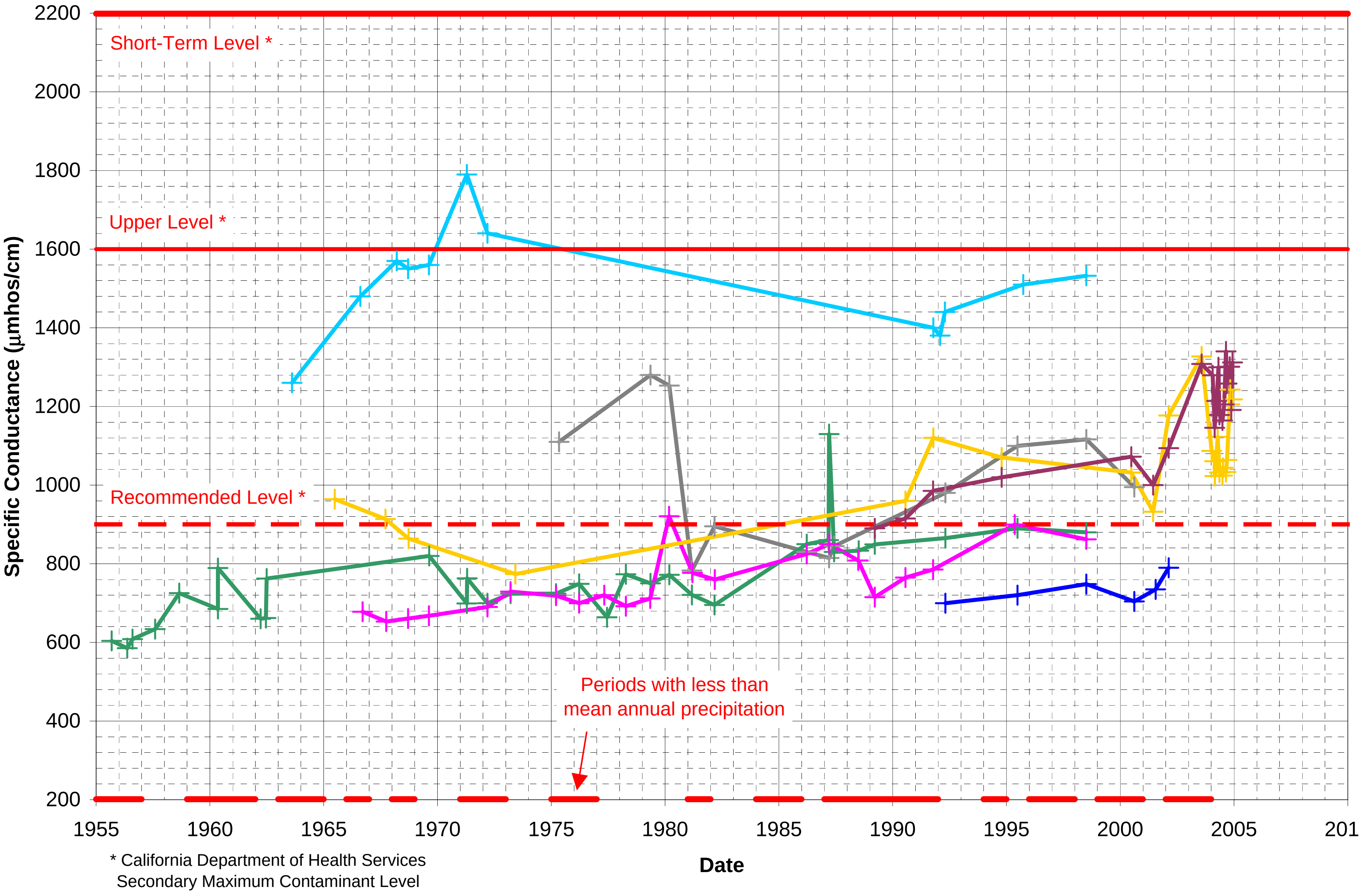
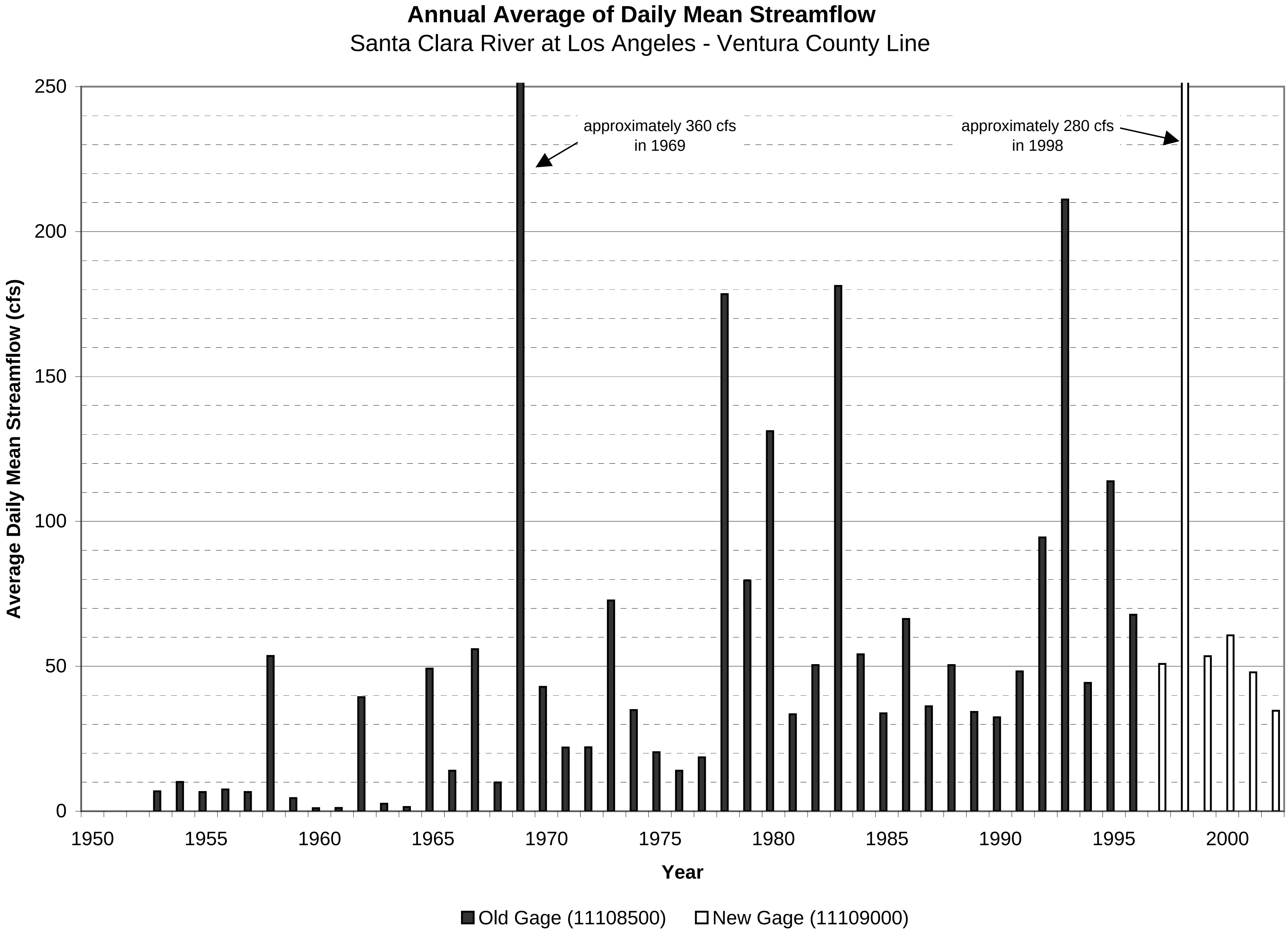


Figure III-12



Annual Average of Daily Mean Streamflow

Santa Clara River at Los Angeles - Ventura County Line

Figure III-13

Historical and Projected Water Use
Santa Clarita Valley

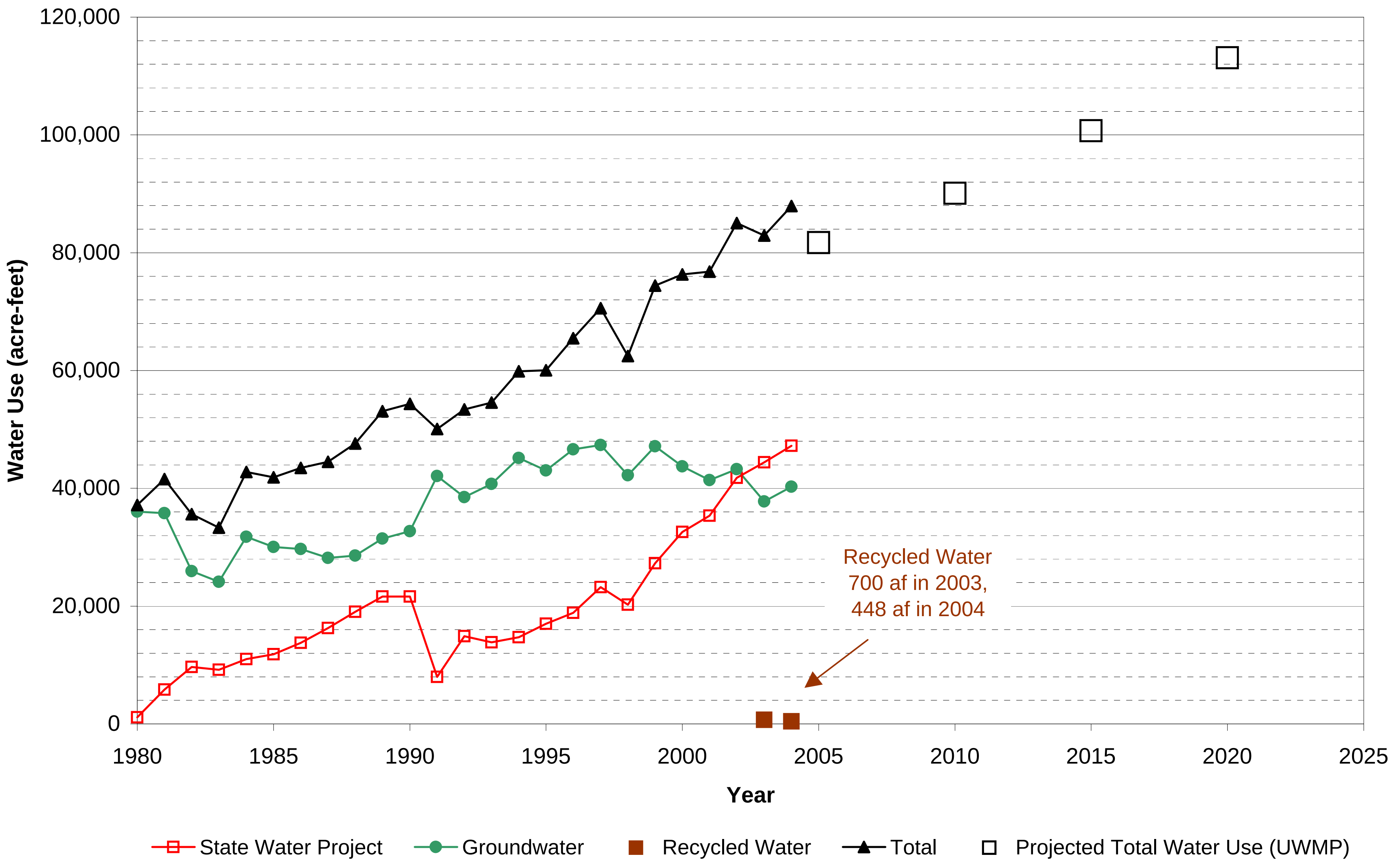


Figure IV-1

2005
Santa Clarita Valley Water Report

Castaic Lake Water Agency (CLWA)
CLWA Santa Clarita Water Division
Los Angeles County Waterworks District 36
Newhall County Water District
Valencia Water Company

April, 2006

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

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(all figures follow their respective sections)

Tables

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Executive Summary

This annual report, which is the eighth in a series that began in 1998, provides current information about the water requirements and water supplies of the Santa Clarita Valley. The report was prepared for Castaic Lake Water Agency (CLWA) and its Santa Clarita Water Division, Los Angeles County Waterworks District 36, Newhall County Water District, and Valencia Water Company.

The Santa Clarita Valley is served by four local retail water Purveyors: Castaic Lake Water Agency's Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LA36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). The CLWA provides water from California's State Water Project (SWP) to the water Purveyors for distribution. Management from these entities and representatives from the City of Santa Clarita and the County of Los Angeles meet as required to coordinate the management of imported SWP water with local groundwater, now augmented by recycled water, to meet water requirements in the Valley.

This report provides information about local groundwater resources, SWP water supplies, water conservation, and recycled water. The report reviews the sufficiency and reliability of supplies in the context of existing water demand, with focus on actual conditions in 2005, and it provides a short-term outlook of water supply and demand for 2006.

In 2005, total water demands in the Santa Clarita Valley were about 83,600 acre-feet (af), of which about 85 percent (70,800 af) was for municipal use and the remainder (12,800 af) was for agricultural and other (miscellaneous) uses, including individual domestic uses. Total demand in 2005 was about five percent lower than in 2004, and about nine percent lower than had been estimated in the previous Water Report, all attributable to the significantly wet conditions that prevailed through winter and spring in the Valley. These total water demands were met by a combination of about 45,100 af from local groundwater resources (nearly 32,300 af for municipal and about 12,800 af for agricultural and other uses), about 38,000 af of SWP water, and about 450 af of recycled water.

Of the 45,100 af of total groundwater pumpage in the Valley in 2005, about 38,700 af were pumped from the Alluvium and slightly less than 6,500 af were pumped from the underlying, deeper Saugus Formation. Alluvial pumpage represented about a 5,000 af increase from 2004, and Saugus pumpage was essentially unchanged from 2004. Neither pumping volume resulted in any overall change in ongoing groundwater conditions (water levels, water quality, etc.) in either aquifer system. SWP deliveries to the Purveyors decreased by about 9,000 af from the previous year, again primarily as a result of decreased water demand due to significantly wet conditions in the early part of the year. Water uses and supplies in 2005 are summarized in the following Table ES-1.

Table ES-1
Santa Clarita Valley
Summary of 2005 Water Supplies and Uses
(acre-feet)

Municipal		
State Water Project		38,034
Groundwater (Total)		32,316
Alluvium	*26,368*	
Saugus	*5,948*	
Recycled Water		438
Subtotal		**70,788**
Agriculture/Miscellaneous		
State Water Project		-
Groundwater (Total)		12,785
Alluvium	*12,280*	
Saugus	*505*	
Subtotal		**12,785**
Total		***83,573***

In accordance with the California Urban Water Management Planning Act, the Valley-wide UWMP was updated in 2005 to extend projected water demands through 2030, and to describe the combination of local groundwater, imported water supplies from the State Water Project, local recycled water supplies, and planned other water supplies to meet the existing and projected water demands in the Valley. The 2005 UWMP describes the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand, including consideration of the impacts of perchlorate contamination on several municipal water supply wells. The 2005 UWMP also describes the plans and ongoing work for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply.

Notable details about each component of water supply in the Valley, and about the water supply outlook for 2006, include the following.

ES.1 Alluvial Aquifer

The groundwater operating plan in the UWMP includes Alluvial pumpage in the range of 30,000 to 40,000 acre-feet per year (afy) in average/normal years, and slightly reduced pumpage (30,000 to 35,000 afy) in dry years. Pumpage from the Alluvium was 38,700 af in 2005, and remained in the overall UWMP range as it has over the last ten years.

On a long-term basis, there is no evidence of any historic or recent trend toward permanent water level or storage decline. In general, throughout a large part of the basin, Alluvial groundwater levels have generally remained near historic highs during the last 30 years. Higher than average precipitation in late 2004 and 2005 resulted in significant water level recovery in the eastern part of the basin, continuing the overall trend of fluctuating groundwater levels within a generally constant range over the last 30 years. These ongoing data indicate that the Alluvium remains in good operating condition and can continue to support pumpage in the range included in the UWMP, as has been the case for the last decade, without adverse results (e.g., long-term water level decline or degradation of groundwater quality.)

Based on an integration of water quality records from multiple wells completed in the Alluvium, there have been historical fluctuations in groundwater quality, typically associated with variations in precipitation and streamflow. However, like groundwater levels, there has been no long-term trend toward groundwater quality degradation; groundwater produced from the Alluvial aquifer remains a viable municipal and agricultural water supply.

In 2002, as part of ongoing monitoring of wells for perchlorate contamination, perchlorate was detected in one Alluvial well located near the former Whittaker-Bermite facility. The detected concentration was slightly below the Notification Level for perchlorate (6 ug/l), and the well has been inactivated for municipal water supply since the detection of perchlorate. In early 2005, perchlorate was detected in a second Alluvial well, VWC's Well Q2. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. Valencia's response plan for Well Q2 was to pursue permitting and installation of wellhead treatment by the fall of 2005, all of which was successfully completed with the return of the well to water supply service in October 2005. All other Alluvial wells operated by the Purveyors continue to be used for municipal water supply service; those wells near the Whittaker-Bermite property are routinely sampled and perchlorate has not been detected. As detailed in the 2005 UWMP and the Q2 Report, the inactivation of either of the Alluvial wells due to perchlorate contamination does not limit the Purveyors' ability to produce groundwater from the Alluvium in accordance with the groundwater operating plan in the UWMP.

The ongoing characterization and plan for control and cleanup of perchlorate in the Valley has focused on the Saugus Formation. In addition, however, on-site cleanup and control activities also extended to the initiation of soil cleanup on one part of the Whittaker-Bermite site, and the initiation of pump and treatment action in the Northern Alluvium.

ES.2 Saugus Formation

The groundwater operating plan in the UWMP includes pumping from the Saugus in the range of 7,500 to 15,000 afy in average/normal years; it also includes planned dry-year pumping from the Saugus of 21,000 to 35,000 afy for one to three consecutive dry years. The UWMP recognizes that such short-term pumping can be recharged during subsequent wet/normal years to allow groundwater levels and storage to recover, as it has in historical periods.

Pumpage from the Saugus Formation was slightly less than 6,500 af in 2005; on average, Saugus pumpage has been about 7,000 afy since 1980. Both rates are near the lower end of the range included in the UWMP. As a result of long-term relatively low pumpage from the Saugus Formation, groundwater levels in that aquifer have remained essentially constant over the last 35 to 40 years; that trend continued in 2005.

In 1997, ammonium perchlorate was discovered in four wells completed in the Saugus Formation in the vicinity of the former Whittaker-Bermite facility located generally toward the east, on the south side of the basin. All four of those impacted wells remain out of active supply service. All other Saugus wells owned and operated by the Purveyors are available for municipal water supply service. As part of regular operation, those wells are sampled on a routine basis and perchlorate has not been detected. Despite the inactivated Saugus wells, the Purveyors still have sufficient pumping capacity in other wells to meet the planned normal range of Saugus pumping in the UWMP.

Work toward the ultimate remediation of perchlorate contamination, including the restoration of impacted groundwater supply continued to progress in 2005, with focus on permitting of a jointly developed plan "pump and treat" contaminated water from two wells to stop migration of the contaminant plume, and to deliver treated water to partially replace impacted well capacity. Environmental review of the project was completed with adoption of a Mitigated Negative Declaration in September. The Final Interim Remedial Action Plan was completed and approved by the State Department of Toxic Substances Control in December. Construction of facilities and pipelines necessary to implement the pump and treat program and to also restore inactivated well capacity is anticipated to commence in the fall of 2006.

ES.3 Imported Water

CLWA's contractual Table A Amount is 95,200 af of water from the SWP. CLWA operates two water filtration plants and has a current total treatment capacity of 86 million gallons per day of capacity where the water is treated, filtered, and disinfected prior to being delivered to Purveyors for distribution. Included in the total CLWA treatment plant capacity is the expansion of its Earl Schmidt Filtration Plant, which was completed in 2005 and added 22.5 mgd of capacity.

CLWA's final allocation of Table A for 2005 was 90 percent, or 85,680 af. On December 1, 2004, the initial allocation for 2005 was announced as 40 percent. On May 27, 2005, it was raised to the final allocation of 90 percent. Utilizing SWP contract provisions, CLWA elected to "carry over" unused remaining Table A Amount into 2006.

The total available SWP supply in 2005 was 88,382 af, including 2,702 af of 2004 carryover delivered in early 2005. CLWA deliveries were 38,034 af to the Purveyors and 20,000 af to the Rosedale-Rio Bravo Water Storage District's Storage and Recovery Program, with 31,377 af of the 2005 Table A Amount for potential carryover to 2006.

CLWA has two groundwater banking agreements with the Semitropic Water Storage District in Kern County. In accordance with those agreements, over a ten-year period (until 2012/13), CLWA can withdraw up to 50,870 af of water that it stored in 2002 and 2003 to meet Valley demands when needed. In addition to the banking in Semitropic, CLWA finalized an agreement with the Rosedale-Rio Bravo Water Storage District in 2005, and banked 20,000 af of surplus Table A Amount in Rosedale-Rio Bravo's Water Storage and Recovery Program in 2005. In accordance with the provisions of that agreement, CLWA can withdraw up to 17,800 of that water to meet Valley water demands when needed.

Since SWP water deliveries are subject to reduction when dry conditions occur in Northern California, the UWMP includes programs, like the Semitropic and Rosedale-Rio Bravo programs, for enhancing water supply reliability during such occurrences. A capital improvement program funded by CLWA has been established to provide facilities and additional water supplies needed to firm up SWP water supplies during times of drought.

ES.4 Recycled Water

Recycled water service was initiated in July 2003 in accordance with CLWA's Draft Reclaimed Water System Master Plan (2002). The amount of recycled water used for irrigation purposes, at a golf course and in roadway median strips, was approximately 450 af in 2005.

ES.5 Water Supply Outlook

In 2006, total water demands are expected to be about 91,500 af, consistent with the growth rate and related water demand projections in the UWMP. It is expected that water demands in 2006 will continue to be met with a generally similar mix of water supplies comprised of imported SWP water, local groundwater, and recycled water.

As of March 23, 2006, the allocation of water from the SWP is 80 percent of CLWA's Table A Amount, representing 76,160 af. Combined with local groundwater from the two aquifer systems (42,500 af), total Flexible Storage Account (6,060 af), net carryover SWP water from 2005 (3,718 af), and recycled water (500 af), the total available water supplies for 2006 are nearly 129,000 af. As a result, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2006.

In any given year, SWP supplies may be reduced due to dry weather conditions or regulatory factors. During such an occurrence, the remaining water demands are planned to be met by a combination of alternate supplies such as returning water from CLWA's accounts in the Semitropic Groundwater Storage Program and the Rosedale-Rio Bravo Water Storage District's Banking Program, deliveries from CLWA's flexible storage account in Castaic Lake Reservoir, local groundwater pumping, short-term water exchanges, and participation in DWR dry-year water purchase programs in accordance with the Urban Water Management Plan. Due to the banking of excess 2002 and 2003 SWP water in the Semitropic Groundwater Storage Program, and banking CLWA can draw upon its account as needed, pursuant to the terms of the banking agreements. The banked excess 2002 and 2003 SWP water in Semitropic now represents nearly 51,000 af of recoverable water for drought water supply, and the banked excess 2005 SWP water in Rosedale-Rio Bravo now represents an additional 17,800 af of recoverable water for drought water supply.

Drought periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and the reverse situation can also occur (as it did in 2002 and 2003). For this reason, CLWA and the Purveyors have emphasized developing water supplies that add diversity in water supply options, especially in dry years. Diversity of supply is considered a key element of reliability, giving Valley water Purveyors the ability to draw on multiple sources of supply during dry year conditions and thereby making the Purveyors less dependent upon direct deliveries from the SWP water supplies.

I. Introduction

1.1 Background

For most residents of the Santa Clarita Valley (Valley), domestic water service is provided by four retail water Purveyors. They are the Castaic Lake Water Agency Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LA36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). Together, the Purveyors provide water to approximately 66,000 service connections. Castaic Lake Water Agency (CLWA) contracts for State Water Project water from Castaic Lake where it is treated, filtered, and disinfected at two treatment plants before distribution to the Purveyors. The staff of these entities meet regularly to coordinate the supply of water in the Valley. Their respective service areas are shown in Figure I-1.

Water supply for a small percentage of Valley residents is provided by individual private water supply wells. The locations, construction details, annual pumpage and other information about these private wells are not currently available. CLWA is currently working with private well owners to receive information about their wells for incorporation in future reports and for planning purposes. Pumping as reported herein includes an estimate of groundwater pumped from private wells; it is expected that this estimate will be refined in future reports as more information about the private wells is obtained.

In addition to municipal and individual private water uses in the Valley, there remains an agricultural water demand that is predominately dependent on local groundwater for its water supply. Accordingly, ongoing agricultural water requirements and the use of local groundwater to meet those requirements are considered in analyses and reports on water supplies such as this report.

Over the years, CLWA and the Purveyors have reviewed and documented the availability of water supplies to meet all water requirements in the Valley. Those reports have also addressed the status of water resources in the region. Past studies have assessed the condition of the local groundwater aquifers, their hydrogeologic character, aquifer storage capacity, operational yield and recharge rate, groundwater quality and contamination, and the potential for conjunctive use of groundwater and imported water resources.

Other efforts have included developing drought contingency plans, evaluating the impact of landfills on the groundwater basin, coordinating emergency response procedures and implementing Valley-wide conservation programs. In 1985, the Purveyors prepared the area's first Urban Water Management Plan (UWMP.) Information in the plan had been coordinated among CLWA and the Purveyors to provide accurate, comprehensive and consistent water supply and demand information for long term planning purposes. In accordance with the California Urban Water Management Planning Act, the Valley-wide UWMP was updated in 2005 to extend projected water demands through 2030, and to describe the combination of local groundwater, imported water supplies from the State Water Project, local recycled water supplies, and planned other water supplies to meet the existing and projected water demands in the Valley. The 2005 UWMP describes the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand, including consideration of the impacts of perchlorate contamination on several municipal water supply wells. The 2005 UWMP also describes the plans and ongoing work for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply.[1]

1.2 Purpose and Scope of the Report

The purpose of this report, which is the eighth in a series of annual water reports that began in 1998, is to provide current information about the available water supplies and demands of the Santa Clarita Valley. CLWA and the Purveyors have prepared this series of reports in response to a request made by the Los Angeles County Board of Supervisors in 1998. This report was prepared for Castaic Lake Water Agency (CLWA) and its Santa Clarita Water Division, for Los Angeles County Waterworks District 36, for Newhall County Water District, and for Valencia Water Company. It continues a format for providing information regarding water uses and the availability of water supplies on an annual basis. It is intended to be a helpful resource for use by water planners and local planning agencies. This report is complemented by the more detailed UWMP for the area, which provides longer-term water supply planning over a 25-year period.

1.3 Santa Clarita Valley Water Purveyors

As introduced above, four retail water Purveyors provide water service to most residents of the Santa Clarita Valley. Brief summary descriptions of those four Purveyors are as follows.

Castaic Lake Water Agency Santa Clarita Water Division has a service area that includes a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Saugus, Canyon Country, and Newhall. Water is supplied from both groundwater and CLWA turnouts to nearly 27,000 service connections.

Los Angeles County Waterworks District 36 has a service area that encompasses approximately 7,635 acres in the Hasley Canyon area and the unincorporated community of Val Verde. LACWWD 36 has 1,320 service connections. The District has traditionally obtained its full water supply from a connection to the CLWA's Castaic Conduit. In 2005, as it had in 2004, the District supplemented its surface water supply with groundwater purchased from the Los Angeles County Peter J. Pitchess Detention Center.

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[1] The 2005 UWMP was challenged in a lawsuit filed in early 2006 by the California Water Impact Network and the Friends of the Santa Clara River, ultimately seeking a mandate that the approval of the UWMP by CLWA and the Purveyors be invalidated. Allegations in the lawsuit include claims that the 2005 UWMP ignored or failed to adequately address cumulative impacts of urbanization on groundwater recharge and on habitat; the impacts of private well use, a number of water quality issues, the timely remediation of perchlorate contamination, and the inability to utilize existing groundwater for Newhall Ranch water supply. Additional allegations include an overstatement of surface water reliability from the State Water Project, uncertainty of 41,000 af of CLWA's SWP Table A Amount, erroneous reliance on 24,000 af of banked groundwater, erroneous reliance on "paper water" in DWR's SWP Delivery Reliability Report, and failure to address known, foreseeable declines in SWP deliveries due to global warming. The 2005 UWMP remains valid unless affected by a future judgment or order of the court. The Purveyors believe the lawsuit is without merit, and will vigorously defend the plan in court.

Newhall County Water District's service area includes portions of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Newhall, Canyon Country, Saugus, and Castaic. NCWD supplies water from both groundwater and CLWA turnouts to approximately 9,200 service connections.

Valencia Water Company's service area serves about 28,800 service connections in a portion of the City of Santa Clarita and in the unincorporated communities of Castaic, Newhall, Saugus, Stevenson Ranch, and Valencia. VWC supplies water from both groundwater and CLWA turnouts; VWC also delivers recycled water for some non-potable uses.

1.4 The Upper Santa Clara River Hydrologic Area

The Upper Santa Clara River Hydrologic Area (HA), as defined by the California Department of Water Resources (DWR), is located almost entirely in northwestern Los Angeles County (Figure I-2). The area encompasses about 654 square miles comprised of flat valley land (about 6 percent of the total area) and hills and mountains (about 94 percent of the total area) that border the valley area. The mountains include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from about 800 feet on the valley floor to about 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of about 3,200 feet at the divide separating this hydrologic area from the Mojave Desert.

The Santa Clara River and its tributaries flow intermittently from Lang Station westward about 35 miles to Blue Cut, just west of the Los Angeles-Ventura County line, where it forms the outlet for the Upper Santa Clara River Hydrologic Area. The principal tributaries of the upper river are Castaic Creek, San Francisquito Creek, Bouquet Creek, and the South Fork of the Santa Clara River. Additionally, the Santa Clara River receives treated wastewater discharge from the Saugus and Valencia Water Reclamation Plants, which are operated by the Sanitation Districts of Los Angeles County (Figure I-2).

The Santa Clara River traverses the Santa Clarita Valley. The mountainous area to the north of the river is dissected by long southwest draining canyons - San Francisquito, Bouquet and Mint Canyons. Castaic Lake and Lagoon are within this Sub-Area. The South Fork of the Santa Clara River, draining the mountains along the southern boundary, traverses the valley floor where it joins with the main stem of the Santa Clara River.

Beneath the Santa Clarita Valley, there are two aquifer systems that comprise the Santa Clara River Valley East Groundwater Subbasin. This groundwater basin is the source of essentially all local groundwater used for water supply in the Santa Clarita Valley. Below Blue Cut, the Santa Clara River continues westward through Ventura County to its mouth near Oxnard. Along that route, the River traverses all or parts of six groundwater basins in Ventura County (Piru, Fillmore, Santa Paula, Oxnard Forebay, Oxnard Plain and Mound) as shown in Figure I-3.

There are two primary precipitation gages in the Santa Clarita Valley, the Newhall-Soledad 32c gage and the Newhall County Water District gage (shown in Figure I-4). The National Climatic

Data Center (NCDC) and Los Angeles County Department of Public Works (LADPW) have maintained records for the Newhall-Soledad 32c gage since 1931. Newhall County Water District has maintained records for the NCWD gage since 1979. The cumulative records from these two gages correlate very closely, with the NCWD gage recording approximately 25 percent more precipitation than the Newhall-Soledad 32c gage. This is likely due to the location of the NCWD gage, which is at the base of the mountains rimming the southern edge of the Santa Clarita Valley.

The Santa Clarita Valley is characterized as having an arid climate. Intermittent periods of less-than-average precipitation are typically followed by periods of greater-than-average precipitation in a cyclical pattern, with each wetter or drier period typically lasting from one to five years. Long-term precipitation records for the Newhall-Soledad 32c gage are illustrated in Figure I-5. The long-term average precipitation is 18.16 inches (1931-2005). Figure I-5 also shows the yearly departure from mean annual precipitation. In general, periods of less-than-average precipitation are longer and more moderate than periods of greater-than-average precipitation. Recently, the periods from 1971 to 1976, 1984 to 1991 and 1999 to 2003 have been drier than average; the periods from 1977 to 1983 and 1992 to 1996 have been wetter than average. 2004 was a slightly wet year, with total precipitation of approximately 23 inches, about 5 inches above average. Wet conditions that began in late 2004 continued into early 2005. Significant storm events in January 2005 produced over 13 inches of measured precipitation, or more than 70 percent of average annual precipitation in the first month of the year. Significant storm events continued in February, resulting in nearly 17 inches of additional measured precipitation, or nearly 100 percent of average annual precipitation in February alone. In total, 2005 had about 37 inches of measured precipitation, or slightly more than 200 percent of long-term average precipitation.

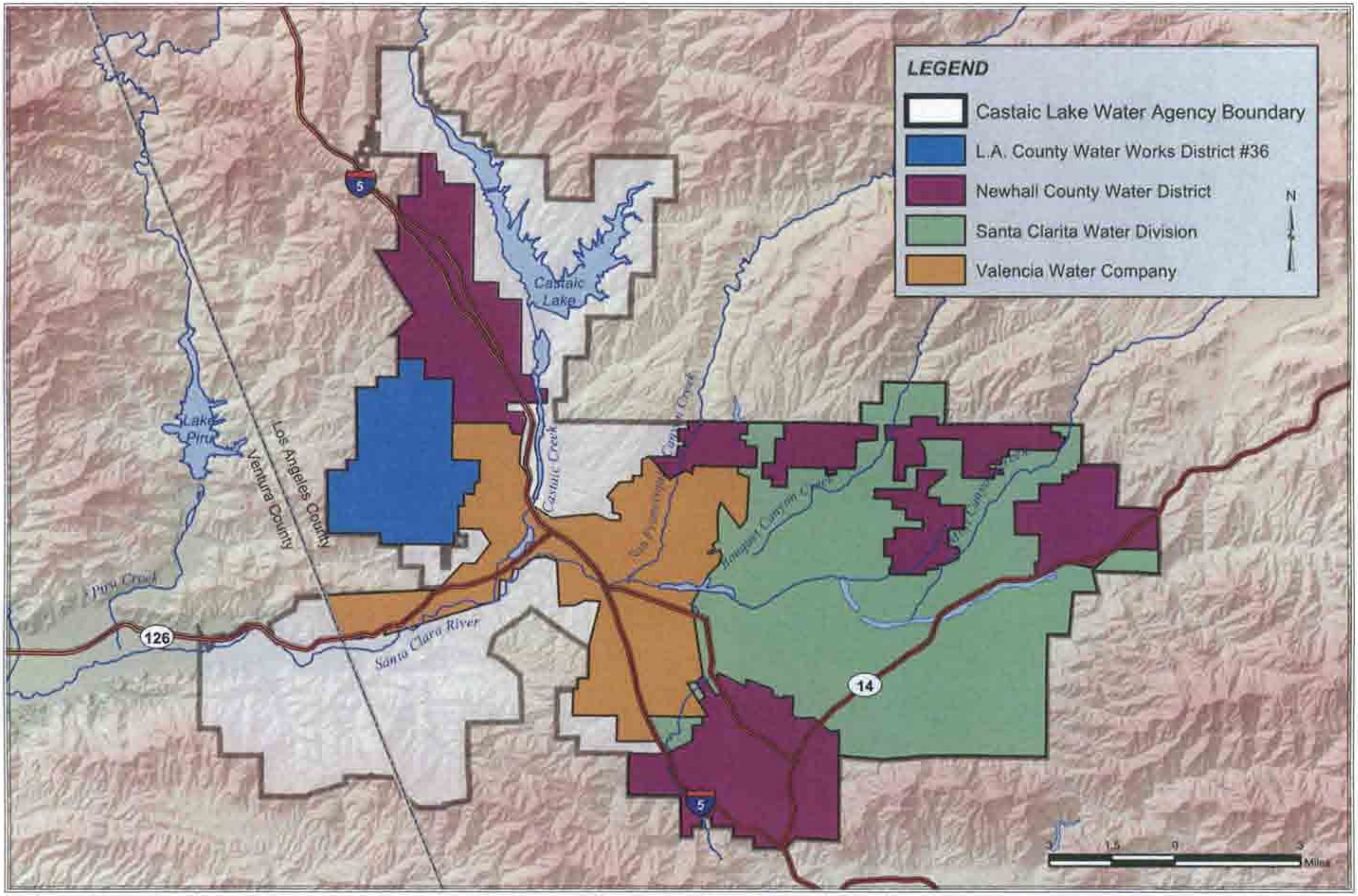

Figure I-1
CLWA and Purveyor Service Areas

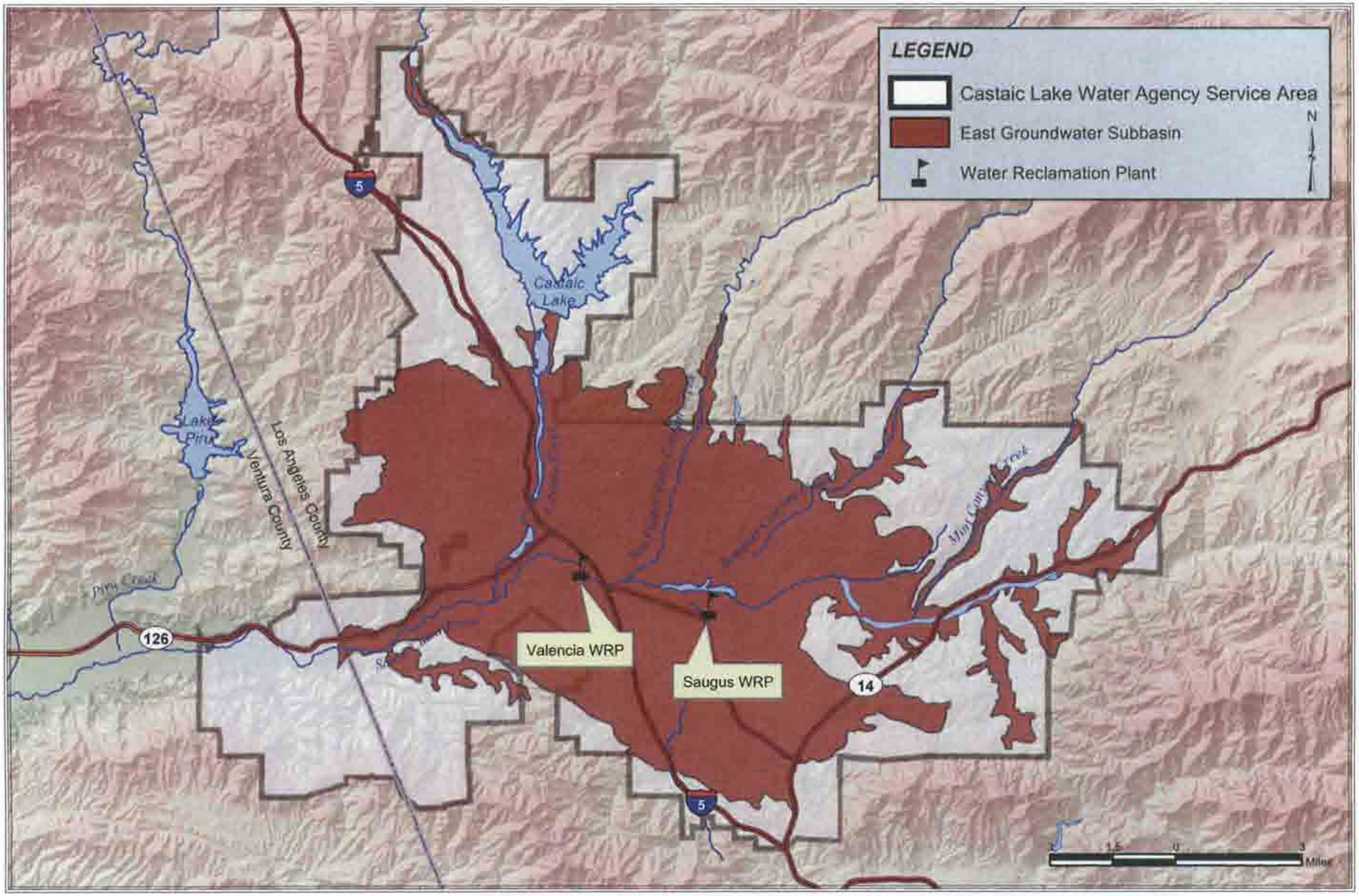

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Figure I-2
Santa Clara River Valley
East Groundwater Subbasin

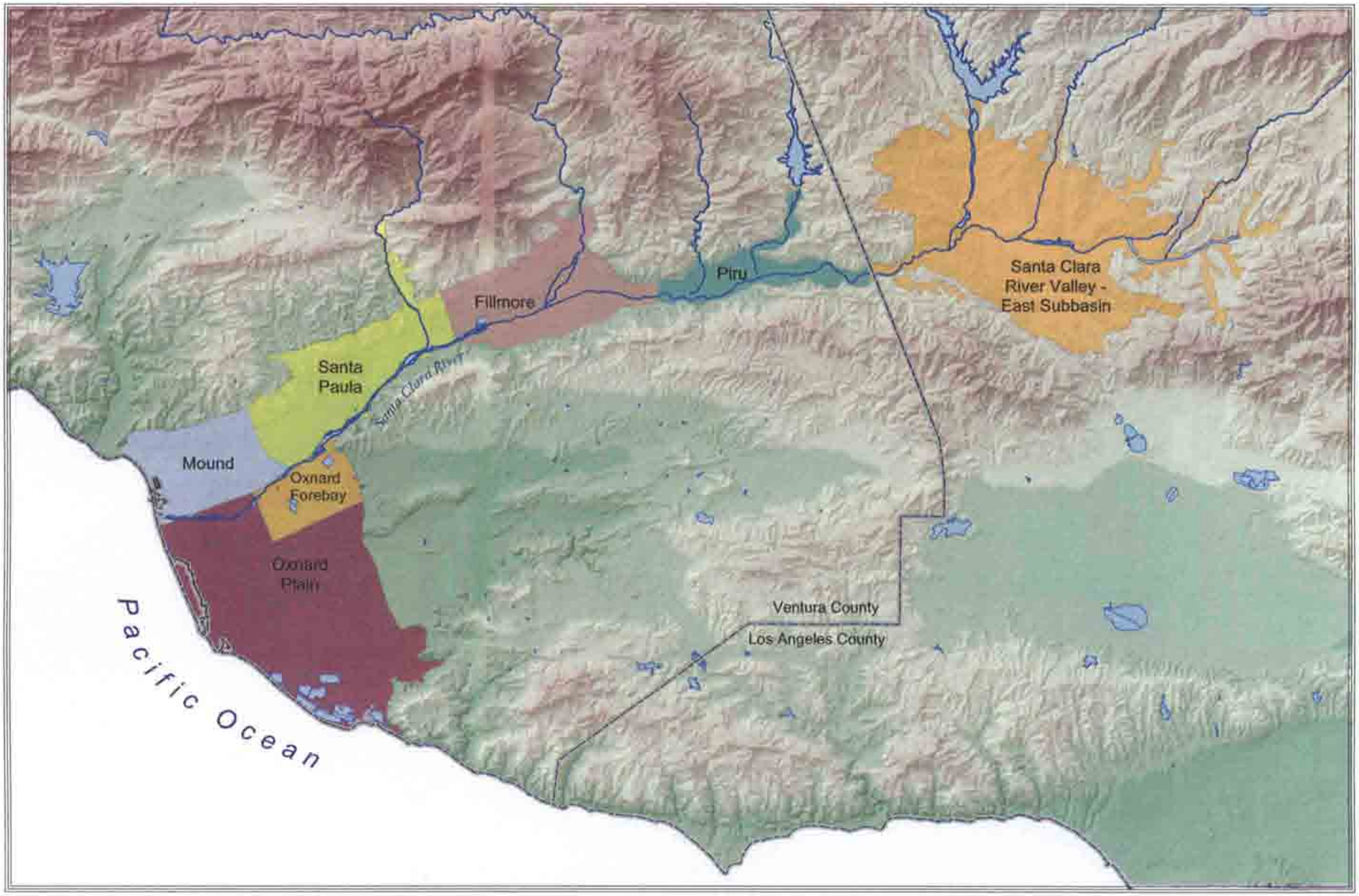

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Figure I-3
Upper and Lower Santa Clara River Basins

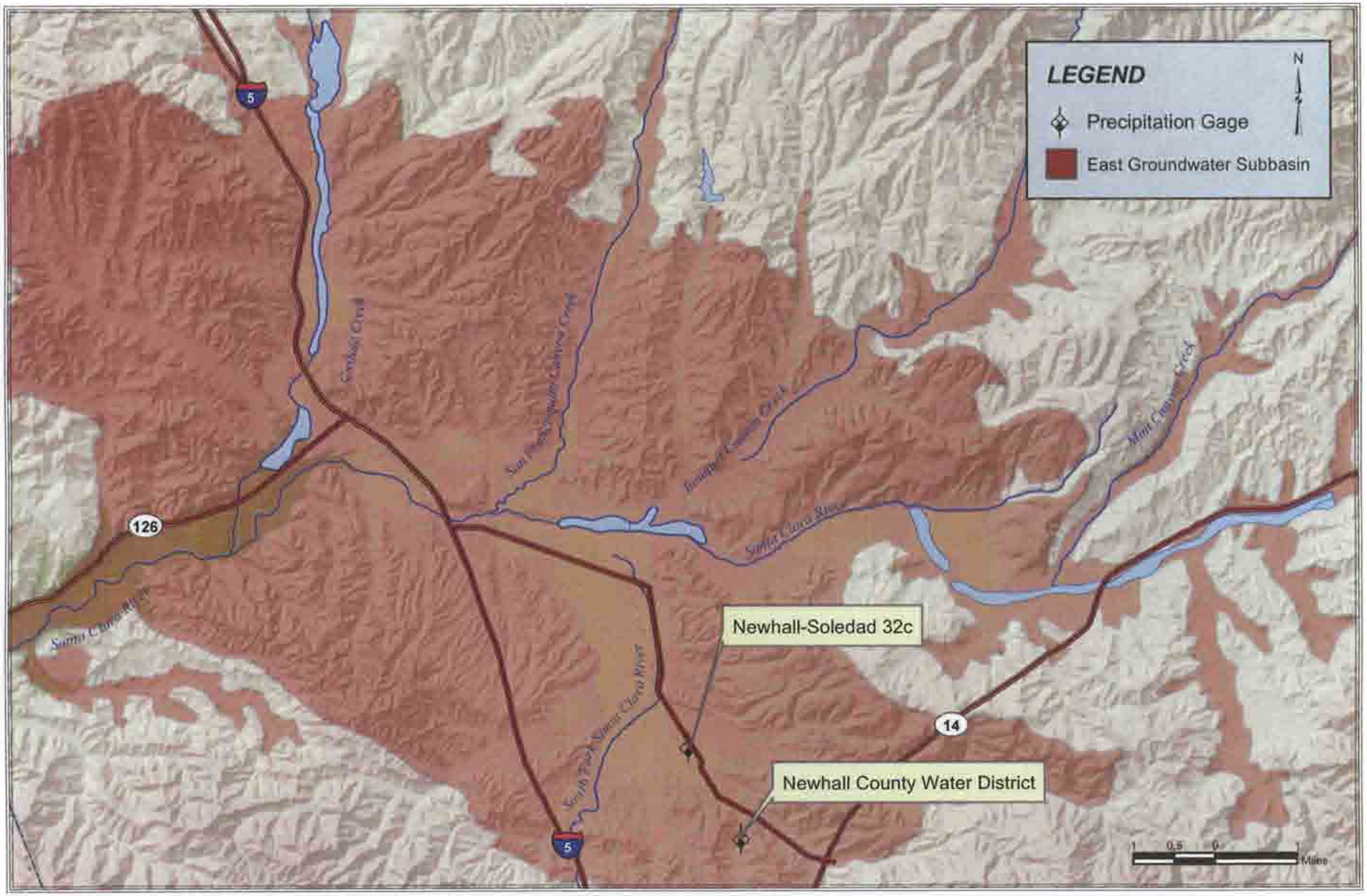

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Figure I-4
Precipitation Gage Locations
Santa Clara River Valley, East Groundwater Subbasin

Annual Precipitation and Departure from Mean Annual Precipitation
Santa Clara River Valley, East Groundwater Subbasin
(Newhall-Soledad 32c Gage)

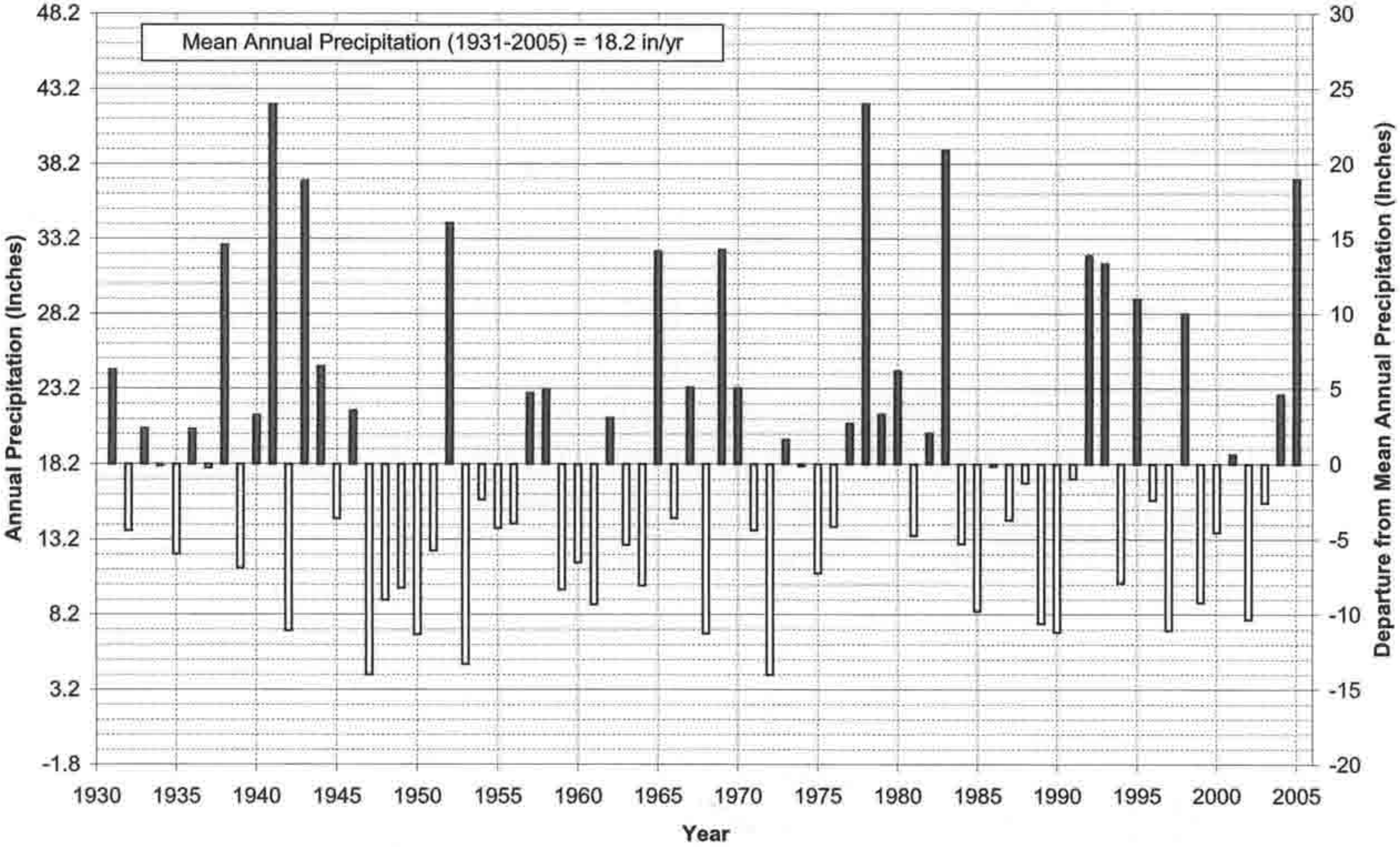


Figure I-5

II. 2005 Water Demands and Supplies

In 2005, total water demands in the Santa Clarita Valley were 83,600 af, a decrease of about 4,400 af from the previous year. Of the total water demand, 85 percent (70,800 af) was for municipal use and the remaining 15 percent (12,800 af) was for agricultural and other (miscellaneous) uses, including individual domestic uses. These total water demands were met by a combination of 45,100 af from local groundwater resources (nearly 32,300 af for municipal and about 12,800 af for agricultural and other uses), about 38,000 af of SWP water, and 438 af of recycled water.

Compared to the previous year, the total water demand in the Santa Clarita Valley decreased by about five percent in 2005. Actual water use in 2005 was also about nine percent lower than the short-term projected water requirement of about 89,000 acre-feet presented in last year's Water Report. The decrease in water use in 2005 was despite an increase of about 1,500 municipal service connections, from 64,800 in 2004 to 66,300 in 2005. The magnitude of decreased water use in 2005, which resulted from the significantly wet winter of 2004-05, was consistent with the analysis of weather impacts on water usage in the 2005 Urban Water Management Plan. As summarized in that Plan, examination of historical water use patterns in the Valley since 1980, when State Water Project deliveries began, show that weather variations have influenced water use by nine to ten percent of normal, or average, use. In hotter, dry years, water demands have been as much as nine percent higher than normal while in cooler, wet years, water demands have been as much as ten percent less than normal. In summary, the extended and significantly wet conditions in early 2005 resulted in a water demand decrease that, over the entire calendar year, was about equal to the largest historical single-year decrease from normal water demands over the last 25 years.

The uses of local and imported water supplies to meet municipal water requirements since 1980, when the importation of SWP water began, are summarized in Table II-1. Water supply utilization by each individual municipal Purveyor is tabulated in Tables II-2 through II-5 for the same period of time.

Water supply utilization for all agricultural and other non-municipal uses is summarized in Table II-6 and tabulated by three categories of agricultural and other users in Table II-7.

Water supply utilization for all uses in the Santa Clarita Valley, again for the period 1980 to present, is summarized in Table II-8. The trends in utilization of local groundwater and imported SWP water, complemented by the recent addition of recycled water, are graphically illustrated in Figure II-1. As can be seen by inspection of Table II-8 and Figure II-1, total water use in the Valley has nearly linearly increased over the last 25 years, with some weather-related fluctuations in certain years. The resultant increase in total water demand, since the inception of supplemental SWP importation, has been from about 37,000 acre-feet in 1980 to the mid-80,000 acre-feet per year range over the last four years. As can also be seen by inspection of Table II-8 and Figure II-1, that increase in water demand has essentially all been met with increasing importation of SWP water; groundwater pumping has remained close to constant, particularly within a very narrow range over the last 15 years.

Table II-1
Water Supply Utilization by Municipal Purveyors*
(Acre-Feet)

* includes CLWA-SCWD, LACWD 36, NCWD and VWC

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	16,625	4,569	-	**22,319**
1981	5,816	14,056	4,950	-	**24,822**
1982	9,659	8,684	3,569	-	**21,912**
1983	9,185	8,803	3,398	-	**21,386**
1984	10,996	12,581	3,809	-	**27,386**
1985	11,823	12,519	4,140	-	**28,482**
1986	13,759	12,418	4,975	-	**31,152**
1987	16,285	12,630	4,962	-	**33,877**
1988	19,033	12,197	6,404	-	**37,634**
1989	21,618	13,978	7,217	-	**42,813**
1990	21,613	13,151	8,302	-	**43,066**
1991	7,968	17,408	14,417	-	**39,793**
1992	13,911	16,897	10,458	-	**41,266**
1993	13,393	19,808	10,151	-	**43,352**
1994	14,389	20,068	11,531	-	**45,988**
1995	16,996	20,590	8,087	-	**45,673**
1996	18,093	24,681	7,373	-	**50,147**
1997	22,148	25,273	6,752	-	**54,173**
1998	20,254	23,898	4,706	-	**48,858**
1999	27,282	27,240	2,728	-	**57,250**
2000	32,579	25,216	3,193	-	**60,988**
2001	35,369	22,055	3,267	-	**60,691**
2002	41,768	22,097	4,360	-	**68,225**
2003	44,419	19,397	3,581	700	**68,097**
2004	47,205	18,970	5,701	448	**72,324**
2005	38,034	26,368	5,948	438	**70,788**

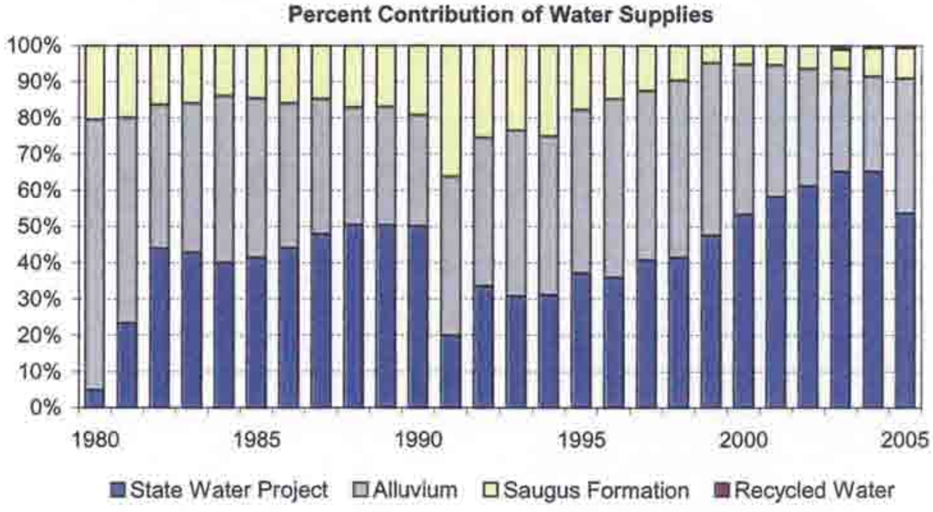


Table II-2
Water Supply Utilization by CLWA Santa Clarita Water Division
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	1,125	9,460	0	**10,585**
1981	4,602	7,109	0	**11,711**
1982	6,454	4,091	0	**10,545**
1983	5,214	4,269	0	**9,483**
1984	6,616	6,057	0	**12,673**
1985	6,910	6,242	0	**13,152**
1986	8,366	5,409	0	**13,775**
1987	9,712	5,582	0	**15,294**
1988	11,430	5,079	63	**16,572**
1989	12,790	5,785	0	**18,575**
1990	12,480	5,983	40	**18,503**
1991	6,158	5,593	4,781	**16,532**
1992	6,350	8,288	2,913	**17,551**
1993	3,429	12,016	2,901	**18,346**
1994	5,052	10,996	3,863	**19,911**
1995	7,955	10,217	1,726	**19,898**
1996	9,385	10,445	2,176	**22,006**
1997	10,120	11,268	1,068	**22,456**
1998	8,893	11,426	0	**20,319**
1999	10,772	13,741	0	**24,513**
2000	13,751	11,529	0	**25,280**
2001	15,648	9,896	0	**25,544**
2002	18,921	9,513	0	**28,434**
2003	20,668	6,424	0	**27,092**
2004	22,045	7,146	0	**29,191**
2005	16,513	12,408	0	**28,921**

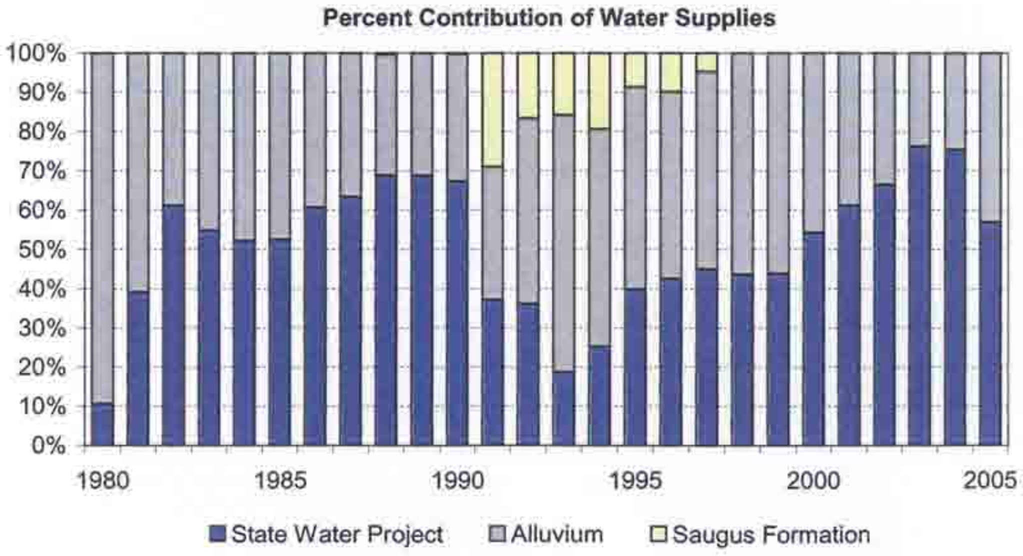


Table II-3
Water Supply Utilization by Los Angeles County Waterworks District 36
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	-	-	**0**
1981	0	-	-	**0**
1982	145	-	-	**145**
1983	207	-	-	**207**
1984	240	-	-	**240**
1985	272	-	-	**272**
1986	342	-	-	**342**
1987	361	-	-	**361**
1988	434	-	-	**434**
1989	457	-	-	**457**
1990	513	-	-	**513**
1991	435	-	-	**435**
1992	421	-	-	**421**
1993	465	-	-	**465**
1994	453	-	-	**453**
1995	477	-	-	**477**
1996	533	-	-	**533**
1997	785	-	-	**785**
1998	578	-	-	**578**
1999	654	-	-	**654**
2000	800	-	-	**800**
2001	907	-	-	**907**
2002	1,069	-	-	**1,069**
2003	1,175	-	-	**1,175**
2004	854	380	-	**1,234**
2005	857	343	-	**1,200**

Groundwater purchased from Los Angeles County Honor Farm

Percent Contribution of Water Supplies

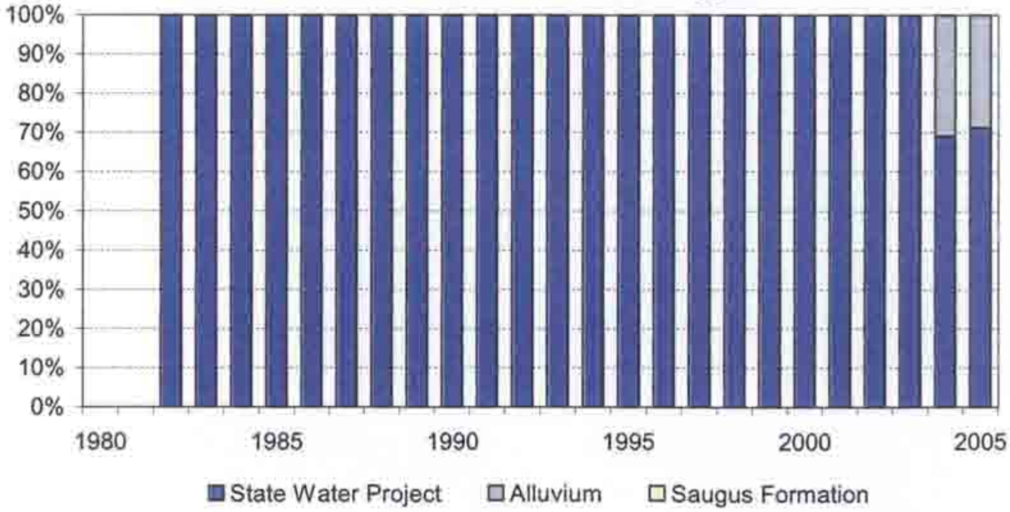


Table II-4
Water Supply Utilization by Newhall County Water District
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	1,170	2,363	**3,533**
1981	0	1,350	2,621	**3,971**
1982	0	1,178	2,672	**3,850**
1983	0	1,147	2,787	**3,934**
1984	0	1,549	2,955	**4,504**
1985	0	1,644	3,255	**4,899**
1986	0	1,842	3,548	**5,390**
1987	22	2,127	3,657	**5,806**
1988	142	2,283	4,041	**6,466**
1989	428	2,367	4,688	**7,483**
1990	796	1,936	4,746	**7,478**
1991	675	1,864	4,994	**7,533**
1992	802	1,994	5,160	**7,956**
1993	1,075	1,977	5,068	**8,120**
1994	906	2,225	5,103	**8,234**
1995	1,305	1,675	4,775	**7,755**
1996	1,213	1,803	4,871	**7,887**
1997	1,324	2,309	5,168	**8,801**
1998	1,769	1,761	4,557	**8,087**
1999	5,050	1,676	2,622	**9,348**
2000	6,024	1,508	2,186	**9,718**
2001	5,452	1,641	2,432	**9,525**
2002	5,986	981	3,395	**10,362**
2003	6,572	1,266	2,513	**10,351**
2004	5,896	1,582	3,739	**11,217**
2005	5,932	1,389	3,435	**10,756**

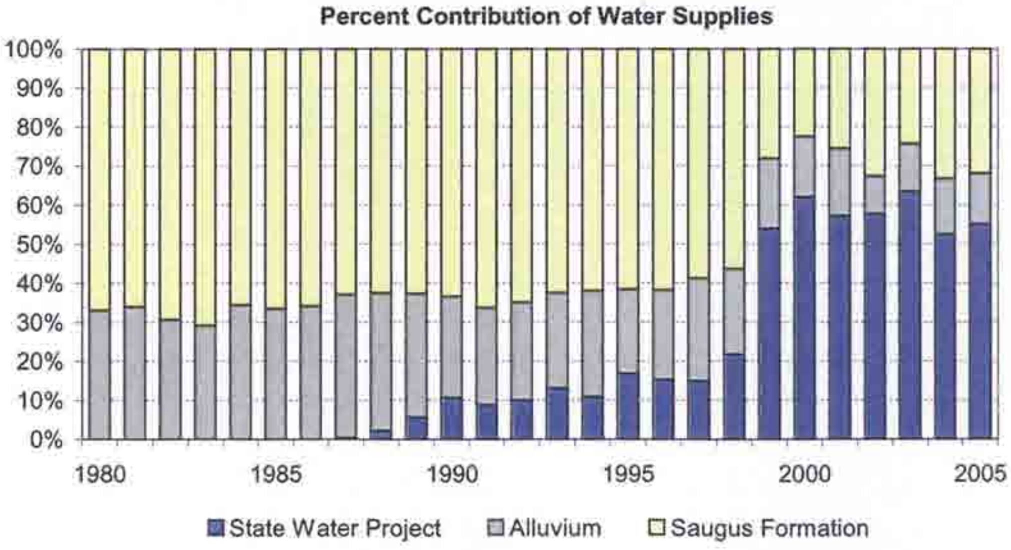
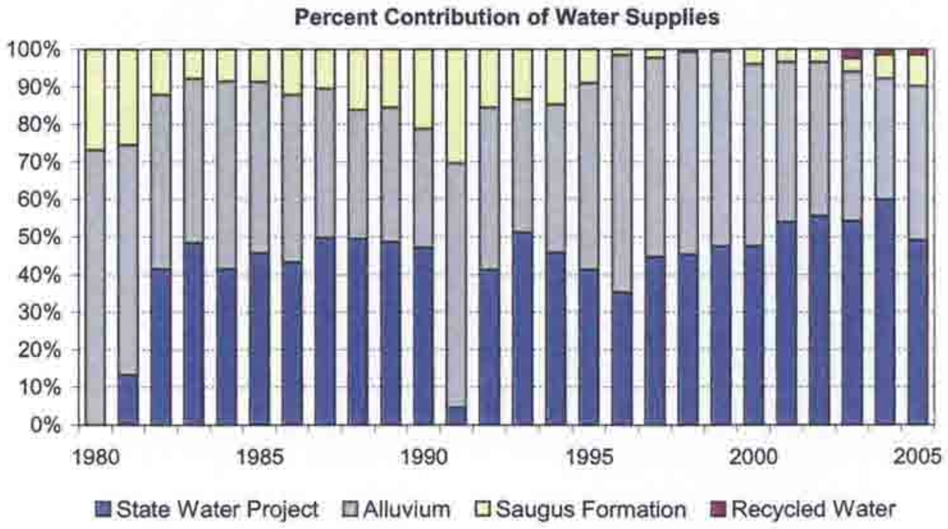

Percent Contribution of Water Supplies

Table II-5
Water Supply Utilization by Valencia Water Company
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	0	5,995	2,206	-	**8,201**
1981	1,214	5,597	2,329	-	**9,140**
1982	3,060	3,415	897	-	**7,372**
1983	3,764	3,387	611	-	**7,762**
1984	4,140	4,975	854	-	**9,969**
1985	4,641	4,633	885	-	**10,159**
1986	5,051	5,167	1,427	-	**11,645**
1987	6,190	4,921	1,305	-	**12,416**
1988	7,027	4,835	2,300	-	**14,162**
1989	7,943	5,826	2,529	-	**16,298**
1990	7,824	5,232	3,516	-	**16,572**
1991	700	9,951	4,642	-	**15,293**
1992	6,338	6,615	2,385	-	**15,338**
1993	8,424	5,815	2,182	-	**16,421**
1994	7,978	6,847	2,565	-	**17,390**
1995	7,259	8,698	1,586	-	**17,543**
1996	6,962	12,433	326	-	**19,721**
1997	9,919	11,696	516	-	**22,131**
1998	9,014	10,711	149	-	**19,874**
1999	10,806	11,823	106	-	**22,735**
2000	12,004	12,179	1,007	-	**25,190**
2001	13,362	10,518	835	-	**24,715**
2002	15,792	11,603	965	-	**28,360**
2003	16,004	11,707	1,068	700	**29,479**
2004	18,410	9,862	1,962	448	**30,682**
2005	14,732	12,228	2,513	438	**29,911**



Percent Contribution of Water Supplies

Table II-6
Water Supply Utilization for Agricultural and Other Uses
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	14,831	20	**14,851**
1981	0	16,737	20	**16,757**
1982	0	13,184	521	**13,705**
1983	0	11,483	454	**11,937**
1984	0	14,737	640	**15,377**
1985	0	12,828	575	**13,403**
1986	0	11,787	510	**12,297**
1987	0	10,012	599	**10,611**
1988	0	9,451	524	**9,975**
1989	0	9,743	542	**10,285**
1990	0	10,725	559	**11,284**
1991	0	9,779	500	**10,279**
1992	987	10,694	466	**12,147**
1993	443	10,318	459	**11,220**
1994	311	13,065	494	**13,870**
1995	6	13,874	473	**14,353**
1996	780	13,757	813	**15,350**
1997	1,067	14,326	993	**16,386**
1998	12	12,750	849	**13,611**
1999	20	16,166	988	**17,174**
2000	3	14,433	887	**15,323**
2001	0	15,218	873	**16,091**
2002	0	16,006	800	**16,806**
2003	0	14,181	626	**14,807**
2004	0	14,787	803	**15,590**
2005	0	12,280	505	**12,785**

Percent Contribution of Water Supplies

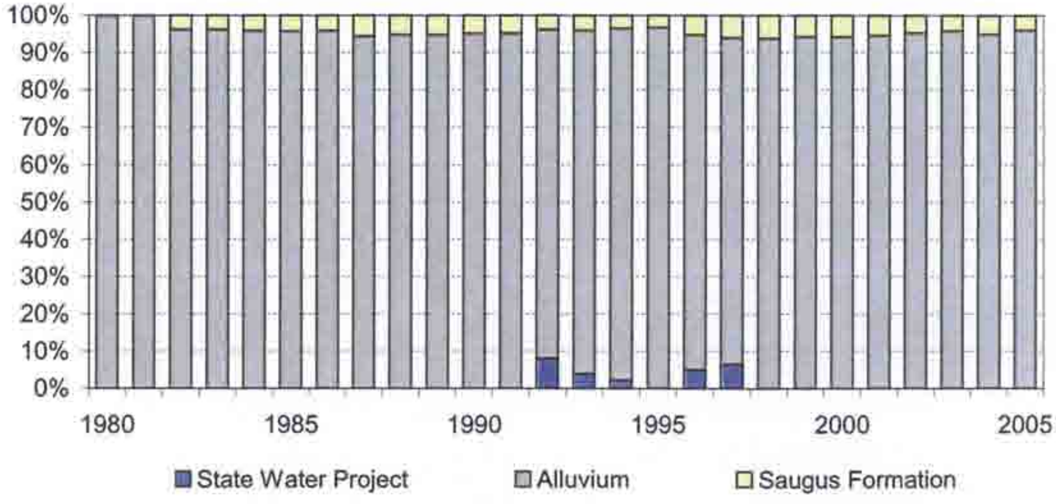


Table II-7
Individual Water Supply Utilization by Agricultural and Other Users
(Acre-Feet)

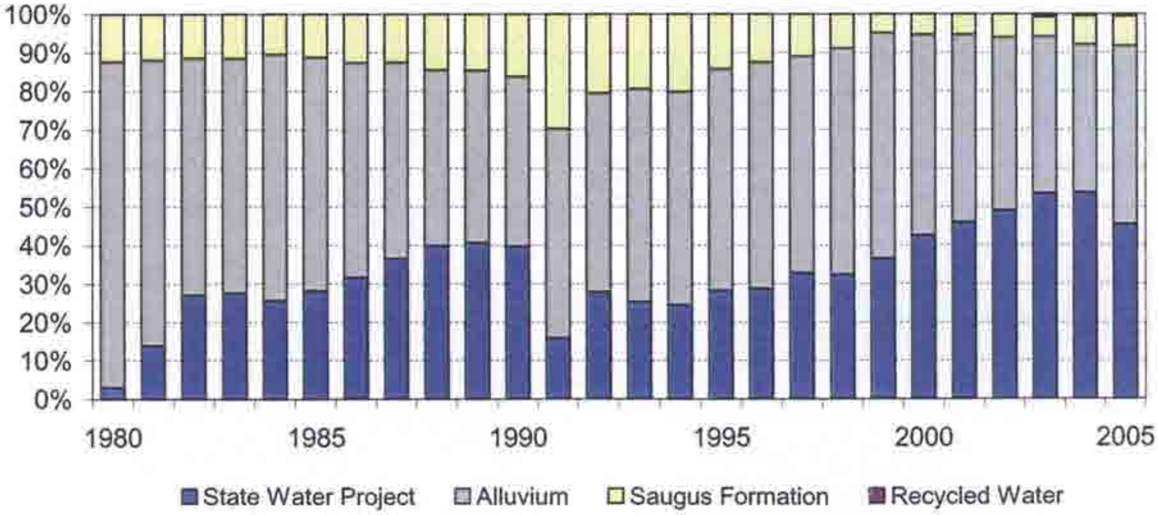
	Newhall Land and Farming			Los Angeles County Honor Farm			Small Private Domestic, Irrigation and Golf Courses Uses		
Year	*Alluvium*	*Saugus Formation*	**Total**	*Alluvium*	*State Water Project*	**Total**	*Alluvium* [1]	*Saugus Formation* [2]	**Total**
1980	11,331	20	**11,351**	3,000	0	**3,000**	500	0	**500**
1981	13,237	20	**13,257**	3,000	0	**3,000**	500	0	**500**
1982	9,684	20	**9,704**	3,000	0	**3,000**	500	501	**1,001**
1983	7,983	20	**8,003**	3,000	0	**3,000**	500	434	**934**
1984	11,237	20	**11,257**	3,000	0	**3,000**	500	620	**1,120**
1985	9,328	20	**9,348**	3,000	0	**3,000**	500	555	**1,055**
1986	8,287	20	**8,307**	3,000	0	**3,000**	500	490	**990**
1987	6,512	20	**6,532**	3,000	0	**3,000**	500	579	**1,079**
1988	5,951	20	**5,971**	3,000	0	**3,000**	500	504	**1,004**
1989	6,243	20	**6,263**	3,000	0	**3,000**	500	522	**1,022**
1990	8,225	20	**8,245**	2,000	0	**2,000**	500	539	**1,039**
1991	7,039	20	**7,059**	2,240	0	**2,240**	500	480	**980**
1992	8,938	20	**8,958**	1,256	987	**2,243**	500	446	**946**
1993	8,020	20	**8,040**	1,798	443	**2,241**	500	439	**939**
1994	10,606	20	**10,626**	1,959	311	**2,270**	500	474	**974**
1995	11,174	20	**11,194**	2,200	6	**2,206**	500	453	**953**
1996	12,020	266	**12,286**	1,237	780	**2,017**	500	547	**1,047**
1997	12,826	445	**13,271**	1,000	1,067	**2,067**	500	548	**1,048**
1998	10,250	426	**10,676**	2,000	12	**2,012**	500	423	**923**
1999	13,824	479	**14,303**	1,842	20	**1,862**	500	509	**1,009**
2000	11,857	374	**12,231**	1,644	3	**1,647**	932	513	**1,445**
2001	12,661	300	**12,961**	1,604	0	**1,604**	953	573	**1,526**
2002	13,514	211	**13,725**	1,602	0	**1,602**	890	589	**1,479**
2003	10,999	122	**11,121**	2,273	0	**2,273**	909	504	**1,413**
2004	10,991	268	**11,259**	2,725	0	**2,725**	1,071	535	**1,606**
2005	8,648	6	**8,654**	2,499	0	**2,499**	1,133	499	**1,632**

1. *Robinson Ranch Golf Course irrigation and estimated private pumping.*
2. *Valencia Country Club and Vista Valencia Golf Course irrigation.*

Table II-8
Total Water Supply Utilization for Municipal, Agricultural and Other Uses
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	31,456	4,589	-	**37,170**
1981	5,816	30,793	4,970	-	**41,579**
1982	9,659	21,868	4,090	-	**35,617**
1983	9,185	20,286	3,852	-	**33,323**
1984	10,996	27,318	4,449	-	**42,763**
1985	11,823	25,347	4,715	-	**41,885**
1986	13,759	24,205	5,485	-	**43,449**
1987	16,285	22,642	5,561	-	**44,488**
1988	19,033	21,648	6,928	-	**47,609**
1989	21,618	23,721	7,759	-	**53,098**
1990	21,613	23,876	8,861	-	**54,350**
1991	7,968	27,187	14,917	-	**50,072**
1992	14,898	27,591	10,924	-	**53,413**
1993	13,836	30,126	10,610	-	**54,572**
1994	14,700	33,133	12,025	-	**59,858**
1995	17,002	34,464	8,560	-	**60,026**
1996	18,873	38,438	8,186	-	**65,497**
1997	23,215	39,599	7,745	-	**70,559**
1998	20,266	36,648	5,555	-	**62,469**
1999	27,302	43,406	3,716	-	**74,424**
2000	32,582	39,649	4,080	-	**76,311**
2001	35,369	37,273	4,140	-	**76,782**
2002	41,768	38,103	5,160	-	**85,031**
2003	44,419	33,577	4,207	700	**82,904**
2004	47,205	33,757	6,503	448	**87,913**
2005	38,034	38,648	6,453	438	**83,573**

Percent Contribution of Water Supplies



Total Water Supply Utilization
Santa Clarita Valley

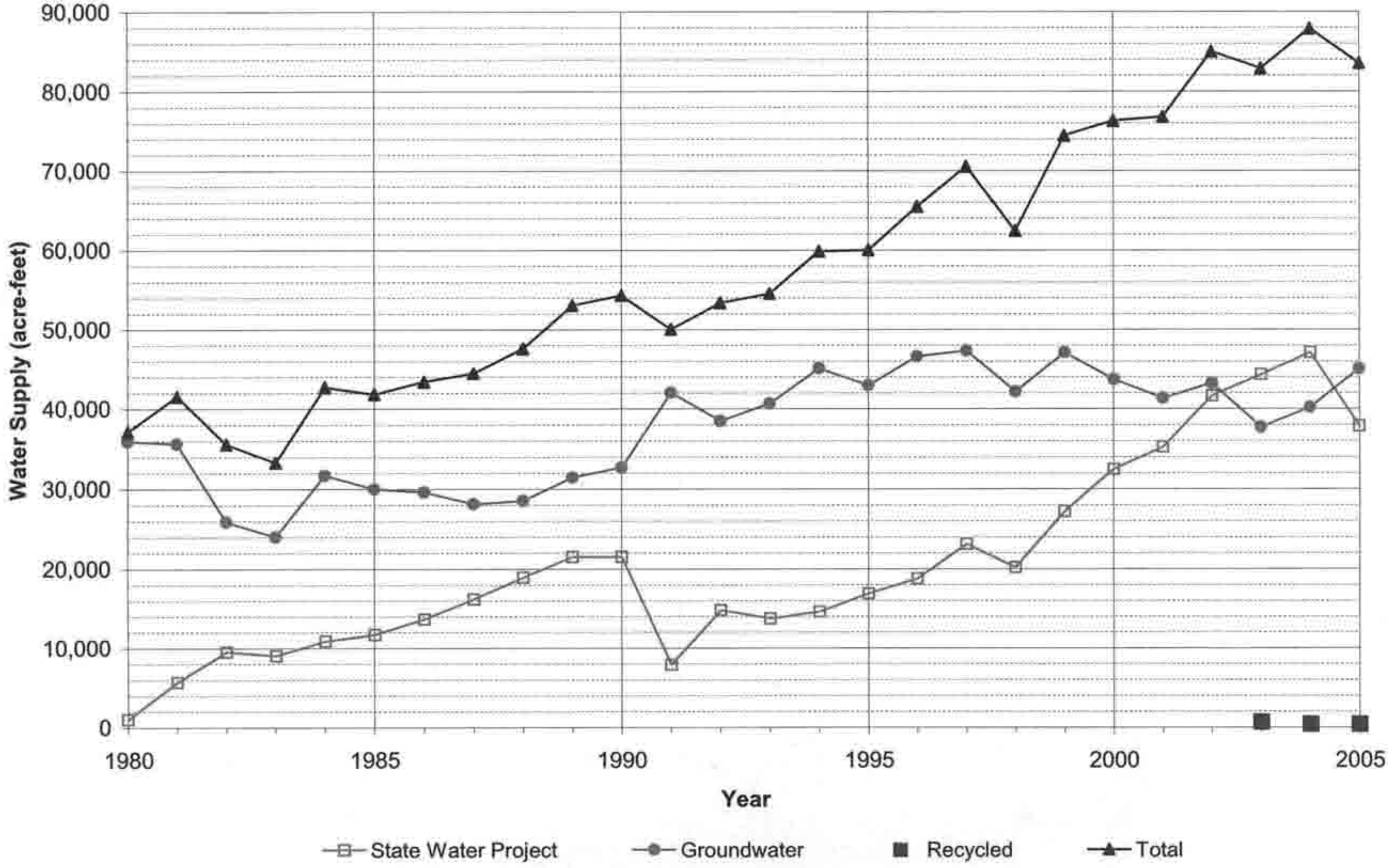


Figure II-1

Prior to 1980, local groundwater extracted from the Alluvium and the Saugus Formation was the sole source of water supply in the Santa Clarita Valley. Since 1980, local groundwater supplies have been supplemented with imported SWP water supplies. Those water supplies were further augmented by the initiation of deliveries from CLWA's recycled water program in 2003. This section describes the groundwater resources of the Santa Clarita Valley, SWP water supplies, and CLWA's recycled water program.

3.1 Santa Clara River Valley Groundwater Basin – East Subbasin

The groundwater basin generally beneath the Santa Clarita Valley, identified in the State Department of Water Resources' Bulletin 118 as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), is comprised of two aquifer systems. The Alluvium generally underlies the Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. The mapped extent of the Santa Clara River Valley East Subbasin in DWR Bulletin 118 and its relationship to the extent of the CLWA service area are illustrated in Figure III-1. The subbasin boundary approximately coincides with the outer extent of the Alluvium and Saugus Formation.

A 2001 Update Report on both the Alluvium and Saugus Formation Aquifers (Slade, 2002), which updated analyses and interpretation of hydrogeologic conditions from earlier reports (Slade, 1986 and 1988), included extensive detail on major aspects of the groundwater basin. Notable parts of the Update Report relative to water supply include:

- Analysis of historical groundwater levels and production indicates that there have been no conditions that would be illustrative of groundwater overdraft;
- Utilization of operational yield (as opposed to perennial yield) as a basis for managing groundwater production would be more applicable in this basin to reflect fluctuating utilization of groundwater in conjunction with imported SWP water;
- Operational yield of the Alluvium would be 30,000 to 40,000 afy for wet and normal rainfall years, with an expected reduction into the range of 30,000 to 35,000 afy in dry years;
- Operational yield of the Saugus Formation would be in the range of 7,500 to 15,000 afy on a long-term basis, with short-term increases during dry periods into a range of 15,000 to 25,000 afy, and to 35,000 afy if dry conditions continue.

In 2004, as part of analyzing the restoration of perchlorate-impacted groundwater supply in the Valley, a numerical groundwater flow model was developed and calibrated for use in analyzing the response of the groundwater basin to long-term operation at the operational yields noted above, with focus on perchlorate extraction and the control of perchlorate migration in the basin. Subsequently, in 2005, the groundwater flow model was utilized to specifically analyze the sustainability of groundwater supplies in both the Alluvium and the Saugus Formation through a long-term (78 year) hydrologic period that was selected to examine groundwater basin response to variations in pumping in accordance with the operating plan. Resultant projections of groundwater levels, groundwater storage, and surface water flows showed the basin to respond in a long-term sustainable manner, with no chronic depletion of groundwater levels, storage, or stream flows. The primary findings of the Basin Yield Report on the preceding work (CH2M Hill and LSCE, 2005), which also assessed current basin conditions based on historical data utilized in the model, included:

- The groundwater basin has historically been, and continues to be, in good operating condition and not in overdraft conditions, as indicated by historical data.
- The groundwater plan is sustainable over varying hydrologic conditions, because it is feasible to intermittently exceed a long-term average yield for one or more years without creating long-term adverse impacts to the groundwater system and the Santa Clara River.
- The groundwater operating plan for the Alluvium and the Saugus Formation can be used for long-term water supply planning purposes. In particular, although increased pumping from the Saugus Formation during dry periods can be expected to cause short-term declines in groundwater levels, it is not projected to cause permanent declines in groundwater discharges or streamflow. Additionally, Saugus groundwater levels will rapidly recover to pre-drought conditions.
- The strategy around which the groundwater operating plan was designed (maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, while limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus pumping during years when SWP supplies are significantly reduced because of drought conditions) is viable on a long-term basis.
- The historical observations of basin conditions and the model simulations together support the historical and ongoing confidence that groundwater can continue to be a sustainable source of water supply under the groundwater operating plan.

3.2 Alluvium – General

The spatial extent of the aquifers used for groundwater supply in the Valley, the Alluvium and the Saugus Formation, are illustrated in Figure III-1. Geologic descriptions and hydrogeologic details related to both aquifers are included in several other technical reports including Slade (1986, 1988 & 2002), CH2M Hill (2005) and LSCE (2005), and in the 2005 Urban Water Management Plan.

Consistent with the 2001 Update Report (Slade), the 2005 Basin Yield Report (CH2M Hill and LSCE), and the 2005 UWMP, the management practice of the Purveyors continues to be to utilize the Alluvium in accordance with the groundwater operating plan, 30,000 to 40,000 afy in wet and normal years, with possible reduction to 30,000 to 35,000 afy in dry years. Such operation will maximize use of the Alluvium because of the aquifer's ability to store and produce good quality water on a sustainable basis, and because the Alluvium is capable of rapid recovery of water levels and storage in wet periods. As with many groundwater basins, it is possible to intermittently exceed a long-term average yield for one or more years without long-term adverse effects. Higher pumpage for short periods may temporarily lower groundwater storage and related water levels, as has been the case in the Alluvium several times since the 1930's. However, subsequent decreases in pumpage limit the amount of water level decline, and normal to wet-period recharge result in a rapid return of groundwater levels to historic highs. Historical groundwater data collected from the Alluvium over numerous hydrologic cycles continue to provide assurance that groundwater elevations, if locally lowered during dry periods, recover in subsequent average or wet years. Such water level response to rainfall is a significant characteristic of permeable, porous, alluvial aquifer systems that occur within large watersheds. In light of these historical observations, complemented by the long-term sustainability analysis using the numerical groundwater flow model, there is ongoing confidence that groundwater will continue to be a sustainable source of water supply at the rates of pumping described in the Basin Yield Report, now incorporated in the 2005 UWMP.

Long-term adverse impacts to the Alluvium could occur if the amount of water extracted from the aquifer were to exceed the amount of water that recharges the aquifer over an extended period. However, the quantity and quality of water in the Alluvium and pumpage from the Alluvium are routinely monitored, and no long-term adverse impacts have ever been evident. Ultimately, the Purveyors have identified cooperative measures to be taken, if needed, to ensure sustained use of the aquifer. Such measures include but are not limited to the continuation of conjunctive use of imported SWP surface water with local groundwater, artificial recharge of the aquifer with local runoff or other surface water supplies, financial incentives discouraging extractions above a selected limit, expanded use of other alternative supplies such as recycled water, and expanded implementation of demand-side management, including conservation.

3.2.1 Alluvium – Historical and Current Conditions

Total pumpage from the Alluvium in 2005 was about 38,700 af, an increase of nearly 5,000 af from the preceding year. Total Alluvium pumping thus remains within the groundwater operating plan range. Of the total Alluvial pumpage in 2005, about 68 percent (26,400 af) was for municipal water supply, and the balance, about 12,300 af, was for agriculture and other smaller uses, including individual domestic uses. In a longer-term context, there has been a change in municipal/agricultural pumping distribution since SWP deliveries began in 1980, toward a slightly higher fraction for municipal water supply (from about 50 percent to more than 60 percent of Alluvial pumpage), which reflects the general land use changes in the area. Ultimately, on a long-term average basis since the importation of SWP water, total Alluvial pumpage has been slightly less than 31,000 afy, which is at the lower end of the range of operational yield of the Alluvium. The overall historic record of Alluvial pumping is illustrated in Figure III-2.

Groundwater levels in various parts of the basin have historically exhibited different responses to both pumpage and climatic fluctuations. During the last 20 to 30 years, depending on location, Alluvial groundwater levels have remained nearly constant (generally toward the western end of the basin), or have fluctuated from near the ground surface when the basin is full, to as much as 100 feet lower during intermittent dry periods of reduced recharge (generally toward the eastern end of the basin). For illustration of the various groundwater level conditions, the Alluvial wells have been grouped into areas with similar groundwater level patterns as illustrated in Figure III-3. Figures III-4 and III-5 present historical groundwater levels organized into hydrograph form (groundwater elevation vs. time) for four areas throughout the basin. The other areas shown in Figure III-2 exhibit groundwater level responses that are similar to those in these four areas.

The 'Mint Canyon' area, located at the far eastern end of the groundwater basin, and the nearby 'Above Saugus WRP' and 'Bouquet Canyon' areas generally exhibit similar groundwater level responses. Those parts of the Alluvium have historically experienced a number of alternating wet and dry hydrologic conditions (Figures III-4 and III-5) during which groundwater level declines have been followed by returns to historic highs. When water levels are low, well yields and pumping capacities in this area can be impacted. The affected Purveyors respond by increasing use of Saugus Formation and imported (SWP) supplies, as shown in Table II-8. The Purveyors also shift a fraction of the Alluvial pumpage that would normally be supplied by 'Mint Canyon' area wells to areas further west, where well yields and pumping capacities remain fairly constant because of smaller groundwater level fluctuations. As shown in Figure III-6, the Purveyors decreased total Alluvial pumpage from the 'Mint Canyon' area steadily from 2000 through 2003, and correspondingly increased pumpage in the 'Below Saugus WRP' and 'Below Valencia WRP' areas. In spite of a continued period of below-average precipitation from 1999 to 2003, that progressive decrease in pumping resulted in a cessation of groundwater level decline in the 'Mint Canyon' area in 2002 and 2003. Subsequently, wet conditions in late 2004, continuing into 2005, resulted in full recovery of groundwater storage. With such high groundwater levels, pumping in the 'Mint Canyon' area was increased in 2005, with no significant change in groundwater levels as a result.

The 'Below Saugus WRP' area (Figure III-4), along the Santa Clara River immediately downstream of the Saugus Water Reclamation Plant, and the 'San Francisquito Canyon' area generally exhibit similar groundwater levels. In this middle part of the basin, historical groundwater levels were lower in the 1950's and 60's than current levels. Groundwater levels in this area notably recovered as pumpage declined through the 1960's and 1970's. They have subsequently sustained generally high levels for much of the last 30 years, with three dry-period exceptions: mid-1970's, late 1980's to early 1990's, and the late 1990's to early 2000's. Recoveries to previous high groundwater levels followed both of the short dry-period declines in the 1970's and 1990's. Most recently, groundwater levels have recovered significantly following a wetter-than-average year in 2004 and significantly wet 2005, indicating that the groundwater level decline that occurred from 1999-2004 also represented a temporary dry-period decline.

The 'Castaic Valley' area is located along Castaic Creek below Castaic Lake. In that area, groundwater levels have remained fairly constant, with slight responses to climatic fluctuations, since the 1950's (Figure III-5).

The 'Below Valencia' WRP area is located along the Santa Clara River downstream of the Valencia Water Reclamation Plant, where discharges of treated effluent from the Valencia WRP to the Santa Clara River contribute to groundwater recharge. Groundwater levels in this area exhibit slight, if any, response to climatic fluctuations, and have remained fairly constant since the 1950's despite, over the last 20 years, a notable increase in pumping in that area (Figure III-5 and III-6).

In summary, depending on the period of available data, all the history of groundwater levels in the Alluvium show the same general picture: recent (last 30 years) groundwater levels have exhibited historic highs; in some locations, there are intermittent dry-period declines (and an associated use of some groundwater from storage) followed by wet-period recoveries (and associated refilling of storage space). On a long-term basis, whether over the last 26 years since importation of supplemental SWP water, or over the last 40 to 50 years (since the 1950's - 60's), the Alluvium shows no signs of water level-related overdraft, i.e., no trend toward decreasing water levels and storage. Consequently, pumpage from the Alluvium has been and continues to be sustainable within the operational yield of that aquifer.

3.3 Saugus Formation – General

Saugus wells operated by the Purveyors are located in the southern portion of the basin south of the Santa Clara River (Figure III-7). Consistent with the 2001 Update Report (Slade) and the 2005 Basin Yield Report (CH2M Hill and LSCE), the management practice of the Purveyors is to utilize the Saugus in accordance with the groundwater operating plan, in the range of 7,500 to 15,000 afy in average/normal years, and planned dry-year pumping of 15,000 to 35,000 afy for one to three consecutive dry years, when shortages to CLWA's SWP water supplies could occur. Such high pumping would be followed by periods of lower pumpage (the 7,500 to 15,000 afy in average/normal years as noted above) in order to allow recharge to recover water levels and storage in the Saugus. Maintaining the substantial volume of water in the Saugus Formation is an important strategy to help maintain water supplies in the Santa Clarita Valley during drought periods.

3.3.1 Saugus Formation – Historical and Current Conditions

Total pumpage from the Saugus in 2005 was slightly less than 6,500 af, essentially the same as in the preceding year. Of the total Saugus pumpage in 2005, most (nearly 6,000 af) was for municipal water supply, and the balance (500 af) was for agricultural and other irrigation uses. Groundwater pumpage from the Saugus peaked in the early 1990's and then steadily declined through the remainder of that decade. Since then, Saugus pumpage has been in the range of about 4,000 to 6,500 afy. On a long-term average basis since the importation of SWP water, total pumpage from the Saugus Formation has ranged from a low of about 3,700 afy (in 1999) to a high of nearly 15,000 afy (in 1991); average pumpage from 1980 to present has been about 6,700 afy. These pumping rates remain well within, and generally at the lower end of the range of operational yield of the Saugus Formation. The overall historic record of Saugus pumping is illustrated in Figure III-8.

Unlike the Alluvium, which has an abundance of wells with extensive water level records, the water level data for the Saugus Formation are limited by the distribution of the wells in this Formation and the periods of record. The wells that do have water level records extending back to the mid-1960's indicate that groundwater levels in the Saugus Formation were highest in the mid-1980's and are currently higher than they were in the mid-1960's (Figure III-9). Based on these data, there is no evidence of any historic or recent trend toward permanent water level or storage decline.

Consistent with the 2001 Update Report (Slade), the 2005 Basin Yield Report (CH2M Hill and LSCE), and the 2005 UWMP, the management practice of the Purveyors continues to be to maintain groundwater storage and associated water levels in the Saugus Formation so that supply is available during drought periods, when Alluvial pumping might be reduced and SWP supplies could be decreased. The period of increased pumpage during the late 1980's and early 1990's is a good example of this management strategy. Most notably, in 1991, when SWP deliveries were substantially reduced, increased pumpage from the Saugus made up almost half of the decrease in SWP deliveries. This increased Saugus pumpage resulted in short-term declining water levels reflecting the use of stored water. However, the water levels subsequently rose when pumpage declined, reflecting recovery of storage capacity of the Saugus Formation.

3.4 Imported Water

CLWA obtains water supplies from the SWP, which is owned and operated by the California Department of Water Resources (DWR). CLWA is one of 29 contractors holding long-term SWP contracts with DWR. SWP water originates as rainfall and snowmelt in northern and central California. Runoff is stored in Lake Oroville, which is the project's largest storage facility. The water is then released from Lake Oroville down the Feather River to the Sacramento River and the Sacramento-San Joaquin Delta. Water is diverted from the Delta into the Clifton Court Forebay, and then pumped into the 444-mile long California Aqueduct. SWP water is temporarily stored in San Luis Reservoir, which is jointly operated by DWR and the U.S. Bureau of Reclamation. Prior to delivery to CLWA, SWP supplies are stored in Castaic Lake, located at the end of the West Branch of the California Aqueduct.

CLWA's service area covers approximately 195 square miles (124,800 acres), including the entire City of Santa Clarita and surrounding unincorporated communities. CLWA obtains SWP water from a SWP terminal reservoir, Castaic Lake. The water is treated, filtered and disinfected at CLWA's Earl Schmidt Filtration Plant and Rio Vista Water Treatment Plant, which have a combined treatment capacity of 86 million gallons per day. Treated water is delivered from the treatment plants by gravity flow to each of the four Purveyors through a distribution network of pipelines and turnouts. At present, CLWA delivers water to the four Purveyors through 18 turnouts.

In 2005, CLWA fulfilled the following major accomplishments in order to enhance, preserve, and strengthen the quality and reliability of existing and future supplies:

- Completed expansion of the Earl Schmidt Filtration Plant from 33.5 mgd to 56 mgd;
- Progressed on construction of the Sand Canyon Pipeline and Reservoir;
- Completed construction of the Pitchess Pipeline;
- Adopted the 2005 Urban Water Management Plan;
- Initiated participation in a long-term water banking program with Rosedale-Rio Bravo Water Storage District and delivered 20,000 af of water into storage, as recommended in the UWMP;

- Obtained the right to utilize 1,376 af of flexible storage in Castaic Lake through an agreement with Ventura County SWP contractors;
- Continued implementation of various water supply programs recommended in the UWMP;
- Continued implementation of the AB 3030 Groundwater Management Plan;
- Continued implementation of the water conservation Best Management Practices;
- Continued cooperative effort with the U.S. Army Corps of Engineers for characterization studies of the former Whittaker-Bermite site and in a task force effort with the City of Santa Clarita, local legislators, and state agencies to effect the clean-up and remediation of all aspects of the former Whittaker-Bermite site, including the perchlorate groundwater contamination;
- Continued work on the design and construction of facilities for restoration of groundwater supply wells impacted by perchlorate contamination;
- Continued recycled water service.

3.4.1 State Water Project Table A Supplies

Each SWP contractor has a specified water supply amount shown in Table A of its contract that currently totals approximately 4.1 million af. The term of the contract is through 2035 and is renewable after that year. Although the SWP has not been fully completed, the SWP can deliver all of the 4.1 million af of Table A Amounts during very wet years.

CLWA has a contractual Table A Amount of 95,200 af per year of water from SWP.[2] CLWA's final allocation of Table A Amount for 2005 was 90 percent, or 85,680 af. On December 1, 2004, the initial allocation for 2004 was announced as 40 percent. On January 14, 2005, it was

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[2] 41,000 af of CLWA's 95,200 af Table A Amount was acquired from the Wheeler Ridge-Maricopa Water Storage District by way of a Table A water transfer agreement executed in March 1999. CLWA prepared an environmental impact report (EIR) to address the environmental consequences of the transfer agreement. The environmental review for the project by CLWA was the subject of litigation in Los Angeles Superior Court. CLWA prevailed in the EIR litigation at the trial court; however, the project opponents (Friends of the Santa Clara River) filed an appeal.

In January 2002, the Court of Appeal issued a decision ordering the Superior Court to decertify the EIR for the transfer agreement on the grounds that it had tiered off of another EIR that had been subsequently decertified in other litigation. In doing so, however, the Court of Appeal also examined all of the plantiffs' other arguments, found them to be without merit, and held that, if the tiering problem had not arisen, it would have affirmed the earlier trial court judgment upholding the EIR.

The Court of Appeal did not invalidate any portion of the completed 41,000 afy transfer agreement. Instead, the Court directed the trial court to vacate certification of the EIR, and to retain jurisdiction until CLWA corrects the tiering technicality by preparing a new EIR. In September 2002, the Los Angeles Superior Court refused to prohibit CLWA from using the 41,000 af of Table A water while a new EIR is being prepared. The Superior Court decision on remand was appealed by Friends of the Santa Clara River to the appellate court in January 2003. In December 2003, the appellate court denied any relief to Friends and affirmed the trial court's ruling.

The revised EIR was released for public review and comment in April 2004. It was subsequently certified by the CLWA Board of Directors on December 23, 2004. On January 24, 2005, separate lawsuits challenging the environmental review for this same project were filed by California Water Impact Network and Planning and Conservation League in the Ventura County Superior Court.

raised to 60 percent. On April 21, 2005 the allocation was raised to 80 percent. On May 27, 2005, it was raised to the final allocation of 90 percent. Utilizing SWP contract provisions, CLWA elected to "carry over" unused remaining Table A Amount into 2006.

CLWA also has access to 4,684 af of "flexible storage" in Castaic Lake. In addition, during 2005 CLWA negotiated an agreement with the Ventura County SWP contractors to allow CLWA to utilize their flexible storage account of 1,376 af. This provides total flexible storage of 6,060 af, which is maintained in Castaic Lake for use in a future dry period or an emergency. This amount was available in 2005, but was not utilized due to wet conditions statewide.

As shown in Table III-1, due to the 90 percent allocation, CLWA had excess SWP water in 2005. As DWR increased the allocation through the year, and due to a total of 2,702 af of carryover from 2004, the total available SWP supply in 2005 was 88,382 af. CLWA deliveries were 38,034 af to the Purveyors, and 20,000 af to its Rosedale-Rio Bravo Banking Program, leaving more than 31,000 af of Table A Amount available for carryover to 2006. Portions of the carryover water from 2004 and 2005 were utilized for local deliveries to the Purveyors, as well as Rosedale-Rio Bravo banking program deliveries; the remainder reverted to overall SWP use, and was allocated among all SWP contractors.

In 2005 CLWA completed an agreement to participate in a long-term water banking program with Rosedale-Rio Bravo Water Storage District in Kern County and delivered 20,000 af of Table A Amount water into storage. This long-term program will allow the storage of 100,000 af at any one time, and will provide significant dry year reliability for the Santa Clarita Valley.

As described in earlier Water Reports, agreements were reached in 2002 and 2004 with the Semitropic Water Storage District in Kern County for groundwater banking purposes. CLWA banked portions of its allocated 2002 and 2003 SWP Table A Amounts in Semitropic and, as a result, has short-term dry year supply available for extraction from that groundwater storage in Kern County until 2012/13.

3.4.2 Imported Water Supply Reliability

In May 2003 the Department of Water Resources finalized its State Water Project Delivery Reliability Report. This report is intended to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies. The report is updated with new information and calculations of delivery reliability every two years, and an updated draft was provided to the SWP Contractors in May 2005 for use in producing their 2005 UWMPs. A discussion of the Reliability Report, as well as the most significant opportunities for meeting the future water supply needs of the Santa Clarita Valley, is provided in the 2005 UWMP.

Groundwater banking and conjunctive use offer significant opportunities to improve water supply reliability for CLWA. Groundwater banking is the process of storing available supplies of water during wet years in groundwater basins. Conjunctive use is the coordinated operation of multiple water supplies to achieve improved supply reliability. During wet periods, additional surface water supplies from the SWP can be used to recharge a local groundwater basin and then recovered for delivery during dry periods.

Table III-1
2005 CLWA State Water Project Supply and Disposition
(acre-feet)

Supply		
Net 2004 Carryover to 2005 [1]		2,702
CLWA 2005 Final Allocation [2]		85,680
Total 2005 SWP Supply		**88,382**
Disposition		
Purveyor Deliveries (Total)		38,034
CLWA SCWD	*16,513*	
Valencia Water Company	*14,732*	
Newhall County Water District	*5,932*	
Los Angeles County WWD 36	*857*	
CLWA/DWR/Purveyor Metering[3]		(1,029)
Rosedale – Rio Bravo WSD Storage Program		20,000
2005 Table A Carryover to 2006[4]		31,377
Total 2005 SWP Disposition [4]		**88,382**

1. Amount used by CLWA, based on final DWR delivery accounting; total 2004 carryover was 15,522 af.

2. Final 2005 allocation was 90% of contractual Table A amount of 95,200 acre-feet, which progressed as follows:

Initial allocation (Dec. 1, 2004)	40%
Allocation increase (Jan. 14, 2005)	60%
Allocation increase (Apr. 21, 2005)	80%
Final allocation (May 27, 2005)	90%

Does not include 2,451 af of Article 21 water used at CLWA's Devil's Den Ranch in Kern and Kings Counties.

3. Reflects meter reading differences and meter outage in 2005 winter storms.

4. Total 2005 Table A carryover to 2006.

As previously described, CLWA entered into two 10-year agreements with Semitropic Water Storage District to bank water for subsequent use in dry years. During that period, CLWA can withdraw up to 50,870 af of 2002 and 2003 SWP Table A water that it stored in Semitropic to meet Valley demands when needed.[3]

As also previously described, CLWA's long-term water banking program with Rosedale-Rio Bravo Water Storage District in Kern County provides significant dry year reliability for the Santa Clarita Valley.

3.5 Water Quality – General

Water delivered by the Purveyors consistently meets drinking water standards set by the Environmental Protection Agency (EPA) and the California Department of Health Services (DHS). An annual Consumer Confidence Report is provided to all Santa Clarita Valley residents who receive water from one of the four water retailers. There is detailed information in that report, about the results of quality testing of the groundwater and treated SWP water supplied to the residents of the Santa Clarita Valley during 2004.

Water quality regulations are constantly changing as contaminants that are typically not found in drinking water are being discovered, and new standards are adopted. In addition, existing water quality standards are becoming more stringent in terms of allowable levels in drinking water. In light of these changes, several constituents of particular interest are discussed in more detail below.

Total Trihalomethanes

In 2002, the United States Environmental Protection Agency implemented the new Disinfectants and Disinfection Byproducts Rule. In part, this rule establishes a new MCL of 80 ug/L (based on an annual running average) for Total Trihalomethanes (TTHM). TTHMs are a byproduct that is created when free chlorine is used as a means for disinfection. To address potential TTHM formation, CLWA and the Purveyors implemented an alternative method of disinfection, chloramination, in 2005 to be able to maintain compliance with the new rule and future regulations relating to disinfection byproducts. TTHM concentrations have remained significantly below the MCL since implementation of alternative disinfection.

Perchlorate

Perchlorate has been a water quality concern in the Valley since 1997 when it was originally detected in four Saugus wells operated by the Purveyors in the eastern part of the Saugus Formation, near the former Whittaker-Bermite facility. In late 2002, perchlorate was detected in a fifth municipal well, in this case an Alluvial well also located near the former Whittaker-Bermite site. In early 2005, perchlorate was detected in a second Alluvial well near the former Whittaker-Bermite site. The six perchlorate-impacted wells were removed from active water supply service after detection of perchlorate. One of the Alluviual wells was returned to active water supply service, with treatment, in late 2005 as discussed below; the other impacted wells remain out of service. The 2005 UWMP specifically addressed the adequacy of groundwater

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[3] Legal challenges to the 2002 banking program with Semitropic were resolved by the appellate court in favor of CLWA on all issues. It is expected the that appellate court decision should become final before July 2006.

supply in light of the inactivation of the impacted Alluvial and Saugus wells; and it addressed the plan and schedule for restoration of perchlorate-impacted wells, including the protection of existing non-impacted wells. As summarized in the 2005 UWMP, the inactivation of the impacted wells does not constrain the ability to meet the groundwater component of water supply in the Valley.

The Purveyors are continuing to test for perchlorate in all of their active Alluvial and Saugus wells at risk. The current DHS Notification Level for perchlorate is 6 micrograms per liter (ug/l). DHS had anticipated proposing a Maximum Contaminant Level (MCL) for perchlorate in 2005; the State Department of Finance is apparently considering the economic impact of several alternative MCL concentrations between 4 and 25.6 ug/l.

In 2005, the impacted Purveyors (SCWD, NCWD, and VWC) and CLWA continued working toward implementation of a jointly developed plan that will combine pumping from two of the impacted wells and a water treatment process to restore the impacted pumping capacity and control the migration of contamination in the aquifer. The plan for restoring "severely impaired" water sources such as the perchlorate-impacted wells must comply with the provisions of the State Department of Health Services' (DHS) Policy Memo 97-005. Work on the documentation required by Policy Memo 97-005 continued in 2005 such that DHS approval is anticipated by early fall, 2006.

The development and implementation of a cleanup plan for the Whittaker-Bermite site and the impacted groundwater is being coordinated among CLWA, the impacted Purveyors, the State Department of Toxic Substance Control (DTSC), and U.S. Army Corps of Engineers. DTSC is the lead agency responsible for regulatory oversight of the Whittaker-Bermite site. In February 2003, DTSC and the impacted Purveyors entered into a voluntary cleanup agreement entitled *Environmental Oversight Agreement*. Under the Agreement, DTSC is providing review and oversight of the response activities being undertaken by the Purveyors related to the detection of perchlorate in the impacted wells. Under the Agreement's Scope of Work, the impacted Purveyors have prepared a Work Plan for sampling the production wells, prepared a report in the results and findings of the production well sampling, prepared a draft Human Health Risk Assessment, prepared a draft Remedial Action Workplan, completed the evaluation of treatment technologies, and completed an analysis to show the integrated effectiveness of a project to restore impacted pumping capacity, extract perchlorate for treatment, and control the migration of perchlorate in the Saugus Formation. Environmental review of that project was completed in September with adoption of a mitigated Negative Declaration. The Final Interim Remedial Action Plan (IRAP) for containment and extraction of perchlorate was completed and approved by DTSC in December. Construction of facilities and pipelines necessary to implement the pump and treat program and to also restore inactivated well capacity is anticipated to commence in the fall of 2006. On the Whittaker-Bermite site, notable accomplishments in 2005 included startup of soil remediation activities in operating unit subareas, and initiation of groundwater pump and treat operations in the Northern Alluvium.

As noted above, perchlorate was detected in a second Alluvial well, VWC's Well Q2, in early 2005. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. The Q2 Report (LSCE, 2005) documented that the temporary inactivation of Well Q2 would not significantly impact the water supplies used to meet demand in the Santa Clarita Valley for the period of time required to respond to the contamination. The results of the Q2 analysis and Report are consistent with the analysis and conclusions in the UWMP. Valencia's response plan for Well Q2 was to pursue permitting and installation of wellhead treatment through the summer of 2005, and to then return the well to water supply service. That work was successfully completed, with wellhead treatment installed by September, and Well Q2 was returned to active water supply service in October.

In 2000, CLWA and the impacted Purveyors had filed a lawsuit against Whittaker Corporation (the former owner of the contaminated property) and Santa Clarita LLC and Remediation Financial, Inc. (the current owners). The lawsuit seeks to have defendants pay all necessary costs of response, removal of the contaminant, remedial action costs, and any liabilities or damages associated with the contamination. Although an Interim Settlement Agreement expired in January 2005, the parties, under California Department of Toxic Substances oversight, jointly developed a plan in 2005 to "pump and treat" contaminated water from two of the Purveyors' impacted wells to stop migration of the contaminant plume. Also during the year, the parties continued negotiations intended to achieve a long term settlement to the litigation; as of March 2006 the negotiations are ongoing.

3.5.1 Groundwater Quality – Alluvium

Groundwater quality is, of course, a key factor in assessing the Alluvial aquifer as a municipal and agricultural water supply. Groundwater quality details and long-term conditions, examined by integration of individual records from several wells completed in the same aquifer materials and in close proximity to each other, have been discussed in previous Annual Water Reports and, most recently, in the 2005 UWMP. There were no changes in groundwater quality in 2005 that would change any of the fluctuations, trends, or other groundwater quality conditions as illustrated in Figures III-10 and III-11. In summary, those conditions include: no long-term overall trend, and most notably no long-term decline in Alluvial groundwater quality; a general groundwater quality "gradient" from east to west, with lowest dissolved mineral content to the east, increasing in a westerly direction; and periodic fluctuations in some parts of the basin, where groundwater quality has inversely varied with precipitation and stream flow. Those variations are typically characterized by increased mineral concentrations through dry, lower stream flow, and lower recharge conditions, followed by lower mineral concentrations through wetter, higher stream flow, higher recharge conditions.

The presence of long-term consistent water quality patterns, although intermittently affected by wet and dry cycles, supports the conclusion that the Alluvial aquifer remains a viable ongoing water supply source in terms of groundwater quality.

3.5.2 Groundwater Quality – Saugus Formation

As discussed above for the Alluvium, groundwater quality is a key factor in also assessing the Saugus Formation as a municipal and agricultural water supply. As with groundwater level data, long-term Saugus groundwater quality data are not sufficiently extensive to permit any sort of basin-wide analysis or assessment of pumping-related impacts on quality. However, integration of individual records from several wells has been used to examine general water quality trends. Based on those records, water quality in the Saugus Formation has not historically exhibited the precipitation-related fluctuations seen in the Alluvium. Based on available data over the last 50 years, groundwater quality in the Saugus has exhibited a slight overall increase in dissolved mineral content as illustrated in Figure III-12. More recently, several wells within the Saugus Formation have exhibited an additional increase in dissolved mineral content, similar to short-term changes in the Alluvium, possibly as a result of recharge to the Saugus Formation from the Alluvium. Dissolved mineral concentrations in the Saugus Formation remain below the Secondary (aesthetic) Upper Maximum Contaminant Level. Groundwater quality within the Saugus will continue to be monitored to ensure that degradation to the long-term viability of the Saugus as an agricultural or municipal water supply does not occur.

3.5.3 Imported Water Quality

CLWA operates two water treatment plants, the Earl Schmidt Filtration Plant located near Castaic Lake and the Rio Vista Water Treatment Plant located in Saugus. CLWA produces water that meets drinking water standards set by the U.S. EPA and California DHS. SWP water has different aesthetic characteristics than groundwater with lower dissolved mineral concentrations (total dissolved solids) of approximately 280 to 314 mg/L, and lower hardness (as calcium carbonate) of 130 to 170 mg/l.

3.6 Recycled Water

Recycled water is available from two existing water reclamation plants operated by the Sanitation Districts of Los Angeles County. In 1993, CLWA prepared a draft Reclaimed Water System Master Plan that outlined a multi-phase program to deliver recycled water in the Valley. CLWA has completed environmental review on the construction of Phase I of the project, which will deliver 1,700 afy of water. Deliveries of recycled water began in 2003 for irrigation water supply at a golf course and in roadway median strips. In 2005, recycled water deliveries were 438 af.

Surveys conducted by CLWA indicate an interest for recycled water by existing water users as well as future development when it becomes available. In 2002, CLWA produced an updated Draft Recycled Water Master Plan. Overall, the program is expected to ultimately reclaim up to 17,000 af of treated (tertiary) wastewater suitable for reuse on golf courses, landscaping and other non-potable uses, as set forth in the UWMP.

CLWA has initiated California Environmental Quality Act (CEQA) analysis of the Recycled Water Master Plan (2002). This analysis will result in a Program Environmental Impact Report covering the various options for a recycled water system outlined in the Master Plan. A Notice of Preparation was released for public review in April 2005. The EIR is expected to be finalized by September 2006.

3.7 Santa Clara River

A significant accomplishment in 2001 was the preparation and execution of a Memorandum of Understanding (MOU) between the Santa Clarita Valley Purveyors and the United Water Conservation District, which manages surface and groundwater resources in seven groundwater basins in the Lower Santa Clara River Valley Area. The MOU initiated a collaborative and integrated approach to data collection; database management; groundwater flow modeling; assessment of groundwater basin conditions, including determination of basin yield amounts; and preparation and presentation of reports, including continued annual reports such as this one for current planning and consideration of development proposals, and also including more technically detailed reports on geologic and hydrologic aspects of the overall stream-aquifer system. Meetings of the MOU participants have continued, and integration of the Upper (Santa Clarita Valley) and Lower (United WCD) Santa Clara River databases has been accomplished. As discussed above, a numerical groundwater flow model of the entire Santa Clarita groundwater basin was developed and calibrated in 2002-2004. Subsequent to its initial use in 2004 for assessing the effectiveness of various scenarios to restore pumping capacity impacted by perchlorate contamination by pumping and treating groundwater for water supply while simultaneously controlling the migration of contaminated groundwater, the model was used in 2005 for evaluation of basin yield under varying management actions and hydrologic conditions. The results completed the determination of sustainable operating yield values for both the Alluvium and the Saugus Formation, which are now incorporated in the 2005 UWMP.

On occasion, issues have been raised about whether use and management of groundwater in the Santa Clarita Valley have adversely impacted surface water flows into Ventura County. Part of the groundwater modeling work has addressed the surface water flow question as well as groundwater levels and storage. While the sustainability of groundwater has logically derived primarily from projected long-term stability of groundwater levels and storage, it has also derived in part from modeled simulations of surface water flows and the lack of stream flow depletion by groundwater pumping. In addition, the long-term history of groundwater levels in the western and central part of the basin, as illustrated in Figures III-4 and III-5, supports the modeled analysis and suggests that groundwater has not been lowered in such a way as to induce infiltration from the river and thus impact surface water flows. Finally, long-term stream flow data gauged near the County line show notably higher flows from the Santa Clarita Valley into the uppermost downstream basin, the Piru Basin, over the last 30 to 35 years, as illustrated in Figure III-13.

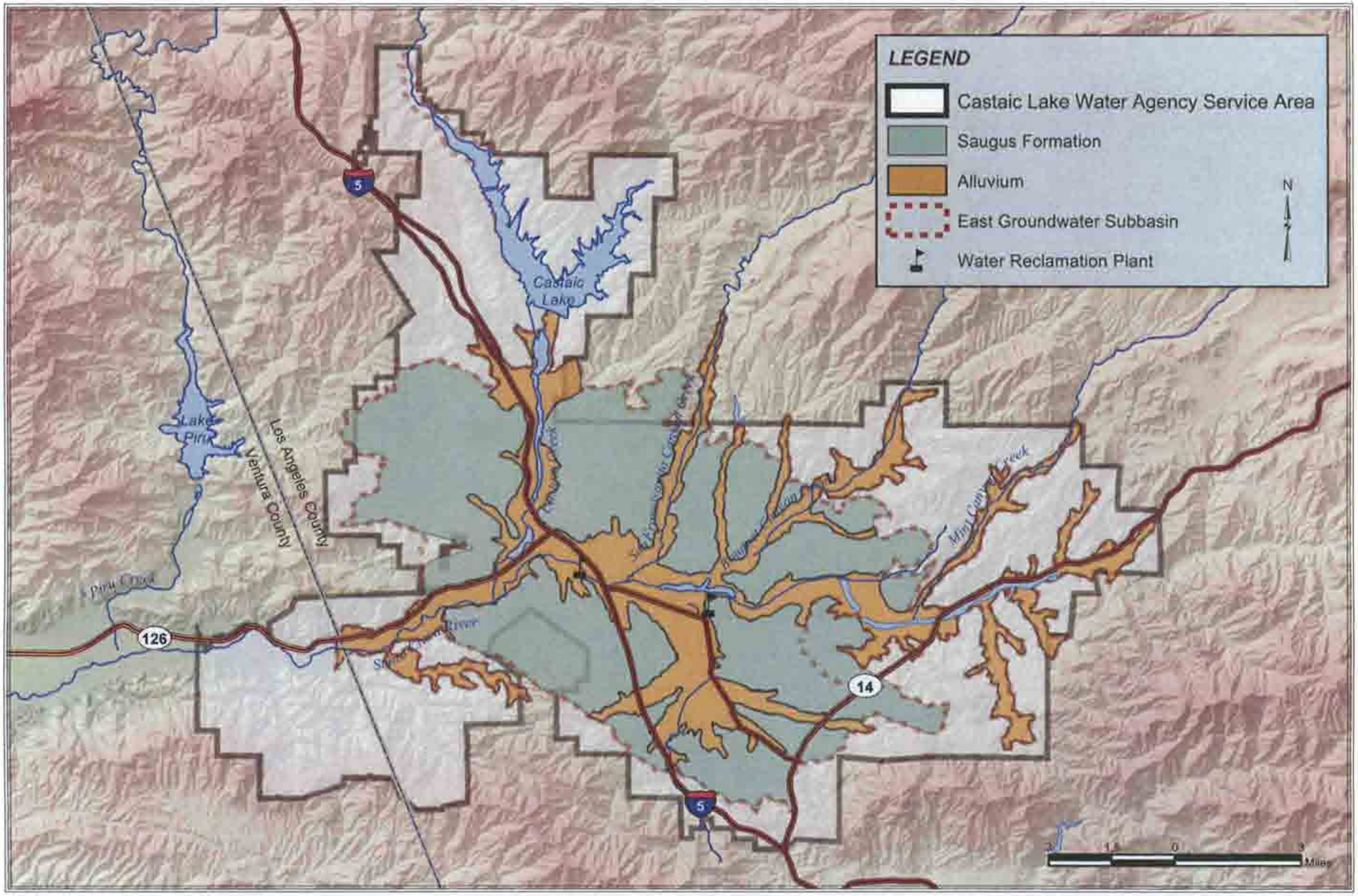

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Figure III-1
Alluvium and Saugus Formation
Santa Clara River Valley East Groundwater Subbasin

IV. Summary of 2005 Water Supply and 2006 Outlook

As reported herein, total water demands in the Santa Clarita Valley were 83,600 af in 2005. This represented a decrease of about five percent from total demand in 2004. Of the total demand in 2005, about 70,800 af was for municipal water supply, and the balance (12,800 af) was for agricultural and other uses, including individual domestic uses. As also discussed herein, the total demand in 2005 was met by a combination of local groundwater and imported SWP water, each within its respective operational yield and contractual Table A Amount, and by a small amount of recycled water.

The water demand in 2005 was less than the short-term projected demand that was estimated in the 2004 Water Report and it was also less than the demand estimated in the UWMP. For illustration, historical water use from 1980 through 2005 is plotted in Figure IV-1; also shown with that historical record are the projected total water demands in the UWMP through 2030. As discussed in the 2005 UWMP, the year-to-year fluctuations in historical water demand range from about ten percent below to about nine percent above the average or "normal" projection that would describe the long-term historical trend in the Valley's total water demand. The primary factor causing the year-to-year fluctuations is weather. In the short term, wetter years have typically resulted in decreased water demand, and drier years have typically resulted in higher water demand. Extended drier periods, however, have resulted in decreases in demand due to conservation and water shortage awareness. The decline in water demand toward the end of the 1987-92 drought is a good example of such reduced demand.

For short-term planning, recognizing the continuation of growth and near normal precipitation in early 2006, water demand in 2006 is projected to be consistent with the projections in the 2005 UWMP, or about 91,500 af. It is expected that both municipal and agricultural water demands in 2006 will be met with a generally similar mix of water supplies as in previous years, notably local groundwater and imported SWP water, complemented by recycled water that will continue to supply a small fraction of total water demand.

As of March 23, 2006, the allocation of water from the SWP in 2006 is 80 percent of CLWA's Table A Amount, or 76,160 af. Combined with local groundwater from the two aquifer systems (42,500 af), total Flexible Storage Account water (6,060 af), net carryover SWP water from 2005 (3,718 af), and recycled water (500 af), the total available water supplies for 2006 are nearly 129,000 af. Consequently, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2006. Projected 2006 water supplies and demand are summarized in Table IV-1.

Recognizing the projected surplus of supply in 2006, CLWA intends to bank an additional 20,000 af in its Rosedale-Rio Bravo WSD Banking Program in 2006.

In addition to the preceding, it is noteworthy that, while not required to meet projected demand in 2006, a total of nearly 51,000 af of recoverable water has been stored in the Semitropic Groundwater Storage Bank in Kern County. Another 17,800 af of recoverable water has been stored in a long-term water banking program with Rosedale Rio Bravo Water Storage District,

Table IV-1
2006 Water Supply and Demand
(acre-feet)

Projected 2006 Demand [1]		**91,500**
Available Water Supplies		
Local Groundwater		42,500
Alluvial Aquifer [2]	*35,000*	
Saugus Formation [3]	*7,500*	
Imported Water		85,938
Table A Amount [4]	*76,160*	
Net Carryover from 2005 [5]	*3,718*	
Flexible Storage Account (CLWA) [6]	*4,684*	
Flexible Storage Account (Ventura County) [6]	*1,376*	
Recycled Water		500
Total Available 2006 Supplies		**128,938**
Dry Year Supplies [7]		
Semitropic Groundwater Storage Bank		50,870
2002 Account	*21,600*	
2003 Account	*29,270*	
Rosedale-Rio Bravo Groundwater Storage Bank		17,800
Total Supplemental Dry Year Supplies		**68,670**

1. Interpolated from 2005 and 2010 projections in UWMP.

2. The Alluvium represents 30,000 – 40,000 afy of available supply under wet-normal conditions, and 30,000 – 35,000 afy under dry conditions. Available supply in 2006 is shown to be mid-range for average/wet conditions.

3. The Saugus represents 7,500 – 15,000 afy of available water supply under non-drought conditions, and up to 35,000 afy under increasingly dry conditions. Available supply in 2006 is shown to be limited to very wet conditions; no short-term increase in Saugus pumping is required or shown for 2006 water supply.

4. CLWA's SWP Table A amount is 95,200 af. The 2006 allocation, as of March 23, 2006 is 80 percent (76,160 af).

5. Amount used by CLWA, including 1,450 af banked in Rosedale-Rio Bravo WSD; total carryover was 31,377 af.

6. CLWA can directly utilize up to 4,684 af of storage capacity in Castaic Lake. By agreement in 2005, CLWA can also utilize 1,376 af of Ventura County SWP contractors' flexible storage capacity in Castaic Lake.

7. Does not include other reliability measures available to CLWA and the retail water Purveyors. These measures include short-term exchanges, participation in DWR's dry-year water purchase programs, local dry-year supply programs and other future groundwater storage programs.

also in Kern County. Total recoverable water in Kern County storage banks is now more than 68,000 af. However, that component of overall water supply is separately reflected in Table IV-1 because it is intended for dry-year supply and will not be used for 2006 water supply.

A significant number of local projects are part of an overall program currently funded by CLWA to provide facilities needed to firm up imported water supplies during times of drought. These involve water conservation, surface and groundwater storage, water transfers and exchanges, water recycling, additional short-term pumping from the Saugus Formation, and increasing CLWA's imported supply. This overall strategy is designed to meet increasing water demands while assuring a reasonable degree of supply reliability.

The Purveyors strive to provide a blend of groundwater and imported water to area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and location in the Valley is an operational decision and varies over time due to source availability and operational capacity of Purveyor and CLWA facilities. The goal is to conjunctively use the available water resources so that the overall reliability of water supply is maximized.

Dry periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and vice versa.

For this reason, CLWA and the Purveyors have emphasized developing water supplies that add diversity to water supply options especially in dry years. Diversity of supply is considered a key element of reliability, giving the Purveyors the ability to draw on multiple sources of supply during dry-year conditions and thereby making the Purveyors' water deliveries more reliable. As a result of this advance planning, no water shortages are anticipated in CLWA's service area for the foreseeable future.

For long-term planning purposes, water supplies and facilities are added on an incremental basis and ahead of need. It would be economically unsound to immediately, or in the short term, acquire all the facilities and water supplies needed for the next twenty to thirty years. This would unfairly burden existing customers with costs that should be borne by future customers. There are many ongoing efforts to produce an adequate and reliable supply of good quality water for Valley residents. Water consumers expect that their needs will continue to be met with a high degree of reliability and quality of service. To that end, CLWA's and the Purveyors' stated reliability goal is to deliver a reliable and high quality water supply for their customers, even during dry periods. Based on conservative water supply and demand assumptions contained in the 2005 UWMP over the next 25 years, in combination with conservation of non-essential demand during certain dry years, CLWA and the Purveyors believe implementing their water plan will successfully achieve this goal.

Groundwater Production - Alluvium

Santa Clara River Valley, East Groundwater Subbasin

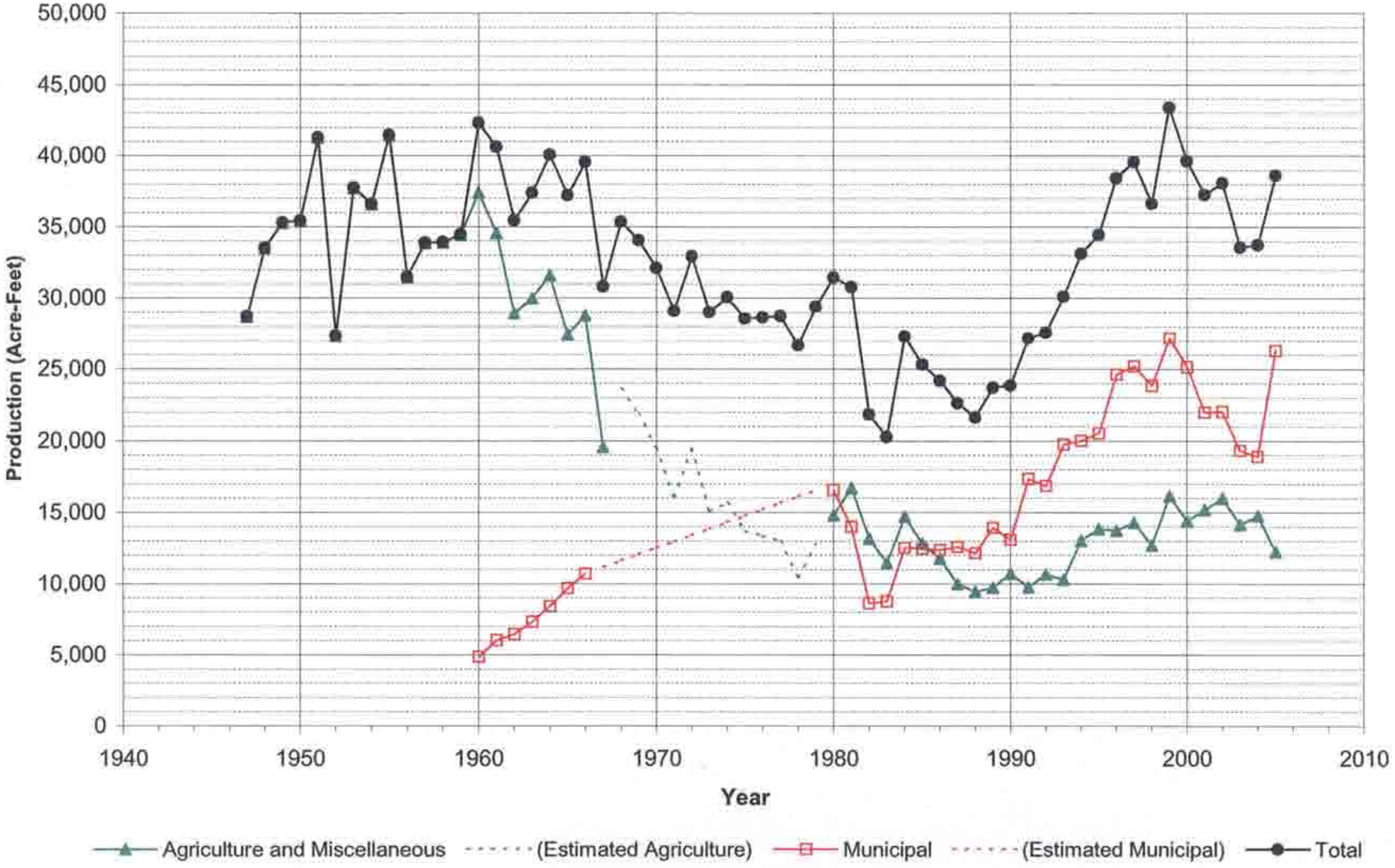

Figure III-2

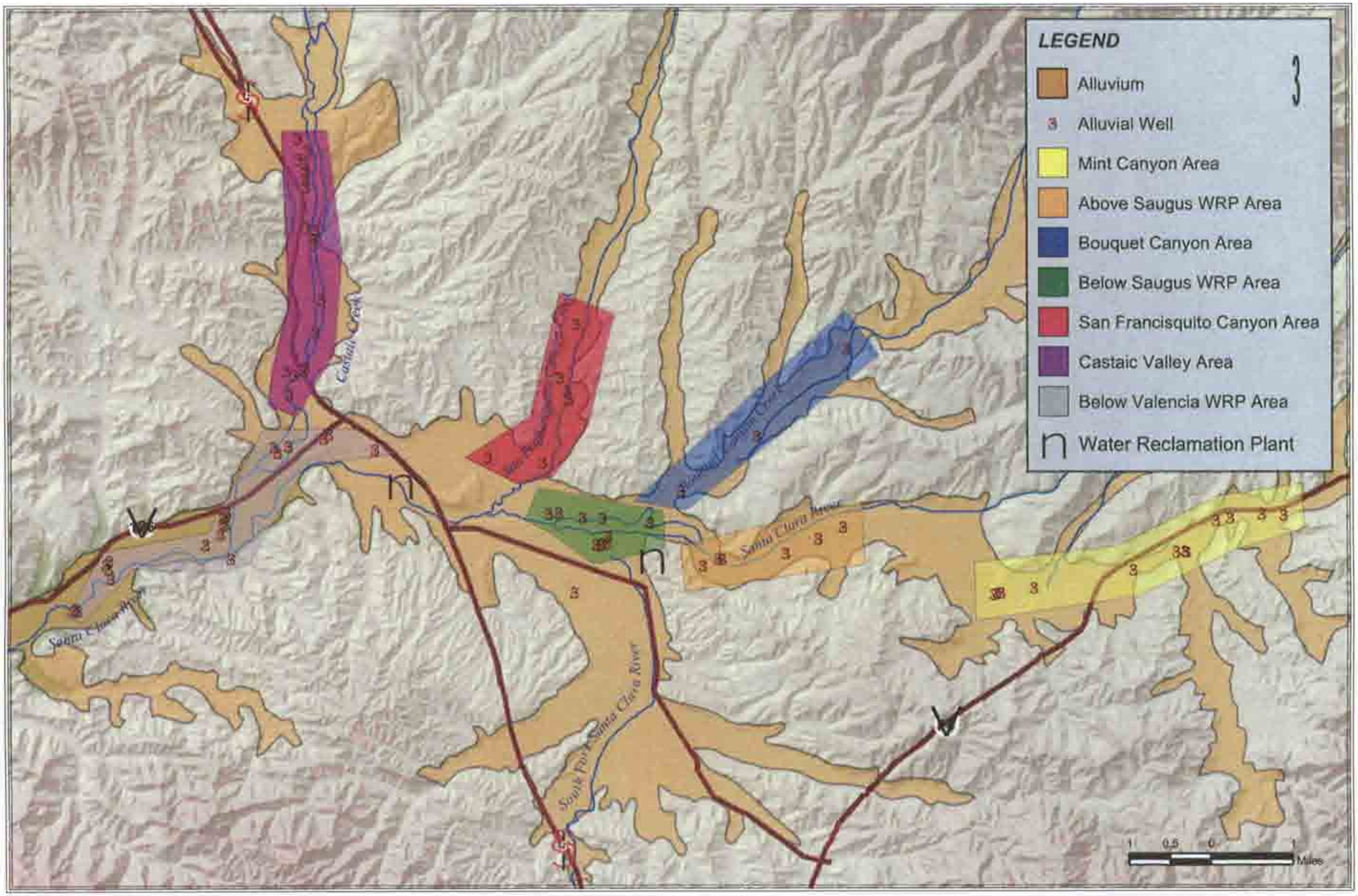

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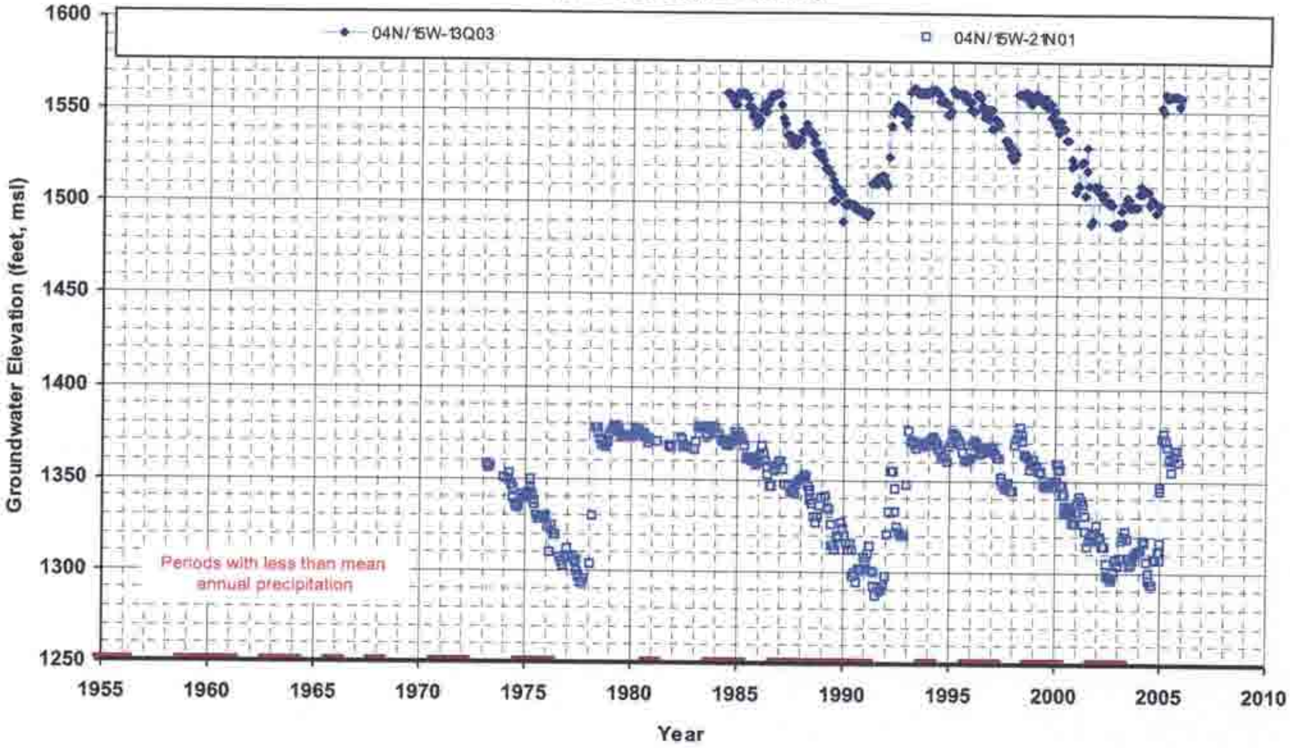
Figure III-3
Alluvial Well Locations By Area
Santa Clara River Valley, East Groundwater Subbasin

Groundwater Elevation for 'Mint Canyon' Area Alluvial Wells
(lowest and highest shown)



Groundwater Elevation for 'Below Saugus WRP' Area Alluvial Wells
(lowest and highest shown)

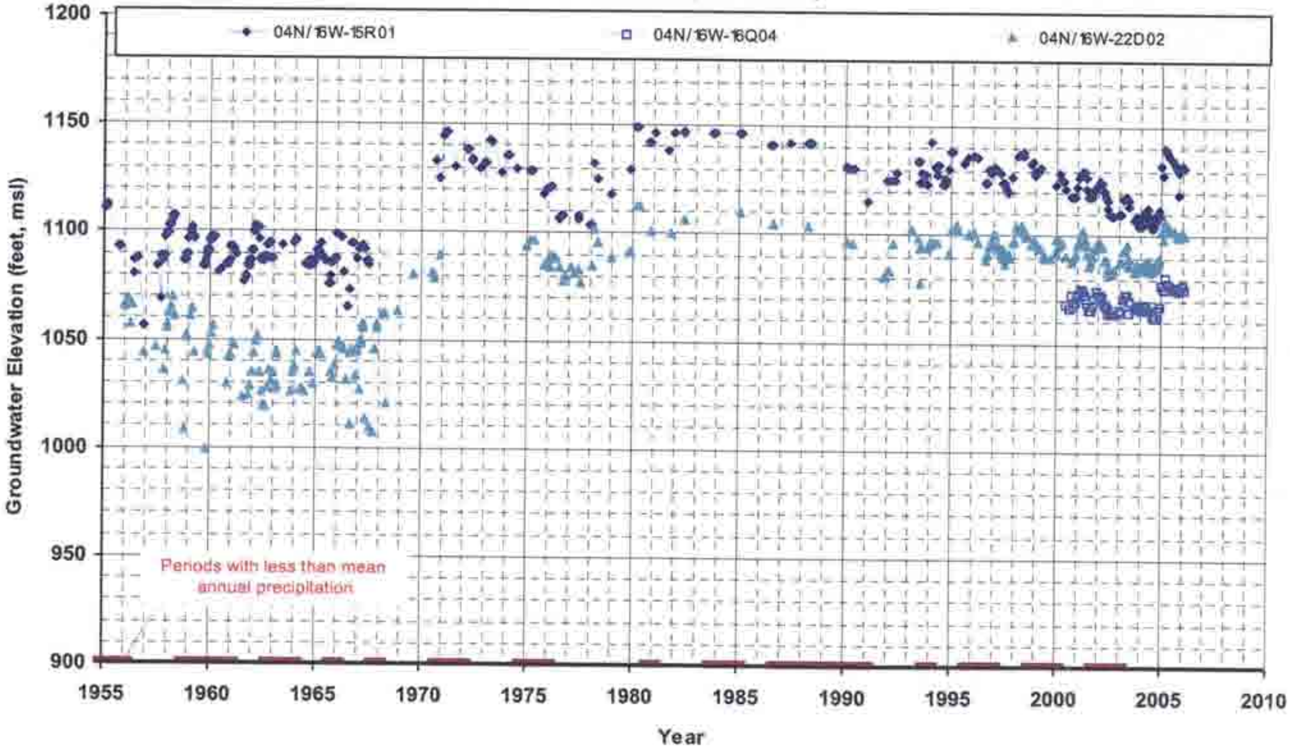
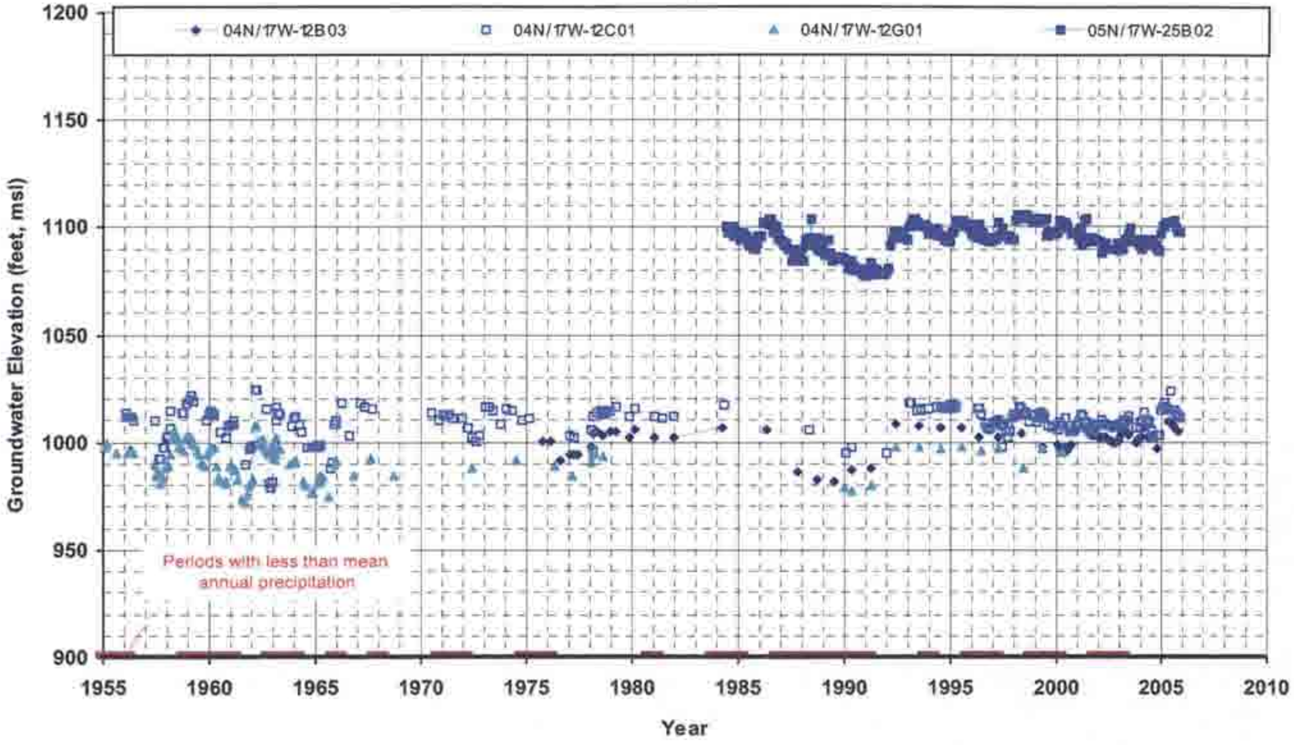


Figure III-4

Groundwater Elevation for 'Castaic Valley' Area Alluvial Wells
(lowest and highest shown)



Groundwater Elevation for 'Below Valencia WRP' Area Alluvial Wells
(lowest and highest shown)

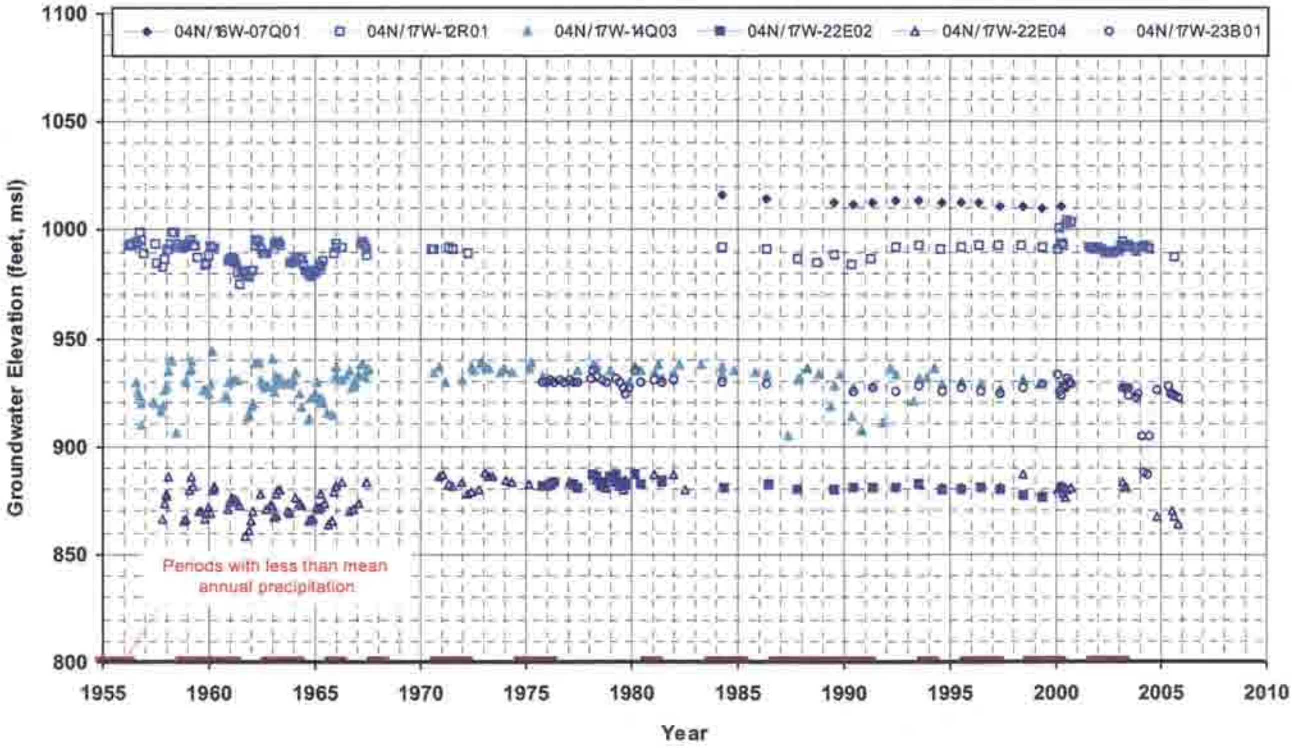


Figure III-5

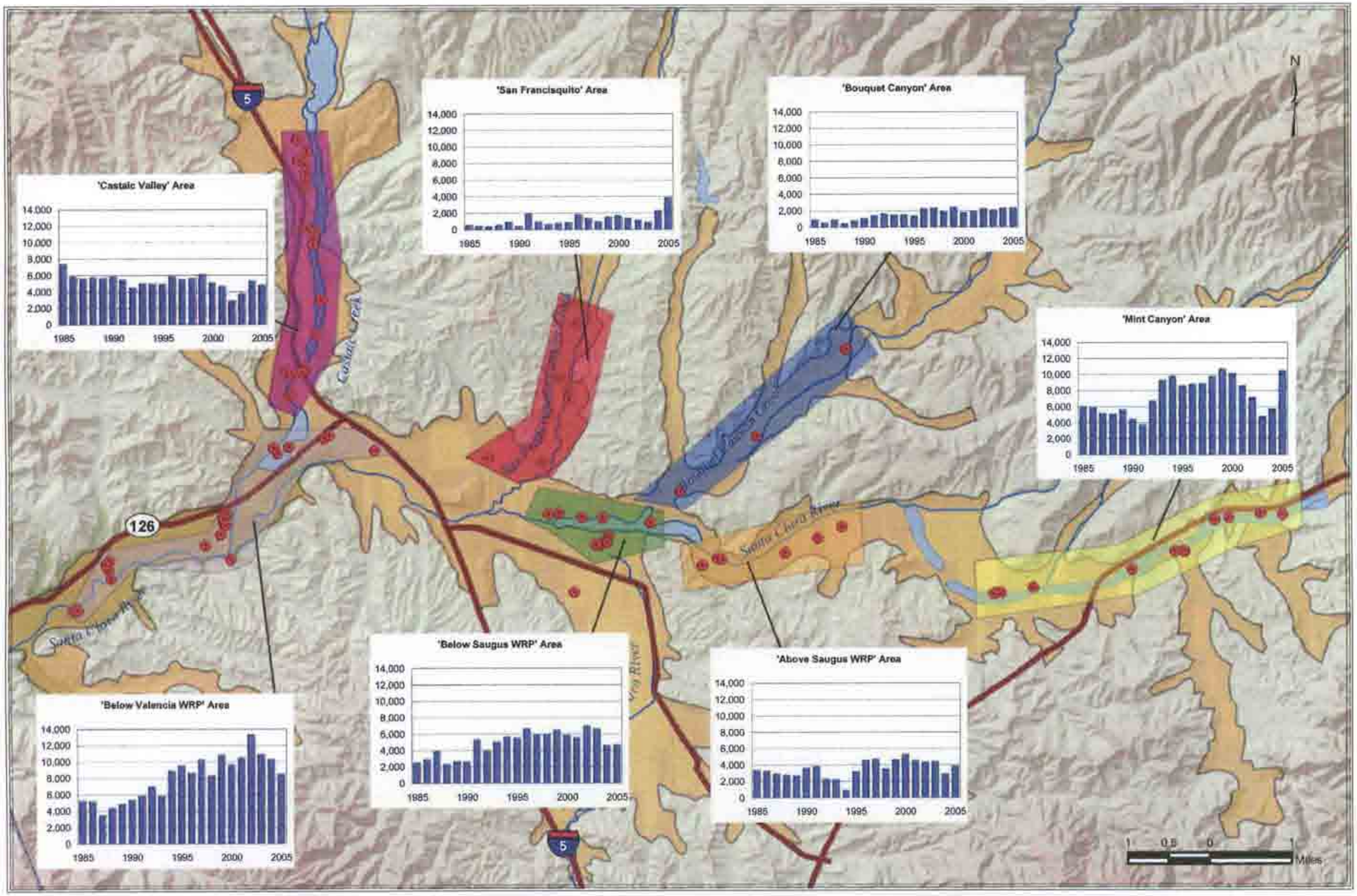


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Figure III-6
Annual Groundwater Production from Alluvium by Area (Acre-feet)
Santa Clara River Valley, East Groundwater Subbasin

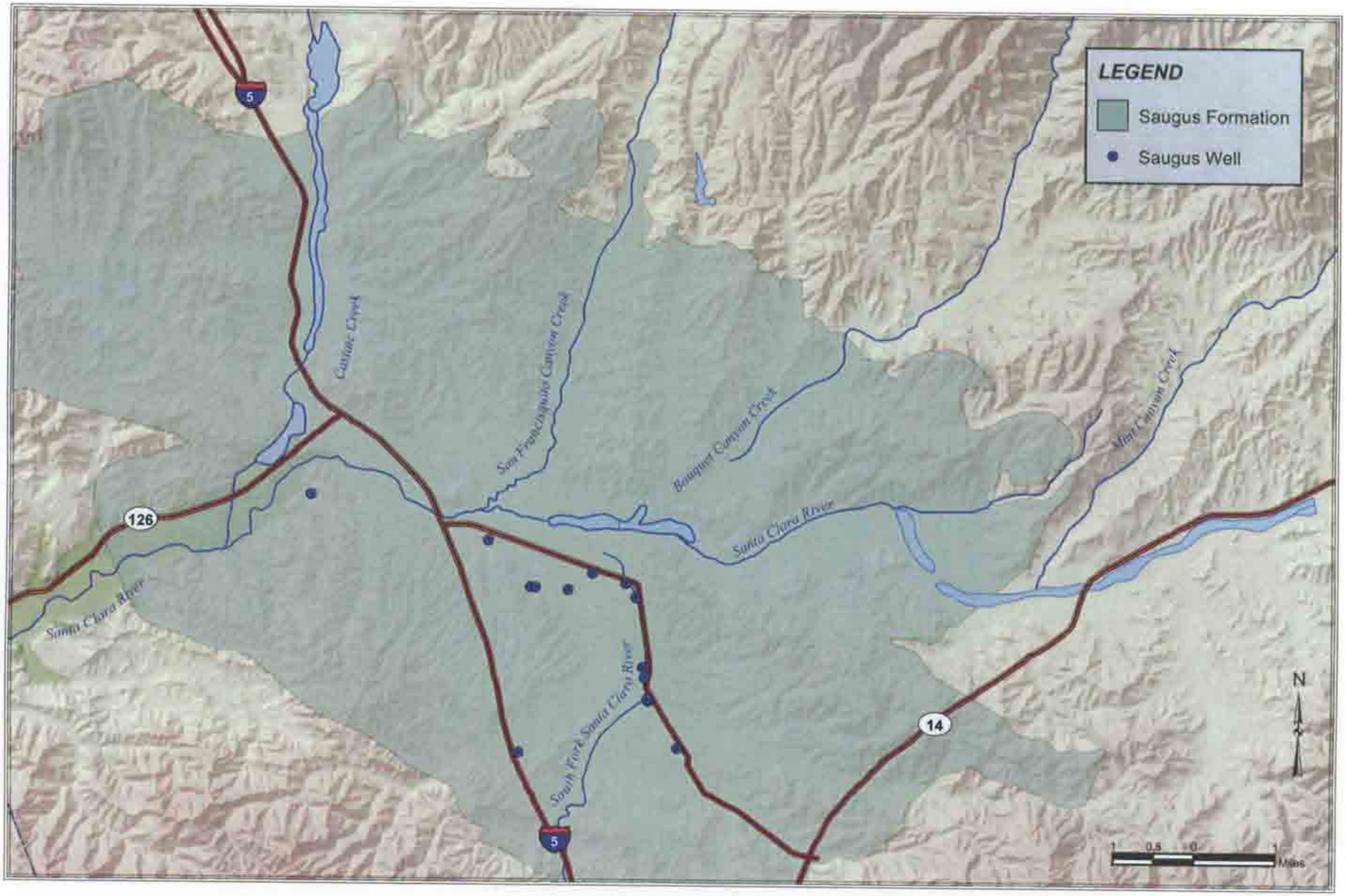

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Figure III-7
Saugus Well Locations
Santa Clara River Valley, East Groundwater Subbasin

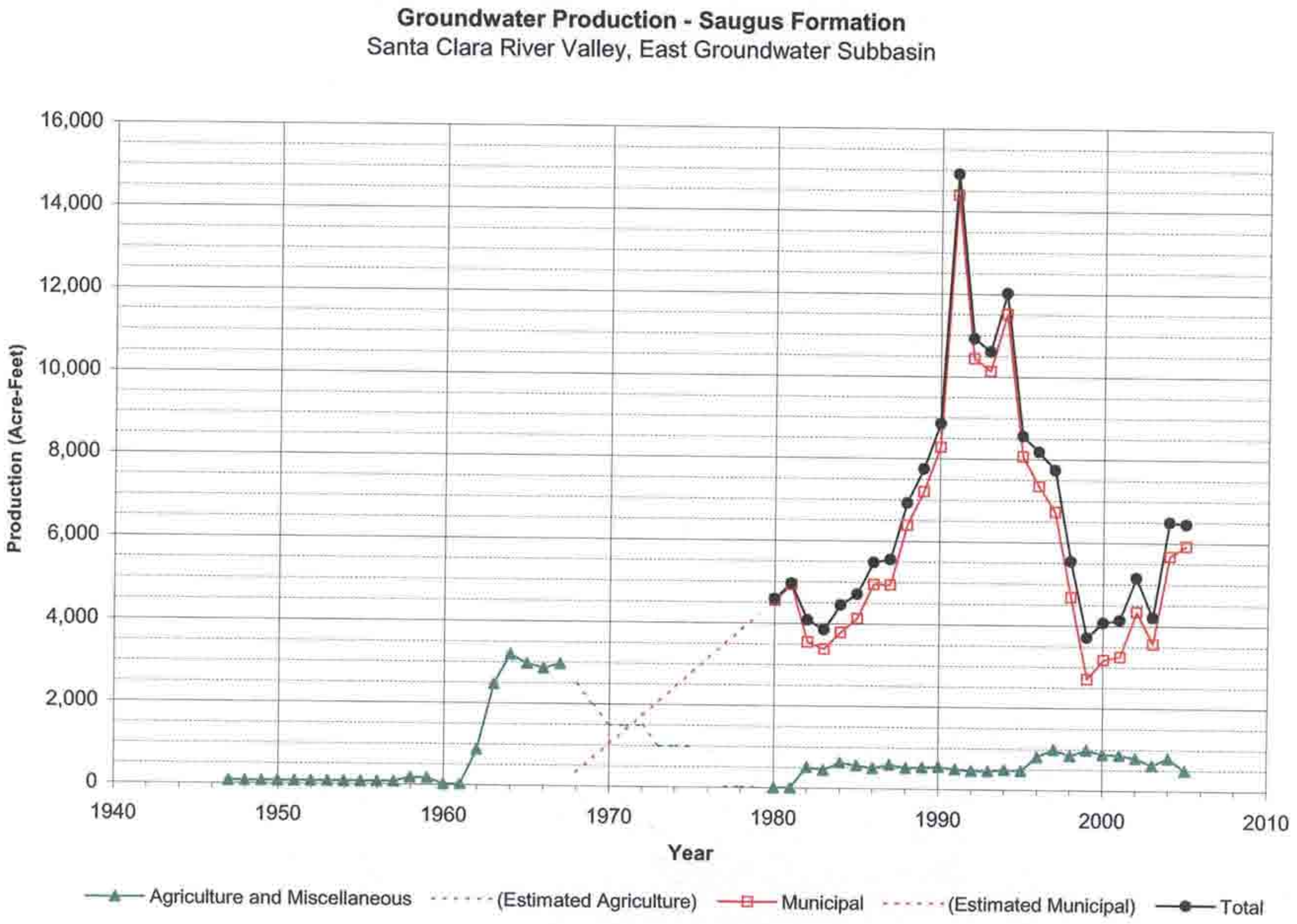
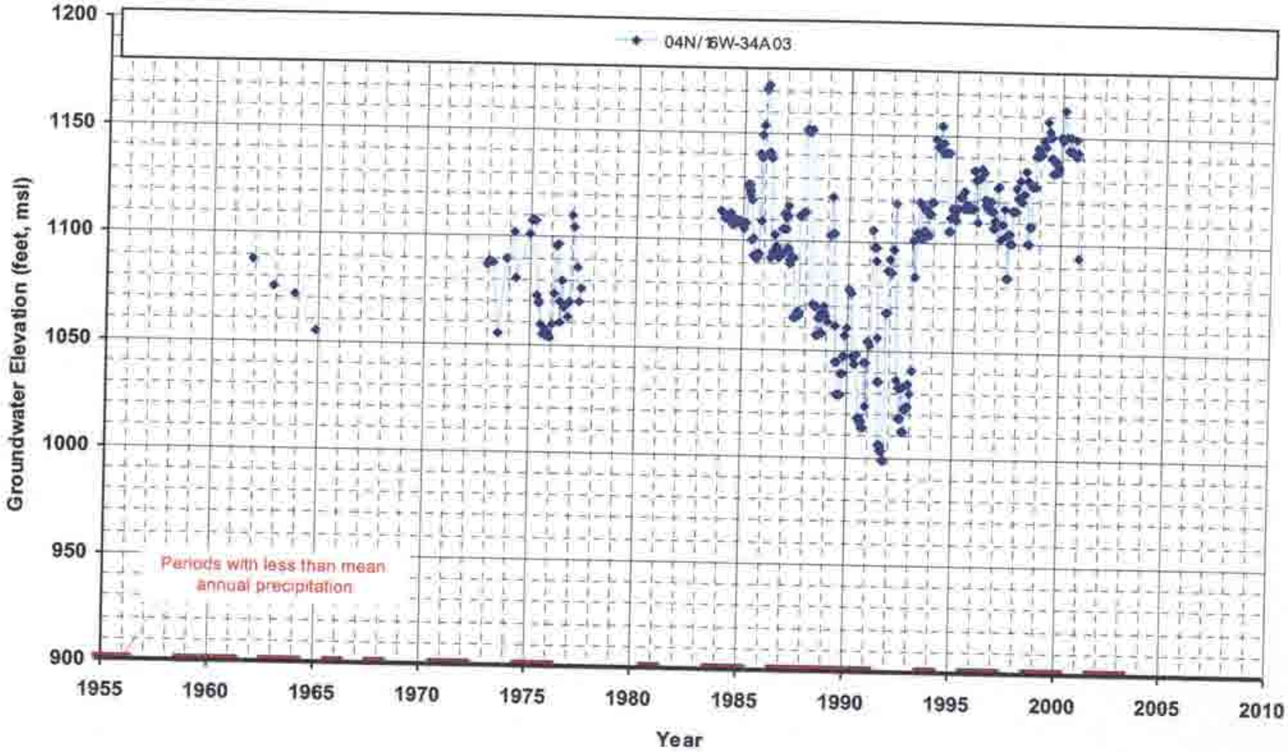

Groundwater Production - Saugus Formation
Santa Clara River Valley, East Groundwater Subbasin
Production (Acre-Feet)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1940
1950
1960
1970
1980
1990
2000
2010
Year
Agriculture and Miscellaneous
(Estimated Agriculture)
Municipal
(Estimated Municipal)
Total

Figure III-8

Groundwater Elevation for Saugus Wells



Groundwater Elevation for Saugus Wells

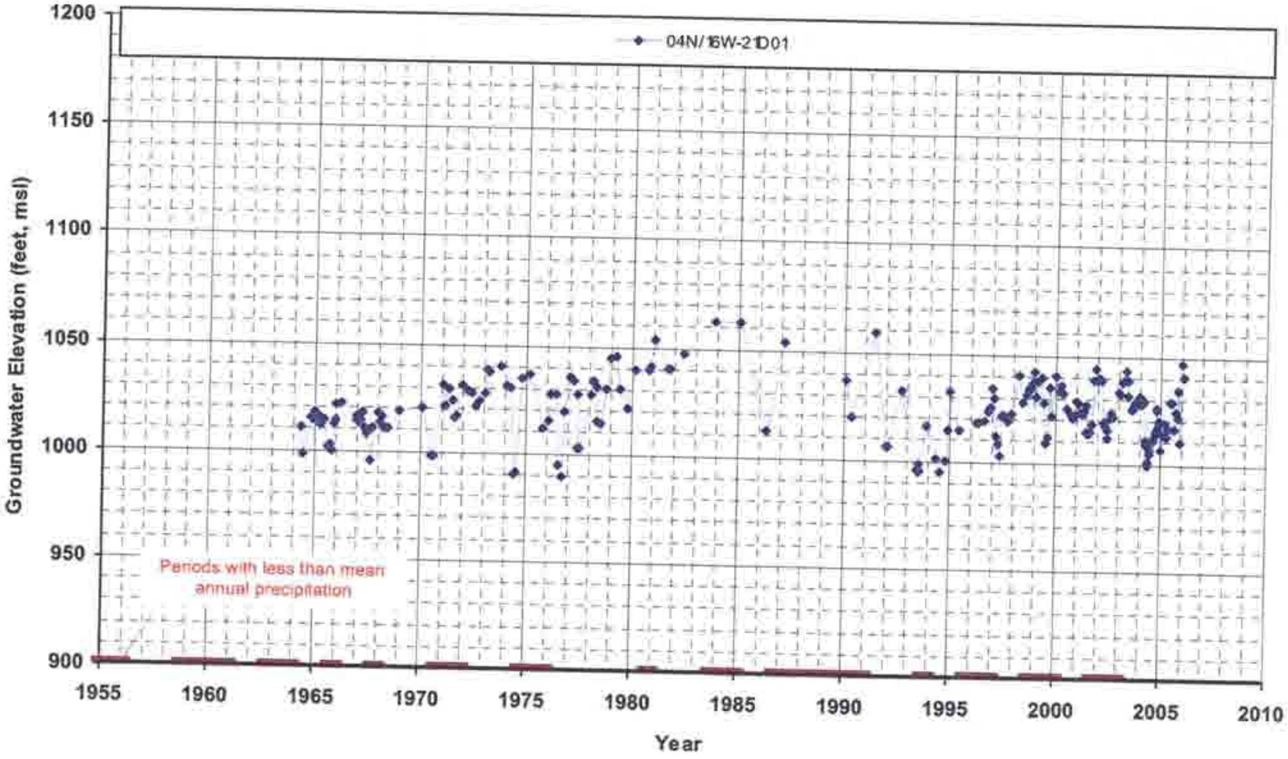
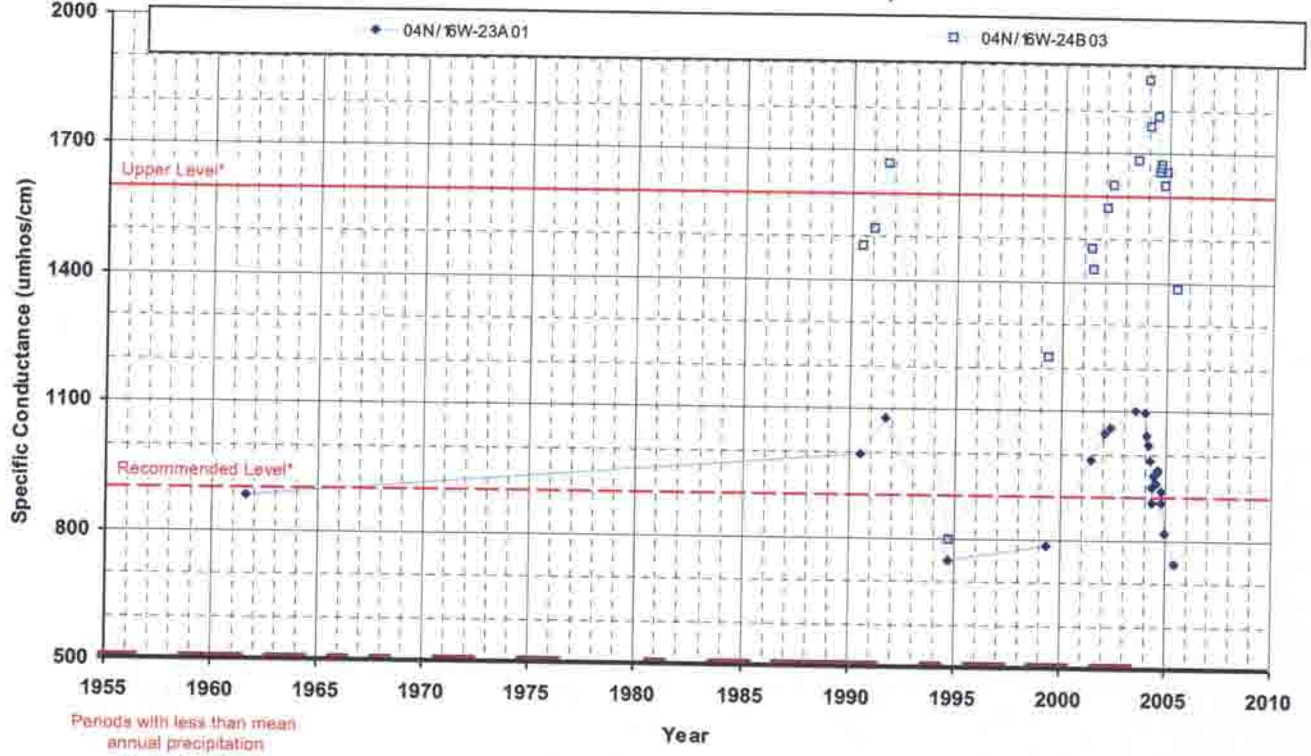
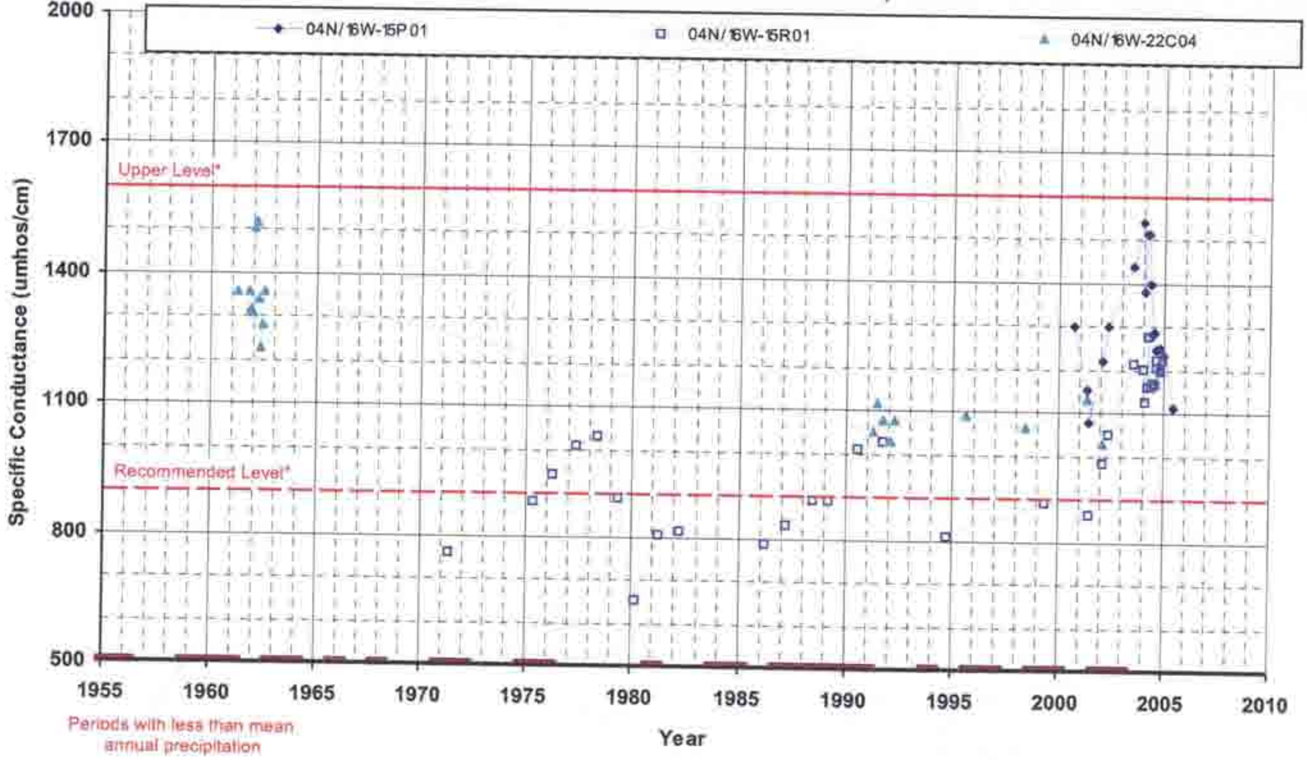


Figure III-9

Water Quality for 'Above Saugus WRP' Area Alluvial Wells
(representative selection for area shown)



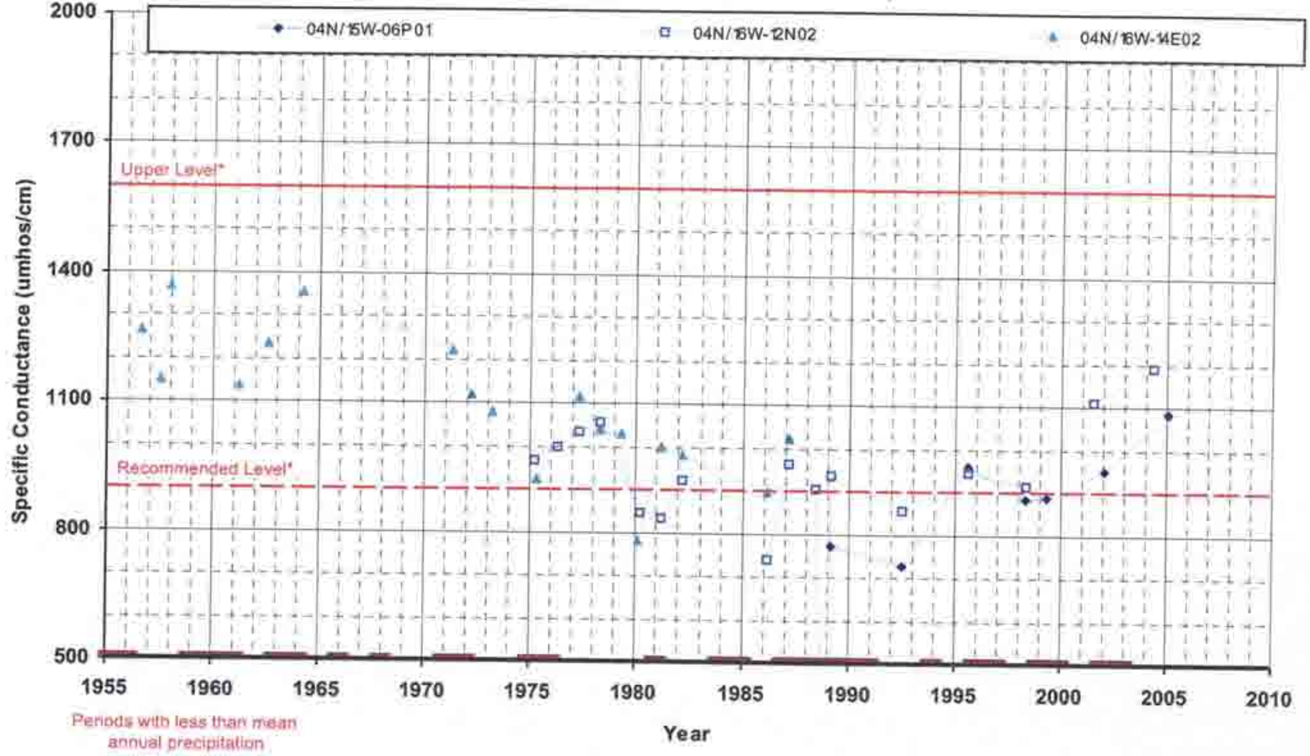
Water Quality for 'Below Saugus WRP' Area Alluvial Wells
(representative selection for area shown)



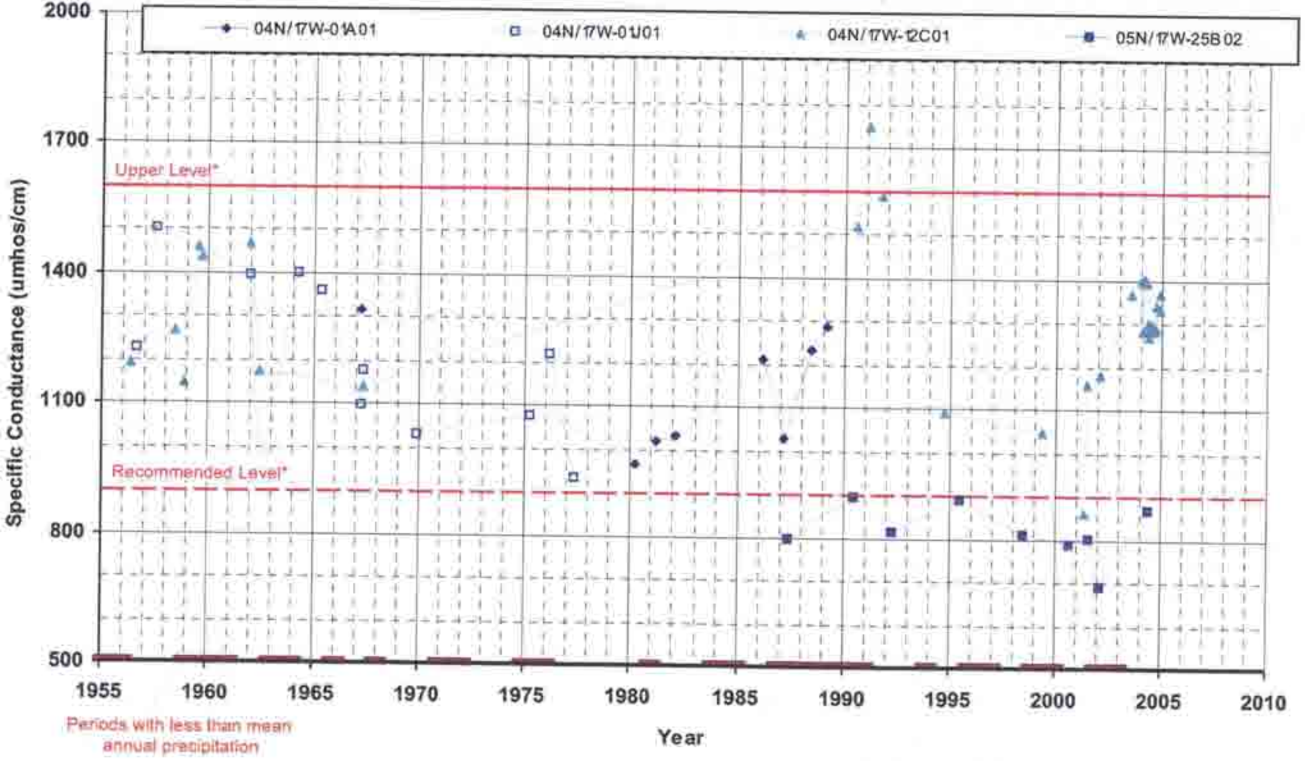
*California Department of Health Services Secondary Maximum Contaminant Level

Figure III-10

Water Quality for 'Bouquet Canyon' Area Alluvial Wells
(representative selection for area shown)

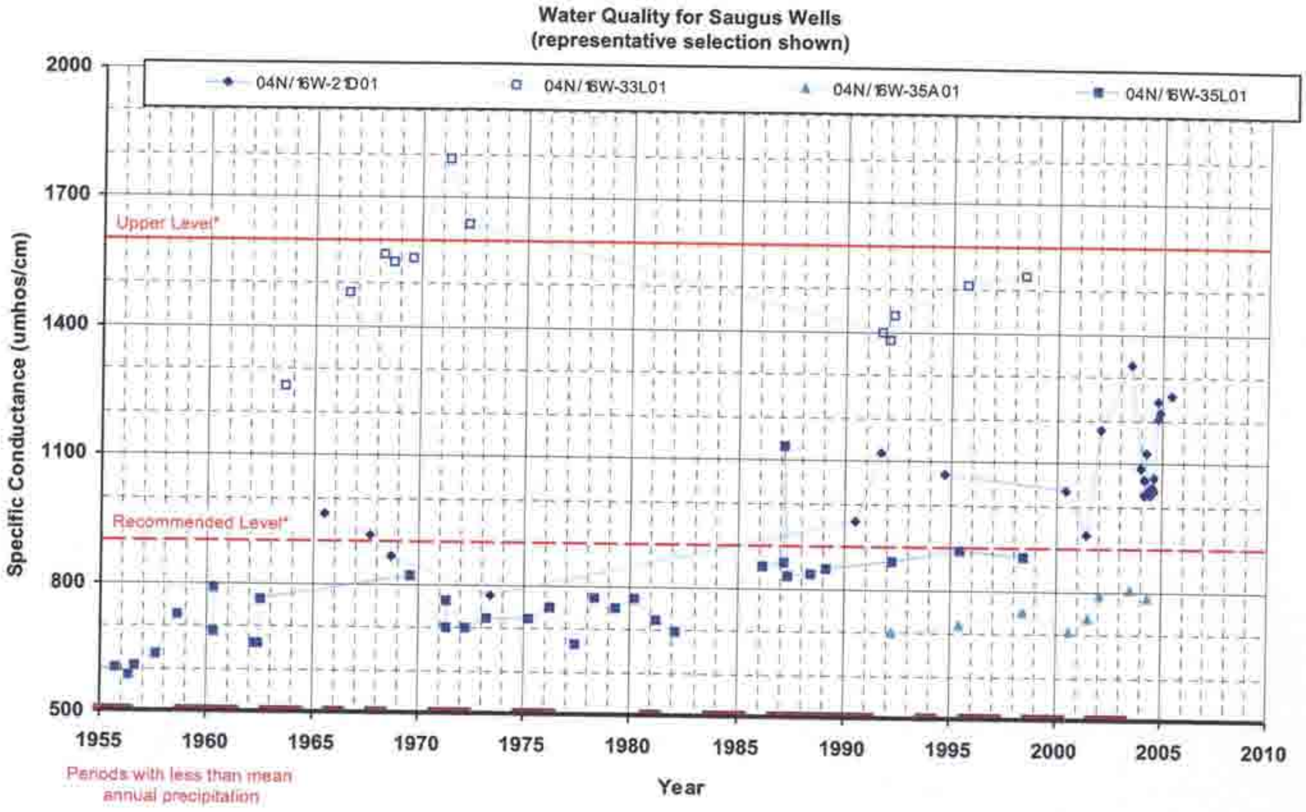


Water Quality for 'Castaic Valley' Area Alluvial Wells
(representative selection for area shown)



*California Department of Health Services Secondary Maximum Contaminant Level

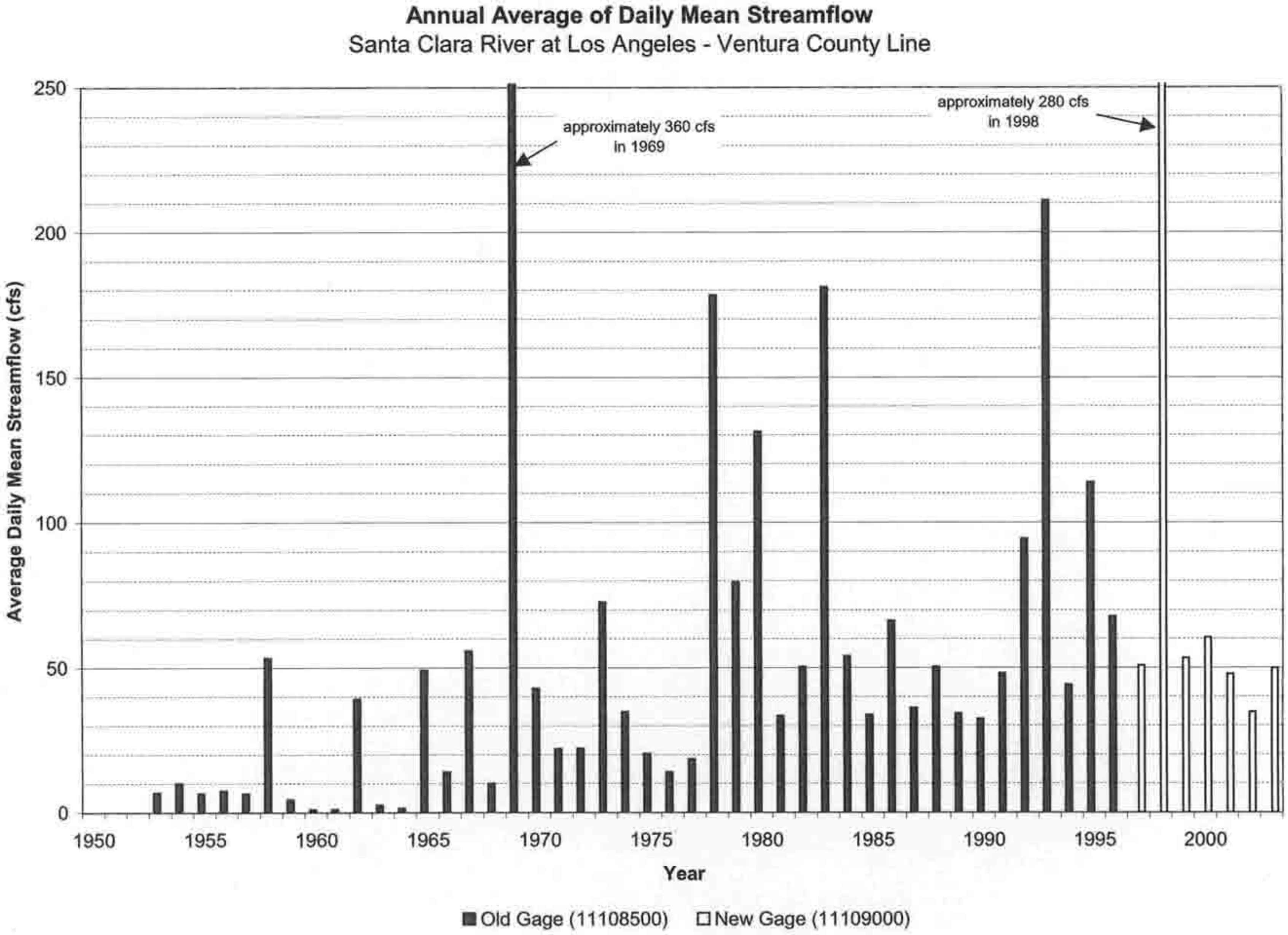
Figure III-11



Water Quality for Saugus Wells
(representative selection shown)

*California Department of Health Services Secondary Maximum Contaminant Level

Figure III-12



Annual Average of Daily Mean Streamflow

Santa Clara River at Los Angeles - Ventura County Line

approximately 360 cfs in 1969

approximately 280 cfs in 1998

Figure III-13

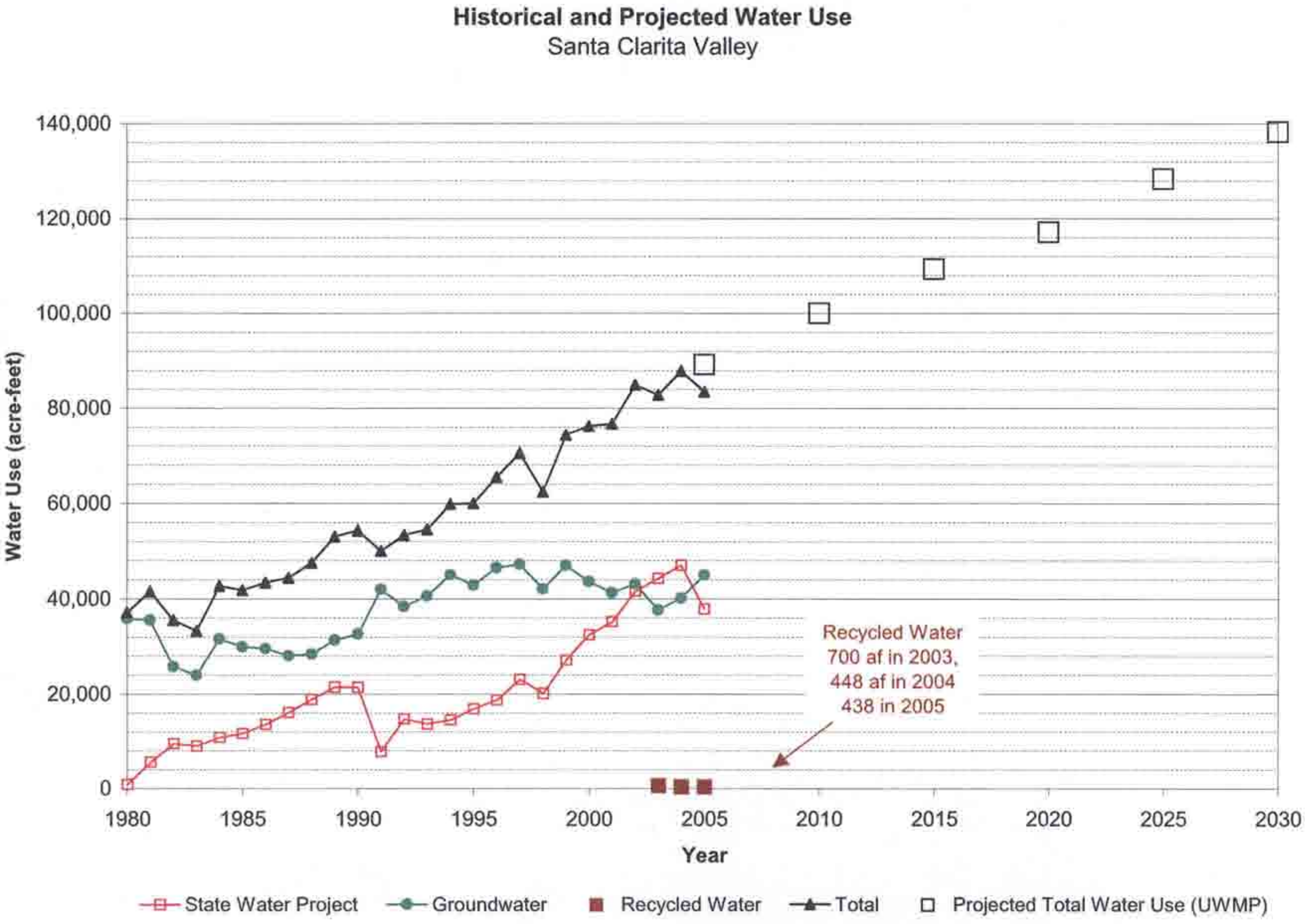

Historical and Projected Water Use
Santa Clarita Valley
Water Use (acre-feet)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Recycled Water
700 af in 2003,
448 af in 2004
438 in 2005
State Water Project
Groundwater
Recycled Water
Total
Projected Total Water Use (UWMP)

Figure IV-1

V. Water Conservation

The California Urban Water Conservation Council (CUWCC) was formed in 1991 through the Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California. The urban water conservation Best Management Practices (BMPs) included in the MOU are intended to reduce California's long-term urban water demands. While the BMPs are currently implemented by the MOU signatories on a voluntary basis, they are specified as part of the Demand Management Measures section of the Urban Water Management Planning Act.

Water conservation can achieve a number of goals, such as:

- Meeting legal mandates
- Reducing average annual potable water demands
- Reducing sewer flows
- Reducing demands during peak seasons
- Meeting drought restrictions

CLWA signed the urban MOU in 2001 on behalf of its wholesale service area, and pledged to implement several BMPs at a wholesale support level (listed below). NCWD signed the MOU in 2002 on behalf of its own retail service area. As a separate MOU signatory and due to its role as a retailer, NCWD is committed to implementing all BMPs that are feasible and applicable in its service area. Efforts are made to coordinate with CLWA and the other Purveyors wherever possible to maximize efficiency and ensure the cost effectiveness of NCWD's conservation program.

In coordination with the Purveyors, CLWA has been implementing the following BMPs (which pertain to wholesalers) for several years (some prior to signing the MOU in 2001):

BMP 3	System Water Audits, Leak Detection and Repair
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 10	Wholesale Agency Programs
BMP 11	Conservation Pricing
BMP 12	Water Conservation Coordinator
BMP 13	Water Waste Prohibition (implementation during last drought)

CLWA and the Purveyors have been implementing these BMPs valley-wide. Since 2001, CLWA has also instituted implementation of BMP 2 (Residential Plumbing Retrofits) and BMP 14 (Residential ULFT Replacement Programs) on behalf of the Purveyors.

NCWD has initiated implementation of the remaining BMPs that are specific to retail water suppliers:

BMP 1	Water survey programs for single-family residential and multi-family residential customers
BMP 3	System water audits, leak detection and repair

BMP 4	Metering with commodity rates for all new connections and retrofit of existing connections
BMP 5	Large landscape conservation programs and incentives
BMP 6	High-efficiency clothes washing machine financial incentive programs
BMP 9	Conservation programs for commercial, industrial, and institutional (CII) accounts
BMP 11	Conservation pricing
BMP 12	Conservation coordinator
BMP 13	Water waste prohibition

Reports to the CUWCC on BMP implementation by CLWA and the Purveyors were included in the 2005 UWMP.

Additional savings are occurring Valley-wide due to state interior plumbing code requirements that have been in effect since 1992, as well as due to changes in lot size and reduction in exterior square footage of new housing and commercial developments. These have begun to impact overall demand in the Valley. The Valley's water suppliers continue to monitor water demand trends through time to assess those factors that are accounting for the reduction, and to attempt to quantify them.

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Results of Laboratory Testing of Valencia Water Company Wells

Valencia Water Company
California Department of Health Services Drinking Water Standards, Title 22
Wells E-14, E-15, E-16, E-17

Primary Standards:
Inorganic Chemicals

Parameter	MCL	DLR	Units	E-14	E-15	E-16	E-17
Aluminum	1000	50	µg/l	ND	ND	ND	ND
Antimony	6	6	µg/l	ND	ND	ND	ND
Arsenic	50	2	µg/l	ND	ND	ND	ND
Barium	1000	100	µg/l	ND	ND	ND	ND
Beryllium	4	1	µg/l	ND	ND	ND	ND
Cadmium	5	1	µg/l	ND	ND	ND	ND
Chromium (Total)	50	10	µg/l	ND	ND	ND	ND
Fluoride	2	0.1	mg/L	0.89	0.9	0.89	0.83
Lead	50	5	µg/l	ND	ND	ND	ND
Mercury	2	1	µg/l	ND	ND	ND	ND
Nickel	100	10	µg/l	ND	ND	ND	ND
Nitrate (as NO3)	45	2	mg/L	11	14.2	16.8	16.8
Nitrite (as N)	1000	400	µg/l	ND	ND	ND	ND
Nitrate + Nitrite (as N)	10000	400	µg/l	2500	3200	3800	3800
Selenium	50	5	µg/l	ND	ND	ND	ND
Thallium	2	1	µg/l	ND	ND	ND	ND

Regulated Organic Chemicals

Parameter	MCL	DLR	Units	E-14	E-15	E-16	E-17
Volatile Organic Chemicals (VOC's)	variable	variable	µg/l	ND	ND	ND	ND
Synthetic Organic Chemicals (SOC's)	variable	variable	µg/l	ND	ND	ND	ND

Secondary Standards:

Parameter	MCL	DLR	Units	E-14	E-15	E-16	E-17
Apparent Color	15	NA	Units	<3	3	3	3
Chloride	250-500-600	NA	mg/L	75	88	89	74
Copper	1000	50	µg/l	ND	ND	ND	ND
Iron	300	100	µg/l	ND	ND	ND	ND
Manganese	50	20	µg/l	ND	ND	ND	ND
MBAS (foaming agents)	0.5	NA	mg/L	ND	ND	ND	ND
Odor	3	1	units (TON)	1	4	3	1
pH	6.5 - 8.5	NA	units	7.5	7.7	7.3	7.4
Silver	100	10	µg/l	ND	ND	ND	ND
Specific Conductance (E.C.)	900-1600-2,200	NA	umho/cm	1240	1290	1390	1360
Sulfate	250-500-600	0.5	mg/L	340	330	340	340
Total Dissolved Solids (TDS)	500-1000-1500	NA	mg/L	900	890	950	960
Turbidity	5	NA	NTU	0.4	0.9	0.2	0.3
Zinc	5000	50	µg/l	ND	ND	ND	ND

Valencia Water Company
California Department of Health Services Drinking Water Standards, Title 22
Wells E-14, E-15, E-16, E-17

Unregulated / Other Chemicals

Parameter	Notification Level	DLR	Units	E-14	E-15	E-16	E-17
Alkalinity	NA	NA	mg/L	230	215	244	254
Bicarbonate (as HCO3)	NA	NA	mg/L	280	262	298	310
Calcium	NA	NA	mg/L	130	120	120	130
Carbonate (as CO3)	NA	NA	mg/L	0.575	0.853	0.386	0.506
Carbon dioxide	NA	NA	µg/l	17700	10500	29900	24700
Hardness (Total as CaCO3)	NA	NA	mg/L	514	481	489	535
Hydroxide	NA	NA	mg/L	0.005	0.009	0.003	0.004
Magnesium	NA	NA	mg/L	46	46	44	51
Potassium	NA	NA	mg/L	4.2	4	3.9	4.4
Sodium	NA	NA	mg/L	100	100	110	110
Total Anions	NA	NA	meq/L	14	13.9	14.8	14.6
Total Cations	NA	NA	meq/L	14.7	14.1	14.7	15.6
Boron	1000	100	µg/l	430	480	460	470
Chromium, hexavalent	NA	1	µg/l	ND	ND	ND	ND
Dichlorodifluoromethane (Freon 12)	100	0.5	µg/l	ND	ND	ND	ND
Ethyl Tert-Butyl Ether (ETBE)	NA	3	µg/l	ND	ND	ND	ND
Langelier Index (25C)	NA	NA	none	0.62	0.75	0.41	0.56
Perchlorate	6	4	µg/l	ND	ND	ND	ND
Tert-Amyl Methyl Ether (TAME)	NA	3	µg/l	ND	ND	ND	ND
Tert-Butyl Alcohol (TBA)	12	2	µg/l	ND	ND	ND	ND
1,2,3-Trichloropropane (1,2,3-TCP)	0.005	0.005	µg/l	ND	ND	ND	ND
Vanadium	50	3	µg/l	ND	ND	ND	ND

Notes: Thiobencarb is listed as both an SOC and a Secondary Standard. The results for thiobencarb are included under SOC results.
MTBE is listed as both a VOC and a Secondary Standard. The results for MTBE are included under VOC results.
Aluminum is considered both a Primary and Secondary Standard. The results for aluminum are listed under Primary Standards.
2,3,7,8 -TCDD is an SOC. The results are attached.
EDB-DBCP are SOC's. They were run separately for E-16. Results are attached to E-16 file.
Alkalinity was run separately for E-14. Results are attached to E-14 file.

CH2MHill Memorandum,
Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley,
February 22, 2004

MEMORANDUM **CH2MHILL**

Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley

TO: Tom Worthington/Impact Sciences, Inc.

FROM: John Porcello/CH2M HILL

DATE: February 22, 2004

Introduction

In a groundwater basin, the effect of urbanization on recharge to underlying groundwater is dependent on land uses, water uses, vegetative cover, and geologic conditions. Groundwater recharge from undeveloped lands occurs from precipitation alone, whereas areas that are developed for agricultural or urban land uses receive both precipitation and irrigation of vegetative cover. In an urban area, groundwater recharge occurs directly beneath irrigated lands and in drainages whose bottoms are not paved or cemented. This memorandum discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley.

Summary of Findings

In the Santa Clarita Valley, stormwater runoff finds its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater.

Increased urbanization in the Valley has resulted in the irrigation of previously undeveloped lands. The effect of irrigation is to maintain higher soil moisture levels during the summer than would exist if no irrigation were occurring. Consequently, a greater percentage of the fall/winter precipitation recharges groundwater beneath irrigated land parcels than beneath undeveloped land parcels. In addition, urbanization in the Santa Clarita Valley has occurred in part because of the importation of State Water Project (SWP) water, which began in 1980. SWP water use has increased steadily, reaching nearly 44,500 acre-feet (AF) in 2003. Two-thirds of this water is used outdoors, and a portion of this water eventually infiltrates to groundwater. The other one-third is used indoors and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

Records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. On a long-term historical basis, groundwater pumping volumes have not increased due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Also, the importation of SWP water is another process that contributes to recharge in the Valley. In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Effect of Pavement on Recharge Beneath Specific Land Parcels

The amount of paved cover on the ground affects the degree to which rainfall and outdoor-applied urban water will be able to infiltrate to groundwater. In heavily industrialized areas with high percentages of paved cover, such as exist in portions of the Los Angeles Basin, less rainfall recharge will occur than if the land is in an undeveloped condition. Furthermore, if the bottoms of rivers and other drainages are paved, then the majority of stormwater generated during a rainfall event will be unable to infiltrate to groundwater. In contrast, the amount of recharge to groundwater will be greater in urbanized areas, such as the Santa Clarita Valley, that have natural soils in the bottoms of rivers and local drainages or that have lower percentages of paved cover on the developed areas lying outside the principal drainages. In these areas, the outdoor use of water for irrigation landscape vegetation or agricultural lands can notably increase the amount of groundwater recharge, particularly if the outdoor water is imported from outside the local groundwater basin. This is discussed further below.

Effect of Vegetative Cover and Water Use

From the 1930s through the 1960s, H.F. Blaney and other researchers at the U.S. Department of Agriculture performed numerous studies to measure the amount of infiltration to groundwater that occurs beneath undeveloped lands and irrigated farmlands, and the differences in recharge rates for different types of native vegetation and crops. In California, these studies included a 1933 study by Blaney in Ventura County, a 1963 study by Blaney and others in the Lompoc Uplands, studies by the U.S. Geological Survey and various consultants in the Montecito and Carpenteria groundwater basins, and a groundwater basin study by Santa Barbara County[1] that incorporated the results of these earlier studies.

Together, these studies concluded that deep percolation to groundwater from undeveloped lands occurs only during years of average or above-average precipitation. This occurs because:

1. Southern California's rainfall is highly seasonal in nature, whereupon most rainfall occurs during the relatively cool period November through March, when plant water

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[1] See Santa Barbara County Water Agency, December 15, 1977. *Report on Adequacy of the Groundwater Basins of Santa Barbara County.*

requirements are low, and little, if any, rainfall occurs during the remaining (and warmer months) when plant water requirements increase.

2. During the summer, when little or no rainfall occurs, the native vegetation extracts the residual moisture that is present in the soil, which substantially decreases the soil moisture within the root zone of the vegetation. At the end of the dry season, soil moisture levels on undeveloped lands are below the soil's field capacity, which is the amount of moisture that must be present in the soil before free drainage of water can occur below the rooting zone of the native vegetation.
3. When the seasonal rains arrive, the incident rainfall that is not consumed by plants and does not become stormwater runoff must first raise the soil moisture level to the soil's field capacity before any groundwater recharge will occur. The various studies indicate that about 17 inches/year of rainfall is necessary to raise the soil moisture to the field capacity on an undeveloped parcel of land. This is similar to the average annual rainfall in the Santa Clarita Valley and in other lowland coastal and near-coastal valleys in southern California.

On irrigated lands, irrigation occurs during several months of the year, with the exact duration depending on the amount and timing of rainfall and also the crops or type of urban landscaping being irrigated. The principal effect of converting undeveloped land to land that receives agricultural or urban irrigation is to increase the amount of water that is applied to the land during the low-rainfall months. This application of water to the vegetative cover on the surface of the developed land parcel results in the maintenance of higher soil moisture levels during the warm, dry months than would occur without development. This has three effects:

1. Because irrigation will generally be performed in a manner that maintains the health of the vegetative cover, enough water will be applied to maintain the soil moisture at, or close to, the field capacity of the soil. This in turn will allow some deep percolation to occur from the irrigation water itself.
2. When the rainy season begins, because irrigation has maintained soil moisture at or near field capacity, less of the initial rainfall entering the root zone needs to be stored in the soil (to meet soil moisture deficits) beneath an irrigated parcel than in the case of an undeveloped parcel. Therefore, a greater percentage of the initial rainfall and annual rainfall will be able to infiltrate to groundwater. The southern California studies estimated that irrigated land parcels would allow rainfall infiltration to occur in years when annual rainfall is at least 10.5 inches/year. This threshold rainfall value is 6.5 inches less than the threshold rainfall value that the studies estimated to be necessary for generating groundwater recharge beneath undeveloped land parcels.
3. Because the majority of irrigation occurs during the dry (low-rainfall) months, the total annual recharge to groundwater from irrigated developed lands is the sum of: (a) the deep percolation arising from irrigation (during the low-rainfall months); and (b) rainfall (during the months when less irrigation is occurring). Therefore, groundwater recharge beneath developed lands is greater and occurs for a longer period of time each year than in the case of undeveloped lands where no irrigation is occurring.

Historical Observations of Groundwater Conditions in the Santa Clarita Valley

The findings of the studies described above for other groundwater basins in southern California are consistent with observations that have been made in the Santa Clarita Valley, which are based on long-term water level records, water budget analyses, and groundwater modeling. Based on a month-by-month calibration to a 20-year record of historical water level records (throughout the Valley) and stream gaging records (at the Los Angeles - Ventura County line), the model simulates 10 percent of the applied outdoor water as being available for recharge to groundwater in retail and residential areas, with greater percentages infiltrating beneath golf courses and agricultural lands. This is consistent with a 1980 study by DWR of the groundwater resources of the Santee and El Monte hydrologic subareas of San Diego County. In that study, which was performed to evaluate reclaimed water use plans, DWR concluded that approximately 20 percent of the applied outdoor water in municipal areas infiltrates to the water table, with the remaining 80 percent going to evapotranspiration and direct evaporation. DWR also concluded that there would likely be no significant change in these percentages as urbanization continues.[2]

In the Santa Clarita Valley, as in any urbanized area, urbanization increases the paved area and can increase the magnitude and intensity of stormwater runoff from paved land areas. In the Santa Clarita Valley, this stormwater runoff will find its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater. Consequently, for a developed land parcel, the water that runs off of the paved portion of the land parcel will infiltrate to groundwater from a detention basin or a riverbed, rather than infiltrating onsite.

Riverbed infiltration is a significant percentage of total recharge in the Santa Clarita Valley in any given year. Streamflow records and the model calibration process together demonstrate that year-to-year fluctuations in total recharge in the Valley arise not just from year-to-year variations in incident rainfall within the Valley, but also from year-to-year variations in streamflows in the Santa Clara River and its tributaries. Because the areas contributing flow to the rivers are located both within and outside of the Valley, the recharge that occurs from riverbeds is a significant source of groundwater recharge within the Valley.

Evidence that stormwater infiltration to groundwater is not significantly decreased by urbanization comes from long-term water level records at wells completed in the Alluvial aquifer. These records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. Also, groundwater pumping volumes have not increased

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[2] See State of California, Department of Water Resources, Southern District. August 1984, *San Diego County Cooperative Ground Water Studies: Reclaimed Water Use, Phase II*. Pages 40-41.

due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Additionally, beginning in 1980, water was imported into the Santa Clarita Valley from the State Water Project (SWP) for urban use, with SWP water use reaching nearly 30,000 acre-feet per year (AF/yr) by the end of the 1990s, and progressively increasing from about 32,500 AF in 2000 to nearly 44,500 AF in 2003. Because two-thirds of the total urban water demand is used outdoors, a substantial portion of the imported SWP water has been and continues to be applied to urban landscaping, thereby increasing the amount of recharge to groundwater. The remaining urban water is used indoors, and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

CH2MHill Final Report,
Regional Groundwater Flow Model for the Santa Clarita Valley
(Model Development and Calibration), April 2004

Final Report

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Development and Calibration

Prepared for

Upper Basin Water Purveyors:

Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water District

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4/6/04
STATE OF CALIFORNIA

April 2004

CH2MHILL

Executive Summary

The water purveyors in the Santa Clarita Valley of Southern California have constructed a regional-scale numerical groundwater flow model of the valley. The model, which is called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. Figure ES-1 shows the study area, including the Regional Model's boundaries. Figure ES-2 shows the extent of the watershed that the valley occupies, and shows the sub-watersheds that drain into the study area covered by the Regional Model.

The Regional Model has been developed as part of the work scope contained in a Memorandum of Understanding (MOU) that was entered into in August 2001 by the Upper Basin Water Purveyors in the Santa Clarita Valley and the United Water Conservation District in Ventura County. This report documents the construction and calibration of the Regional Model, including presenting the conceptual hydrogeologic model on which the Regional Model is based.

ES.1 Model Development Objectives and Approach

The Regional Model is intended to become an evolving tool for managing the local groundwater resource. Specific objectives that are identified for the model are:

a. To be able to evaluate the long-term sustainability (yield) of the two aquifer systems that are present in the valley, the Alluvial Aquifer and the Saugus Formation, under a range of existing and potential future water resource management conditions

b. To be able to evaluate artificial recharge to increase the long-term sustainability of the aquifer system, particularly in conjunction with the availability of imported surface water supplies

c. To evaluate the influences of future water management plans and alternatives on groundwater conditions within the valley and on the flows of water into the downstream basins in Ventura County

d. To facilitate general management of water quantity and water quality issues

The approach to developing the Regional Model included the following steps:

1. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system
2. Creating a variety of data sets to conduct steady-state and transient calibrations
3. Constructing the Regional Model using the MicroFEM® finite-element groundwater flow code, and also using the available database and geographic information system (GIS) for the Santa Clarita Valley

4. Calibrating the Regional Model
5. Performing sensitivity tests on the Regional Model

ES.2 Hydrogeology of the Santa Clarita Valley

Section 2 of the report describes the hydrogeology of the Santa Clarita Valley, including the geologic system; groundwater occurrence; groundwater recharge and discharge mechanisms; the relationship of surface hydrology to the valley's groundwater resources; historical trends in the valley's hydrology; the role of the State Water Project (SWP) in the valley's water resources and water supply; and key findings from prior studies conducted in the valley. This section of the report focuses particularly on information of specific relevance to development of the Regional Model. Figure ES-3 is a schematic representation of the regional-scale geology and hydrologic cycle in the Santa Clarita Valley. Figure ES-4 is a geologic map.

ES.2.1 Geology

The geology of the valley is defined in part by the non-water-bearing bedrock that underlies and surrounds the valley's aquifer systems. This bedrock forms a bowl-shaped aquifer system, which is thickest at the center of the valley and progressively thins outwards towards the margins of the valley. The deeper of the two aquifer systems is contained in the Saugus Formation, which consists of lenticular and interfingered beds of poorly- to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. The most productive portion of the Saugus Formation is thought to be the area southwest of the San Gabriel Fault. The deeper and older portion of the Saugus Formation, the Sunshine Ranch Member, was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone that preclude development of municipal water supplies. Evidence from geophysical logs also indicates that the groundwater in much of the Sunshine Ranch Member may be somewhat brackish in quality.

Overlying the Saugus Formation is the Alluvial Aquifer, which consists of extensively interlayered and interfingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. In general, alluvium in the main river valley ranges from medium-grained sand to sandy gravel and cobbles. Due to its unconsolidated to poorly consolidated condition, and its lack of cementation, the alluvium has relatively high permeability and porosity.

ES.2.2 Groundwater Recharge

Average annual rainfall in the Santa Clarita Valley is approximately 18 inches per year, and higher (up to 30 inches per year or more) in the surrounding mountains. Natural groundwater recharge occurs from direct precipitation and from stormwater flowing in the Santa Clara River and its tributaries. Each of these streams have their headwaters in areas lying upstream of the Alluvial Aquifer and Saugus Formation. Consequently, stormwater that is generated in these upstream watersheds flows into the valley and is an important source of groundwater recharge. Because the climate is semi-arid, rainfall and stormwater runoff occur primarily between November and March and can vary considerably in magnitude from year to year. The direct precipitation in the valley and the recharge of stormwater generated in upstream watersheds together provide approximately 94 percent of the total groundwater recharge to the valley's groundwater resources. Irrigation on agricultural and urban lands represents another 4 percent, and underflow beneath Castaic Dam into the adjoining Alluvial Aquifer is estimated to represent approximately 2 percent of the total basinwide groundwater recharge.

ES.2.3 Groundwater Discharge

Groundwater discharge from the Alluvial Aquifer occurs primarily as discharge to the Santa Clara River and evapotranspiration (ET) by the riparian vegetation growing along the river corridor. The Alluvial Aquifer also discharges as subsurface outflow into the Piru Basin at Blue Cut, which is located just downstream of the Los Angeles-Ventura County line. Groundwater pumping occurs from both the Alluvial Aquifer and the Saugus Formation, and Saugus Formation groundwater also discharges to the Alluvial Aquifer.

ES.2.4 Aquifer Physical Properties

Specific capacity data from Alluvial Aquifer production wells indicates that the horizontal hydraulic conductivity is approximately 300 to 700 feet per day, and possibly higher, along the Santa Clara River. In the tributaries, the horizontal hydraulic conductivity is approximately 100 to 600 feet per day. The horizontal hydraulic conductivity in the Saugus Formation has been estimated to be approximately 6.5 feet per day, based on pumping and injection tests conducted on production wells with long screen intervals.

ES.2.5 Basin Hydrology

Long-term records of groundwater elevations and pumping exist for the Alluvial Aquifer throughout the valley. These records indicate that groundwater elevations can fluctuate significantly from year to year in the eastern part of the valley, in response to patterns of droughts and above-normal rainfall. In the western part of the valley, groundwater levels are stable, as this is the regional groundwater discharge area. Despite the variations in groundwater elevations in the eastern valley and the variations in pumping throughout the valley during the past five decades, groundwater elevations in the Alluvial Aquifer have shown no permanent long-term declines. In addition, the availability of SWP water has allowed the valley to become increasingly urbanized, and the resulting gradual increase in urbanization and SWP water imports have resulted in a gradual increase in flows in the Santa Clara River.

Similar conditions are seen in the Saugus Formation. From the late 1980s through the early to mid-1990s, groundwater elevations declined in response to drought conditions and increased pumping. However, starting in the mid-1990s, Saugus groundwater elevations increased notably as pumping decreased and rainfall increased. As with the Alluvial Aquifer, the Saugus Formation showed groundwater elevation recovery to levels seen prior to the drought.

ES.2.6 Water Supply

The Santa Clarita Valley obtains its water supply from local groundwater sources and from SWP water that is delivered to the Castaic Lake Water Agency by the California Department of Water Resources (DWR) via the California Aqueduct. Water use includes municipal and agricultural uses.

Before 1970, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 acre-feet per year (AF/yr). Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr until 1993. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. In response to statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available. The water management practices of the purveyors call for maximizing the use of Alluvial Aquifer and SWP water. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. Consequently, since 1995, Saugus pumping has ranged between approximately 4,000 and 8,500 AF/yr.

The Castaic Lake Water Agency (CLWA) has a contract amount of SWP Table A water of 95,200 AF/yr. Modeling by DWR has indicated that actual SWP water imports, based on the current CLWA Table A contract amount, will be 66,300 AF/yr in wet years, 56,800 AF/yr in average years, and 37,900 AF/yr in multiple dry years. The occurrences of drought years in the SWP system is based on the hydrology of Northern California, and hence only occasionally coincides with the occurrence of drought locally. In addition to the above entitlements, DWR occasionally releases flood flows into Castaic Creek from Castaic Dam. These flows averaged 15,700 AF/yr during the 24-year period of water years 1977 through 2000. However, no flood flows were stored or delivered in five of those years, and the median flow was 2,800 AF/yr (only 18 percent of the average flow).

ES.3 Model Construction

The Regional Model was constructed using the three-dimensional finite-element groundwater modeling software called MicroFEM® (Hemker and de Boer, 2003). The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line gage area in the west. The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. The upper model layer simulates the Alluvial Aquifer, or the upper portion of the Saugus Formation wherever the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and the Sunshine Ranch Member.

The boundary conditions in the model consist of specified flux boundaries for precipitation; irrigation; recharge from ephemeral streams; pumping; and underflow from beneath Castaic Dam. Head-dependent flux boundaries are used in the perennial reach of the Santa Clara River, and to model any residual drainage of groundwater that might occur in the ephemeral reach under high water table conditions. A head-dependent flux boundary is also used for ET. A constant-head boundary was used in the Alluvial Aquifer at the downgradient (western) end of the valley, at the County Line gage.

Groundwater recharge rates were estimated using precipitation records; streamflow records; watershed maps; topographic maps; and aerial photography. These recharge rates were calculated using a detailed Surface Water Routing Model that was written specifically for the construction and calibration of the Regional Model. Pumping rates and pumping depths were defined from groundwater pumping and well construction records.

ES.4 Model Calibration Process

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation. The steady-state calibration was performed for calendar years 1980 through 1985, and the transient calibration was performed for calendar years 1980 through 1999. The goals of the calibration process were generally to match groundwater flow directions, groundwater gradients, and groundwater elevations that were measured throughout the 20-year simulation period at wells across the valley. Figures ES-5 and ES-6 show the locations of wells that were used to evaluate calibration in the Alluvial Aquifer and the Saugus Formation, respectively. The figures also show how each aquifer was subdivided into zones to facilitate parameter selection and model calibration. An additional calibration goal was to match the patterns of total flow in the Santa Clara River and estimated groundwater discharge rates to the river. Model variables were adjusted in a manner that sought to honor independent estimates of parameter values while resulting in the best possible calibration.

ES.5 Model Calibration and Sensitivity

The Regional Model meets most of the qualitative and quantitative goals that were established for the calibration process. For the steady-state model, statistical goals for the head residuals, which are equal to the modeled minus measured groundwater elevations, were easily met for the Alluvial Aquifer and adequately met for the Saugus Formation. For the transient model, trends in groundwater elevations were generally well matched. However, during the mid- and late 1990s, the model tended to simulate too much decline in Alluvial Aquifer groundwater elevations in the eastern-most portion of the valley and water level fluctuations that were too variable in Castaic Creek. Groundwater discharges to the river were simulated well for both the steady-state and transient models.

The groundwater budget for the 20-year transient calibration period showed that recharge from precipitation and streamflows varied considerably from year to year, ranging from less than 15,000 AF/yr in the driest years to as much as 270,000 AF/yr in the wettest years (see Figure ES-7). In contrast, total groundwater discharges were less variable, ranging from approximately 61,000 AF/yr at the end of the late 1980s/early 1990s drought to 116,000 AF/yr during 1998 (see Figure ES-8). This variability in groundwater discharge did not follow the year-to-year pumping patterns, but instead was caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlated well with groundwater recharge patterns. During the 20-year transient calibration period, changes in the volume of groundwater stored in the combined Alluvial-Saugus aquifer system varied primarily according to year-to-year variations in regional rainfall. No long-term decline in groundwater storage was observed in the field or simulated by the model (see Figure ES-9) during this period. As Section 2.6.2 of this report will discuss, available data dating back to the 1950s also show that no long-term water level declines have occurred in the valley, despite past periods of significant pumping (particularly during the 1950s) and drought cycles.

Sensitivity analyses were performed to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the Regional Model. Variables that were tested were the hydraulic properties (horizontal and vertical hydraulic conductivities and storage coefficients) for the Alluvial Aquifer and the Saugus Formation; the riverbed leakage terms for the Santa Clara River and Castaic Creek; and the ET parameters. The sensitivity analysis indicated that the model is calibrated well and that it is sensitive to the choices of horizontal hydraulic conductivity in both aquifers and vertical hydraulic conductivity in the Saugus Formation. The Regional Model was also sensitive to the riverbed leakage terms in both groundwater recharge and groundwater discharge areas. However, the model was insensitive to the choice of ET parameters.

The process of calibrating the Regional Model to a 20-year period of groundwater elevation and streamflow data has resulted in a model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary attributes of the model's calibration that makes this tool appropriate for its intended uses are:

a. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased SWP water imports (from outside the valley), and associated changes in land use and water use

b. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property)

c. Its use of an integrated model of the watershed, the Surface Water Routing Model, to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system

The calibration process has resulted in a Regional Model that closely simulates, on a monthly basis, total flows in the river and estimated volumes of groundwater discharging to the river. The calibration process has also resulted in a Regional Model that closely simulates the short-term and long-term time-varying trends in groundwater elevations throughout the valley, which is necessary for evaluating groundwater management strategies. The close calibration of the groundwater elevation trends and absolute groundwater elevations in both the Alluvial Aquifer and the Saugus Formation near the Whittaker-Bermite property also renders the Regional Model suitable for particle-tracking analyses, to support the design of a long-term pumping and groundwater treatment plan that will restore impaired water supplies while also preventing contamination in unimpacted portions of the aquifer.

ES.6 Model Use and Recommendations

The Regional Model is generally well-calibrated and therefore can be applied to meet the objectives for which it was developed. Nonetheless, because no model is perfect, it should be used with care, and all model results should be examined by qualified and experienced hydrogeologists and water resource managers. It is recommended that future applications of the model include sensitivity analyses on key variables and that the Regional Model and the Surface Water Routing Model be updated as water use conditions change in the future. Additionally, data gathering efforts should continue or resume, to facilitate updates of the Regional Model. In particular, controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties at the locations of new Saugus Formation wells and streamflow monitoring should resume at the Lang gage, in order to better understand the magnitudes and timing of Santa Clara River flows into the valley.

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Figures

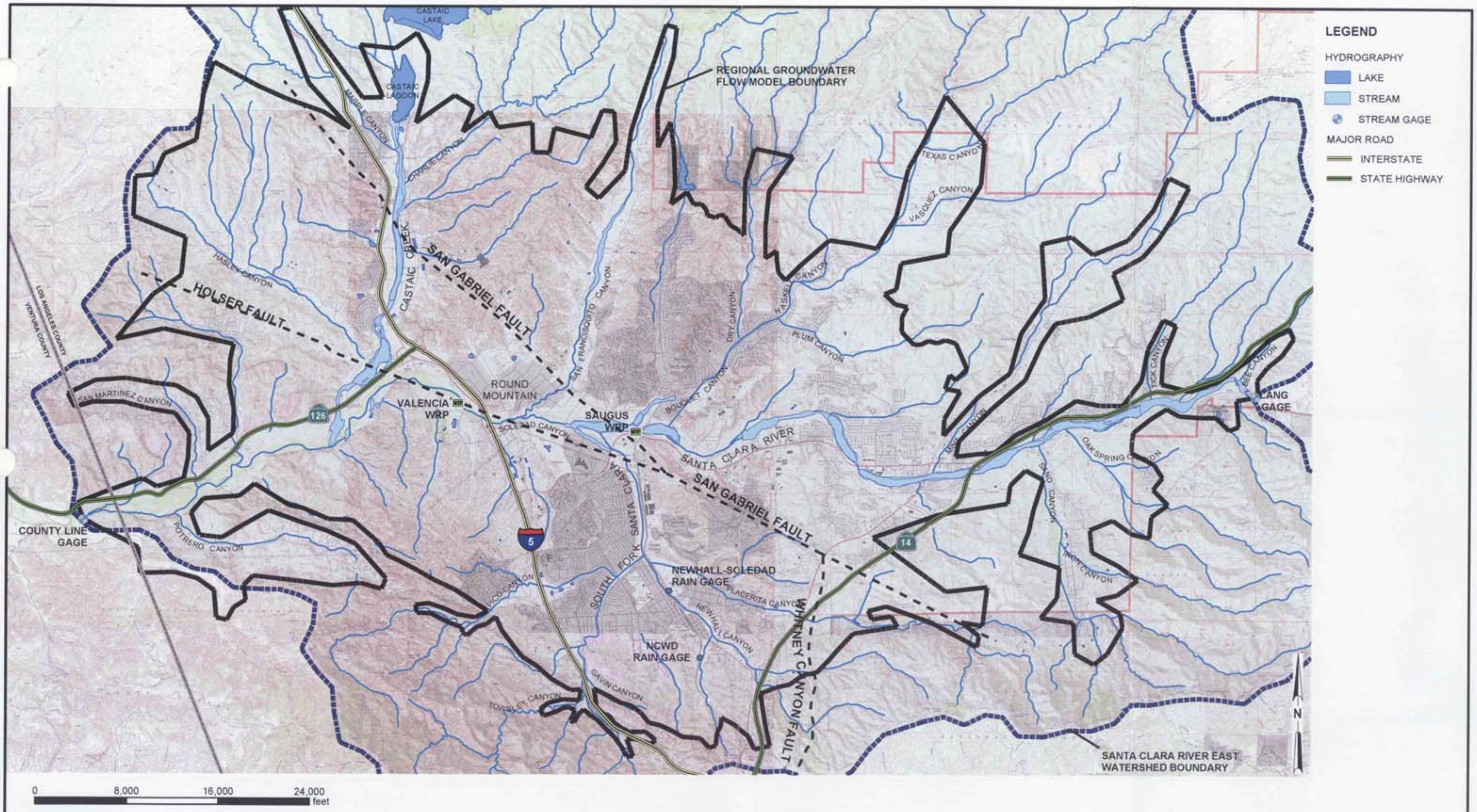

FIGURE ES-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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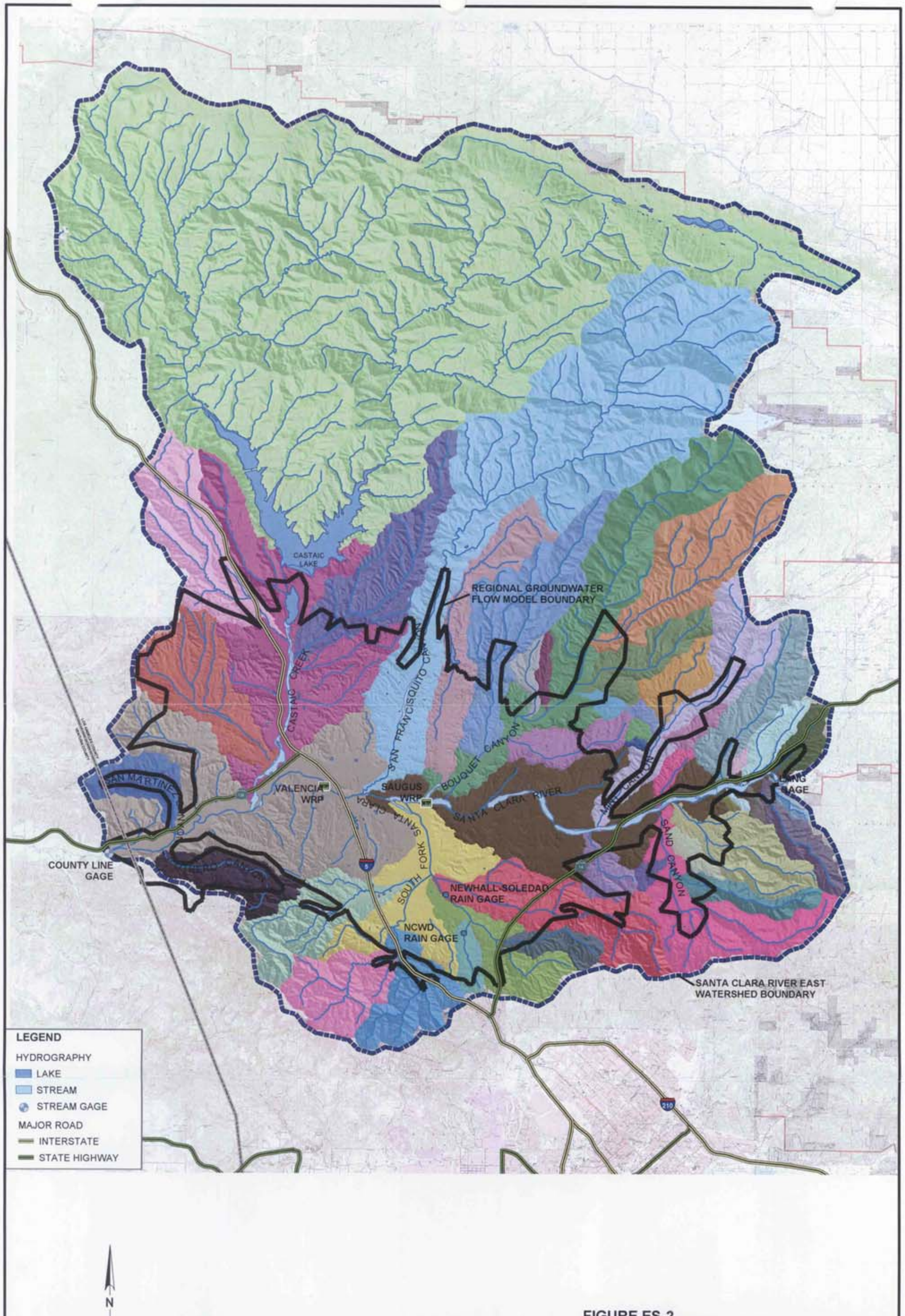

FIGURE ES-2
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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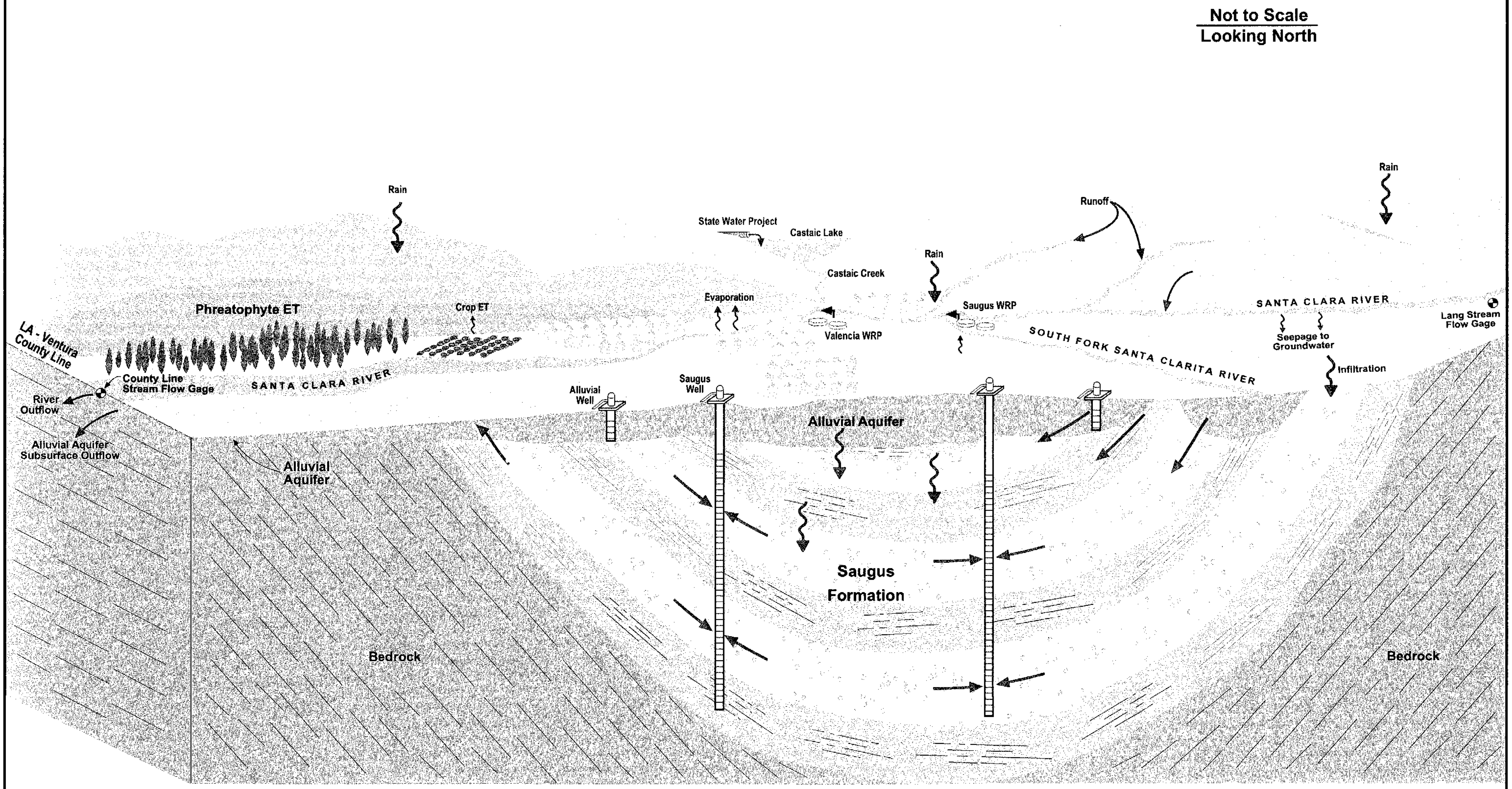

FIGURE ES-3
SANTA CLARITA VALLEY HYDROLOGY
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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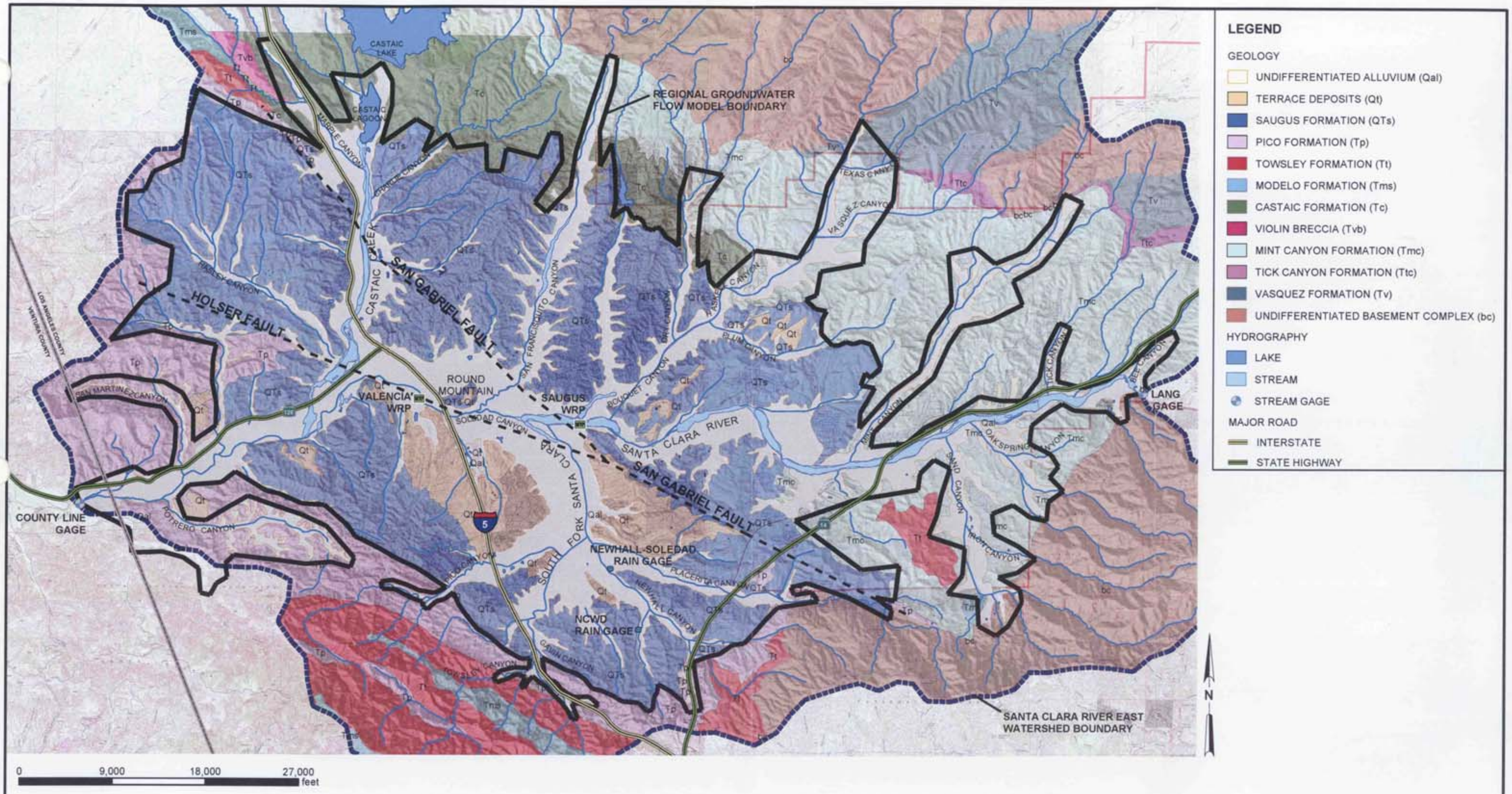

FIGURE ES-4
BASIN GEOLOGIC MAP

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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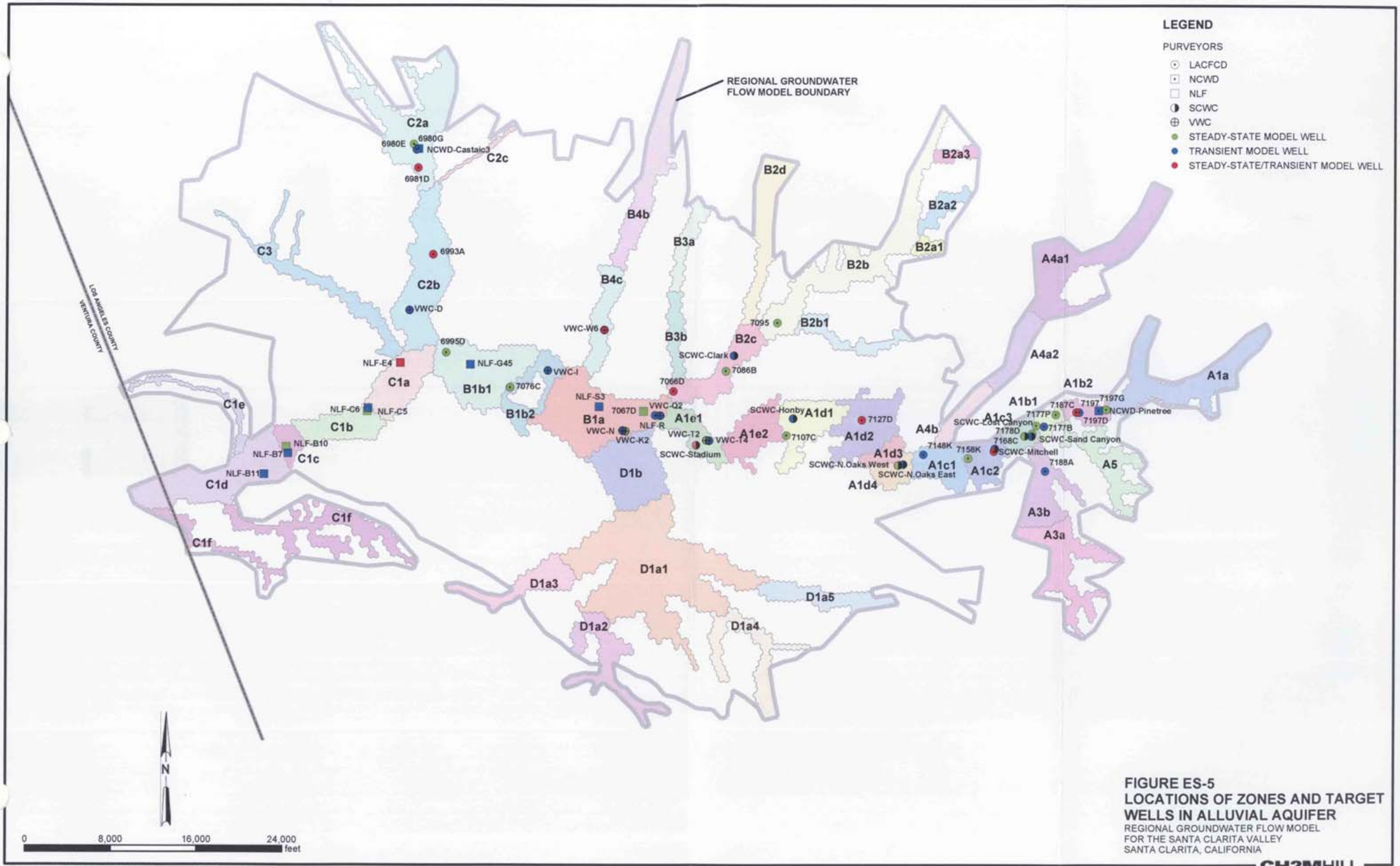

FIGURE ES-5
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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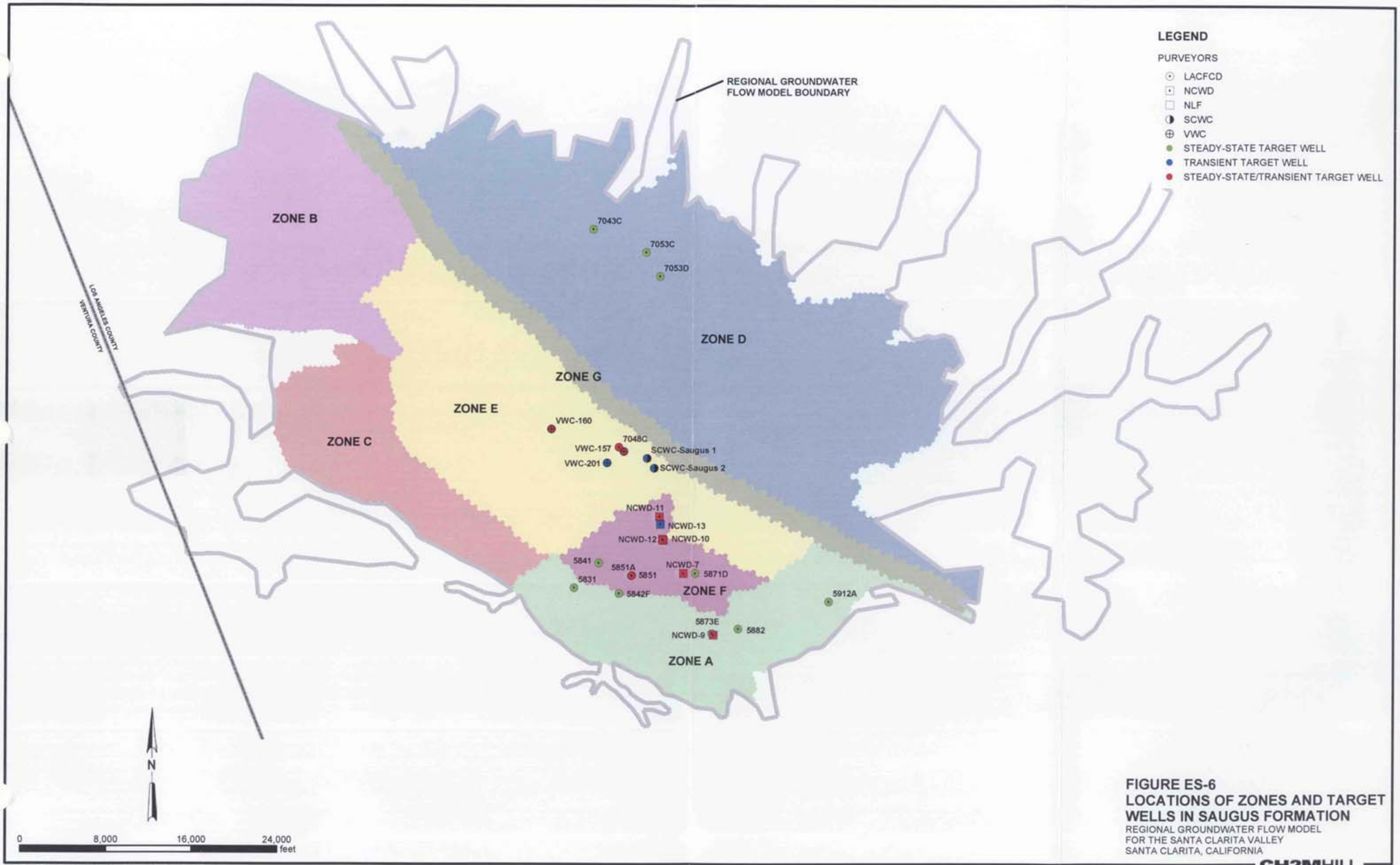

FIGURE ES-6
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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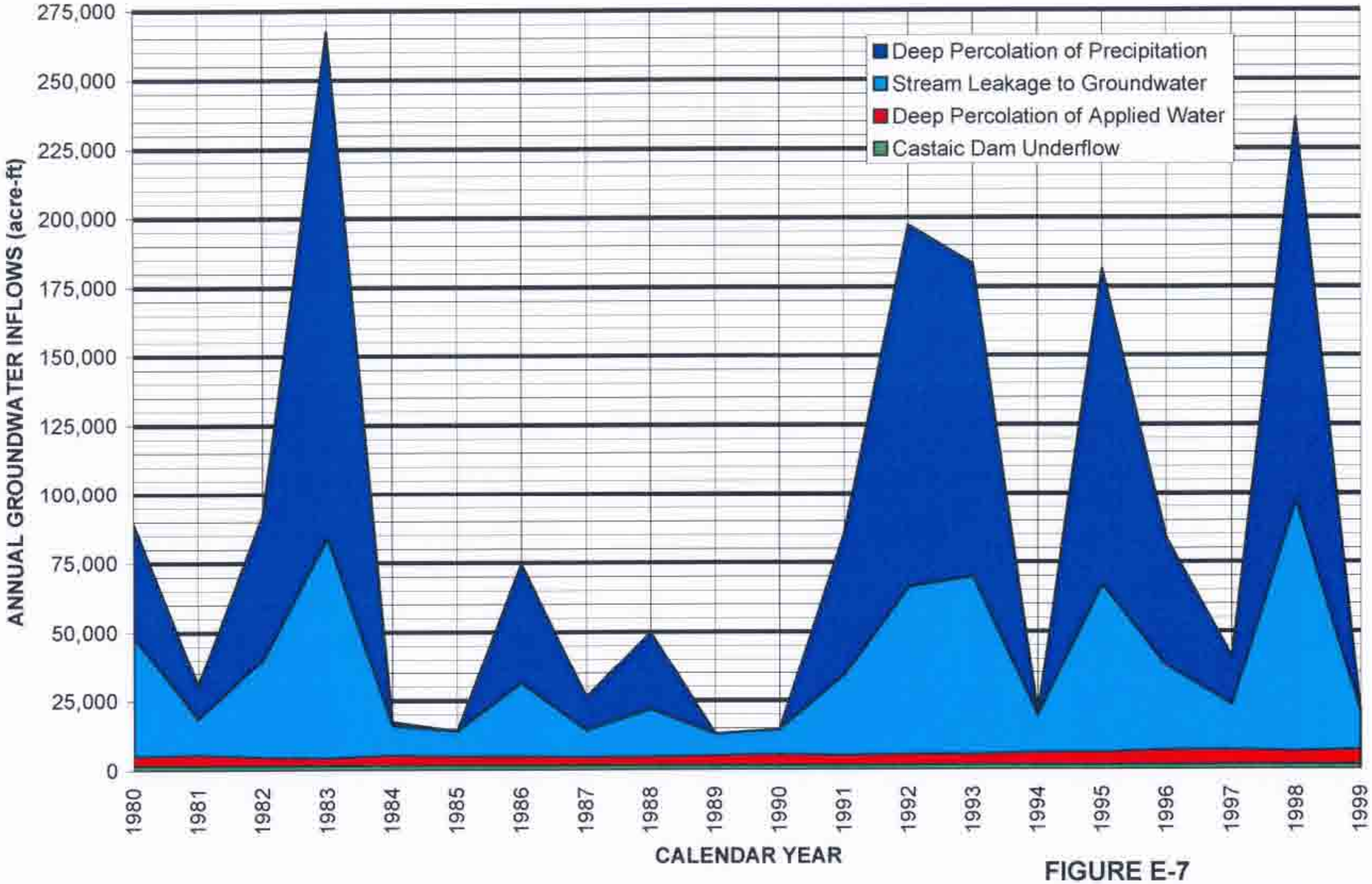

FIGURE E-7
ANNUAL GROUNDWATER INFLOWS

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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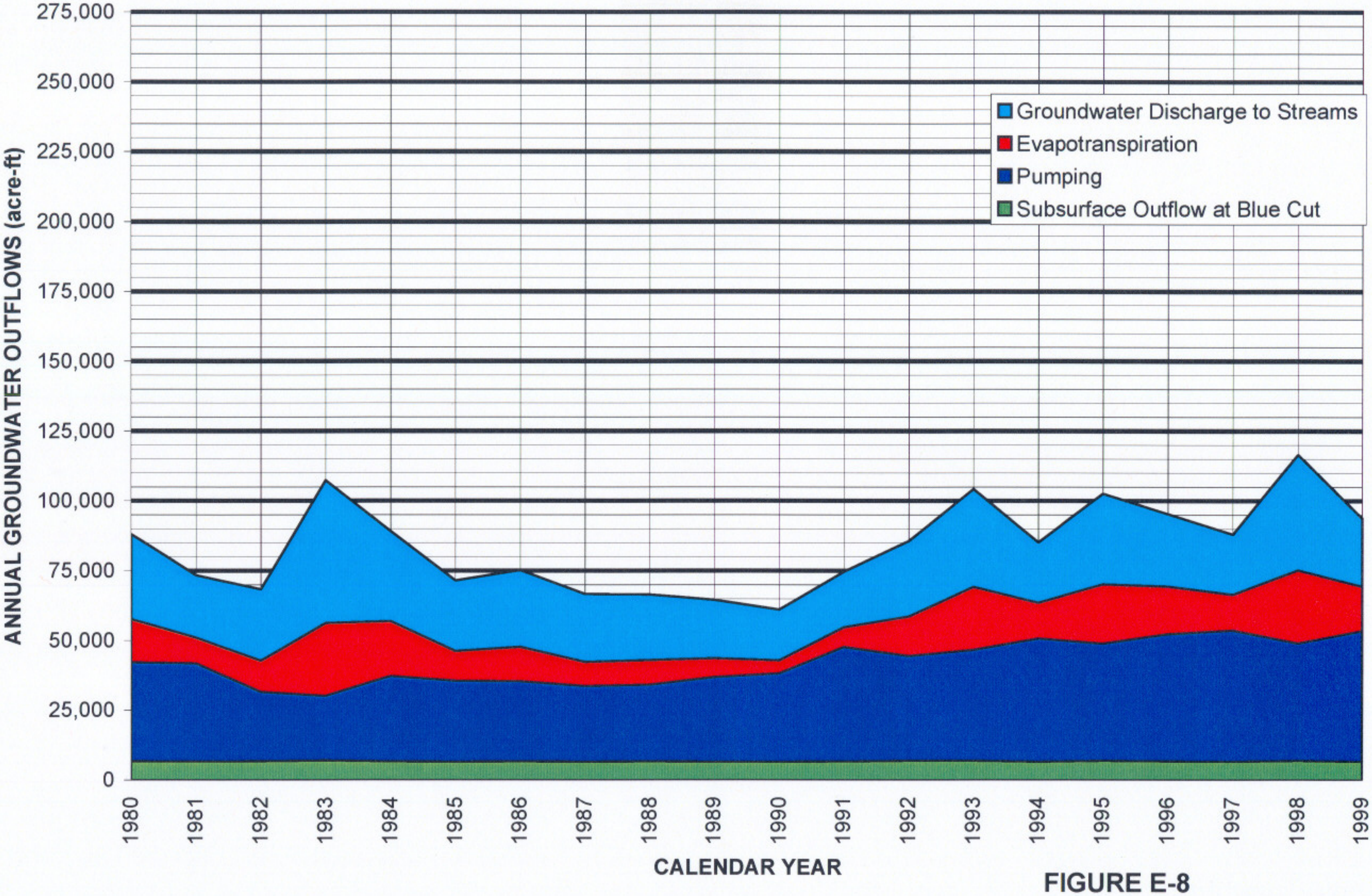

FIGURE E-8
ANNUAL GROUNDWATER OUTFLOWS
REGIONAL GROUNDWATER FLOW MODEL REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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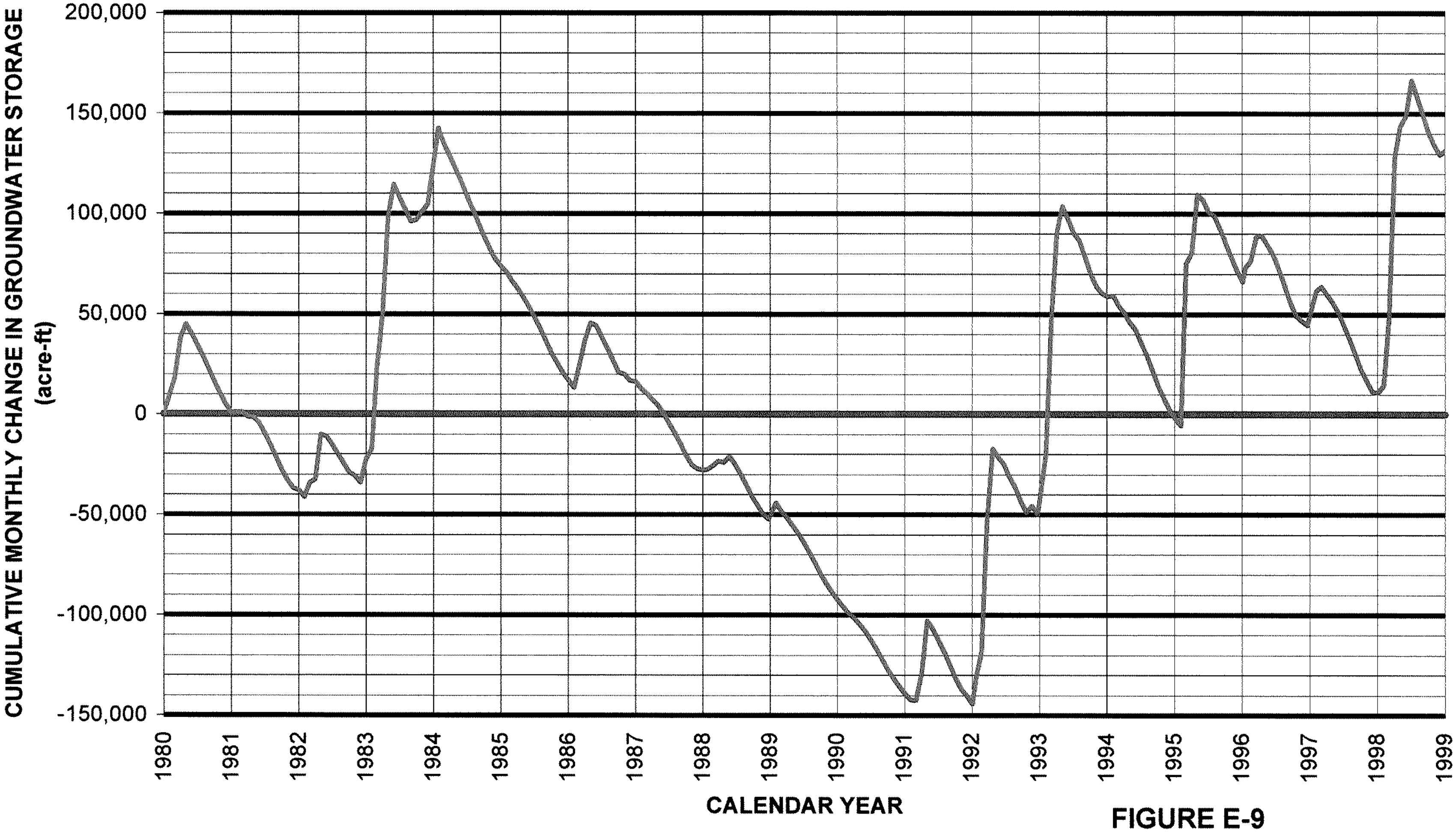

FIGURE E-9
CUMULATIVE CHANGE IN GROUNDWATER STORAGE

REGIONAL GROUNDWATER FLOW MODEL REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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Acronyms and Abbreviations

°F	degrees Fahrenheit
AF	acre-feet
AF/yr	acre-feet per year
ASR	aquifer storage and recovery
bgs	below ground surface
cfs	cubic feet per second
CLWA	Castaic Lake Water Agency
cm/sec	centimeters per second
county line	Los Angeles-Ventura County line
Downstream Water Users	Los Angeles County Waterworks District, Newhall Land & Farming Company, Newhall County Water District, and United Water Conservation District
DWR	California Department of Water Resources
ET	evapotranspiration
ft/day	feet per day
ft^2/day	square feet per day
ft/yr	feet per year
GIS	geographic information system
gpd	gallons per day
gpd/ft	gallons per day per foot
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GPS	global positioning system
I-5	Interstate 5
in/yr	inches per year
K	hydraulic conductivity
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation District

LACWWD	Los Angeles County Waterworks District
LADPW	Los Angeles County Department of Public Works
MOU	Memorandum of Understanding
NCDC	National Climate Data Center
NCWD	Newhall County Water District
NLF	Newhall Land & Farming Company
Purveyors	Upper Basin Water Purveyors
R	vertical anisotropy ratio (Kh:Kv)
RCS	Richard C. Slade and Associates, LLC
Regional Model	Santa Clarita Valley Groundwater Model
residual	residual error
RMS	root-mean-square
SCWC	Santa Clarita Water Company
SWP	State Water Project
SWRM	Surface Water Routing Model
Sy	aquifer specific yield
T	transmissivity
UWCD	United Water Conservation District
USGS	U.S. Geological Survey
VWC	Valencia Water Company
WHR	Wayside Honor Rancho
WRP	water reclamation plant
WY	water year

SECTION 1

Introduction

This report describes the development of a regional groundwater flow model for the Santa Clarita Valley, located in northwestern Los Angeles County, California. The model, called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. It has been developed for the water purveyors in the valley as a tool for the analysis of groundwater management options in the context of future water demands and water supply conditions in the valley. Figure 1-1 is a map showing the study area.

1.1 Model Use Objectives

The Regional Model has been developed as part of the work scope contained in a Memorandum of Understanding (MOU) that was entered into in August 2001 by the water purveyors in the Santa Clarita Valley (the Purveyors) and the United Water Conservation District (UWCD), located downstream in Ventura County. The MOU, which is contained in Appendix A, is a commitment by the Purveyors to expand the analysis of groundwater conditions such that the adequacy of the local water supply is well understood and questions about surface water and groundwater resources can be more readily addressed. The MOU contained a number of technical components, including the development and calibration of a regional-scale groundwater flow model and the preparation of technical reports on topics such as groundwater model development. This report and the model described herein reflect the accomplishment of two of the MOU technical components.

The Regional Model is intended to become a tool for managing the local groundwater resource, including the relationship of surface water to groundwater in the valley. The model has been designed to be an evolving tool that will analyze groundwater development, natural and artificial recharge (particularly in conjunction with the availability of imported surface water supplies), and the resultant impacts of these activities on groundwater conditions within the valley and on the flows of water into the downstream basins in Ventura County. As discussed in the MOU, one use will be to evaluate the long-term sustainability, or operational yield, of the shallow Alluvial Aquifer and the deeper groundwater resources that are present in the underlying Saugus Formation. Specifically, this assessment will look at basin operations over a multi-year wet/dry cycle, with operational yield defined as a basin operating plan that allows continued pumping from these aquifers while assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. The parties to the MOU agreed to use the Regional Model for this assessment because (1) data show no long-term lowering of the water table or degradation of water quality has occurred during the 50 to 60 years of historical groundwater development in the valley, and (2) current planning places future pumping of the Alluvial Aquifer in the same range as historical pumping. At this time, the primary question of interest to the MOU parties is the effect of pumping the Saugus Formation during short-term dry periods at rates that are higher than have been historically pumped from that formation. An additional planned application of the model will be to evaluate the restoration of pumping capacity that has been impacted by perchlorate contamination in the vicinity of the Whittaker-Bermite property in the central part of the valley.

Based on these objectives, the MOU specified that a model would be constructed that covers the entire area within the Santa Clarita Valley where Alluvial and Saugus groundwater resources are present, and that the model should be subjected to a transient calibration.

1.2 Model Development

The approach to developing the model included:

a. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system.

b. Creating a variety of data sets to conduct steady-state and transient calibrations.

c. Constructing the groundwater flow model using the MicroFEM® finite-element groundwater flow code, and also using the available database and geographic information system (GIS) for the Santa Clarita Valley.

d. Calibrating the flow model.

e. Performing sensitivity tests on the flow model.

This project was conducted for the parties to the MOU, who are the United Water Conservation District (UCWD) in Ventura County and the Upper Basin Water Purveyors, the water providers in the Santa Clarita Valley. The Upper Basin Water Purveyors consist of four retail purveyors of municipal water and the Castaic Lake Water Agency (CLWA), which has a contract with the State of California to obtain water from the State Water Project (SWP), and which furnishes SWP water to the four retail purveyors. The four retail purveyors are Los Angeles County Waterworks District (LACWWD) No. 36, the Newhall County Water District (NCWD), Santa Clarita Water Company (SCWC, a division of CLWA), and the Valencia Water Company (VWC).

1.3 Previous Studies

There are several previous studies of the groundwater system in the Santa Clarita Valley that were used to help develop the conceptual and numerical models of the hydrogeologic system. These studies include reports on the regional geology and hydrogeology, and a previous modeling analysis of the feasibility of constructing an aquifer storage and recovery (ASR) system. These studies are listed below and are described in more detail in Section 2.7 of this report.

a. *Hydrogeologic Investigation: Perennial Yield and Artificial Recharge Potential of the Alluvial Sediments in the Santa Clarita River Valley of Los Angeles County, California* (Richard C. Slade and Associates, LLC [RCS], 1986). This report was the first comprehensive study of the geology and hydrology of the Alluvial Aquifer.

b. *Hydrogeologic Assessment of the Saugus Formation in the Santa Clara Valley of Los Angeles County, California* (RCS, 1988). This report was the first comprehensive study of the geology and hydrology of the Saugus Formation.

c. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001). This report documented the results of ASR field tests in the Saugus Formation that evaluated the feasibility of injecting water into, and recovering water from, deep Saugus Formation wells.

d. *2001 Update Report: Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems* (RCS, 2002). This report was a summary and update of the 1986 and 1988 RCS reports.

e. *Newhall Ranch ASR Impact Evaluation* (CH2M HILL, 2001). This document evaluated the longer-term basinwide influences that would occur for an ASR program that was proposed as part of the water supply for the planned Newhall Ranch community.

f. *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002). This document updated the ASR impact evaluation, including analyzing the effects of all aspects of the Newhall Ranch community (not just ASR) on the valley's water resources.

1.4 Report Organization

The remainder of this report is organized as follows:

Section 2 describes the hydrogeology of the Santa Clarita Valley, including the geologic system; groundwater occurrence; groundwater recharge and discharge mechanisms; the relationship of surface hydrology to the valley's groundwater resources; historical trends in the valley's hydrology; the role of the SWP on the valley's water resources and water supply; and key findings from prior studies conducted in the valley. This section of the report (along with Appendix B) focuses on information of specific relevance to development of the regional flow model.

Section 3 discusses the construction of the model, including the modeling software; the grid design; the layer-by-layer representation of the aquifers; the boundary conditions; the estimation of groundwater recharge rates; and the assignment of pumping rates in the model. Appendix C describes the design, operation, and data for a surface water routing model that was developed to provide the Regional Model with recharge rates from urban irrigation, agricultural irrigation, direct precipitation, streamflows entering the model domain, and discharges from water reclamation plants (WRP).

Section 4 describes the calibration conditions; the calibration goals; the model variables that were adjusted during calibration; the calibration procedure; and the measured (target) data that were used to evaluate calibration quality.

Section 5 presents quantitative and semi-quantitative evaluations of the calibration results, with a focus on the assessment of the model's calibration quality compared with the calibration goals presented in Section 4. Section 5 then concludes with a sensitivity analysis that further evaluates calibration quality and demonstrates the sensitivity of simulated groundwater elevations and water budget terms to changes in model parameter values.

Section 6 summarizes the applicability of the model for use in managing local groundwater resources, including the key attributes of the model and recommendations for further data collection and future model updates.

Section 7 is the reference list.

Figures

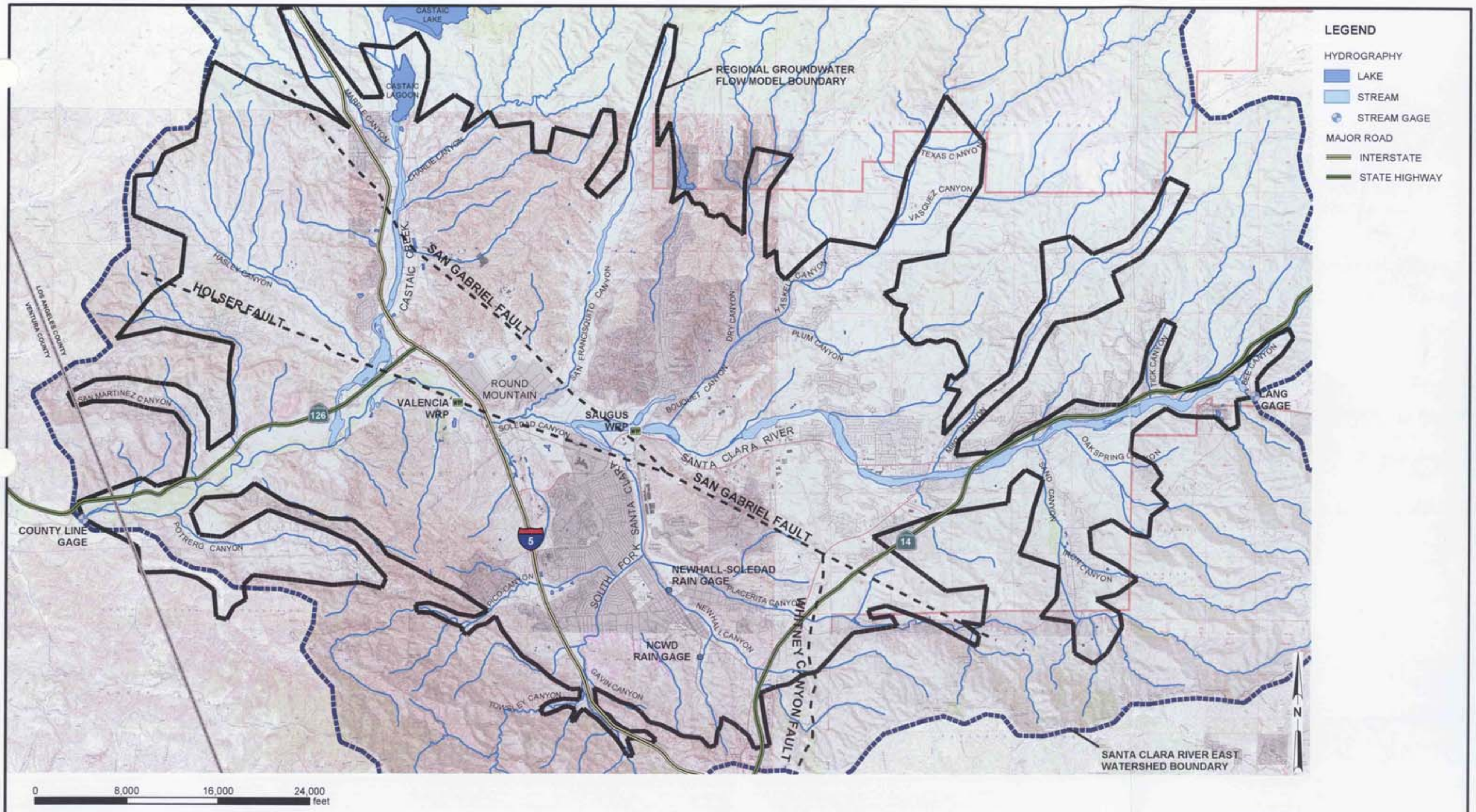

FIGURE 1-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 2

Hydrogeology of the Santa Clarita Valley

The geology and hydrogeology of the Santa Clarita Valley are described in this section, which is derived primarily from the reports described in Section 1.3 and Section 2.7. Figure 2-1 is a schematic representation of the regional scale geology and hydrologic cycle in the Santa Clarita Valley. As shown on Figure 2-1, the two aquifer systems in the Santa Clarita Valley are the Alluvial Aquifer and the Saugus Formation. Groundwater is exchanged between these two units. Additionally, the aquifer systems are affected by direct rainfall; streamflows in the Santa Clara River and its tributaries; evapotranspiration (ET) by riparian vegetation along portions of the river; and human influences which consist of pumping, agricultural and urban irrigation, discharge of treated water into the Santa Clara River from two water reclamation plants, and occasional releases of water into Castaic Creek from Castaic Lake and Castaic Lagoon.

Figure 2-2 shows the location of the Santa Clarita Valley groundwater basin. This groundwater basin is identified by the California Department of Water Resources (DWR) as the Santa Clara River Valley East Groundwater Subbasin and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Figure 2-3 is a map of the Santa Clarita Valley, showing the locations of production wells completed in the Alluvial Aquifer and Saugus Formation.

2.1 Setting

The study area comprises the relatively flat-lying Santa Clarita Valley and portions of the surrounding hills and mountains. The study area extends from approximately the Los Angeles-Ventura County line (county line) on the west to the community of Lang on the east, and from the southern end of Castaic Lake on the north to the intersection of the Golden State Freeway (Interstate 5 [I-5]) and the Antelope Valley Freeway (State Highway 14) on the south. The mountains that surround the Santa Clarita Valley include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from approximately 800 feet on the valley floor to approximately 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of approximately 3,200 feet at the topographic divide separating the Upper Santa Clara River Hydrologic Area from the Mojave Desert.

The largest community in the study area is the City of Santa Clarita, which was formed in 1987 through the amalgamation of the communities of Newhall, Valencia, Saugus, and Canyon Country. Other smaller unincorporated communities in the study area include Stevenson Ranch and Val Verde in the west, Castaic in the northwest, and Lang in the east. The population of the City of Santa Clarita was estimated to be approximately 151,260 in the 2000 U.S. Census. In 2001, the Southern California Association of Governments estimated the population of the surrounding unincorporated Santa Clarita Valley at 48,237. Hence, the total current population of the Santa Clarita Valley is approximately 200,000 (RCS, 2002).

Prior to the 1960s, the predominant land use in the Santa Clarita Valley was agricultural, with much of the valley undeveloped. Urbanization began gradually in the 1960s, with a rapid increase beginning in the late 1970s and early 1980s and continuing to the present. Accompanying the rapid population increase has been a gradual change in valley land use patterns, from largely agricultural to urban and suburban developments. Nevertheless, a considerable portion of the hills and low mountains bordering the main river valley remain in a natural, undeveloped condition (RCS, 2002).

2.2 Climate

The study area has a semi-arid Mediterranean-type climate, characterized by long, dry summers and relatively short, wet winters. Temperatures in the Santa Clarita Valley range from a minimum of 20 degrees Fahrenheit (°F) to 30°F in the winter to a maximum of approximately 100 to 110°F during the summer. Mean monthly temperatures range between approximately 48°F in the winter and 77°F in the summer.

Rainfall data have been recorded since 1883 at the Newhall-Soledad gage (Station No. FC32CE), located at the Los Angeles County Department of Public Works (LADPW) Newhall-Soledad Division Headquarters office, on San Fernando Road in the community of Newhall. The average rainfall at this gage was 17.95 inches from 1883 through 2000 and 17.84 inches from 1950 through 2000.[1] A second rain gage is located approximately 1.3 miles to the south, at the NCWD office. Figure 2-4 shows the annual rainfall at the Newhall-Soledad and NCWD gages for calendar years 1950 through 2000. As shown in the figure, annual rainfall is highly variable from year to year. During this period, the highest calendar-year rainfall was 42.17 inches in 1978 at the Newhall-Soledad gage, and 48.33 inches in 1983 at the NCWD gage. The lowest amount of annual rainfall from 1950 through 2000 was 4.15 inches in 1972 at the Newhall-Soledad gage, and 8.47 inches in 1989 at the NCWD gage. Average annual rainfall from 1979 through 2000 was 18.67 inches at the Newhall-Soledad gage and 22.88 inches at the NCWD gage. Rainfall at the NCWD gage is usually greater than at the Newhall-Soledad gage, because the NCWD gage is located closer to the hills that form the southern boundary of the watershed and receive a greater amount of orographic precipitation.

Rainfall is not only variable on an annual basis, but is also highly seasonal. Approximately 80 percent of the annual precipitation in the Santa Clarita Valley falls between November and March. Most of the precipitation comes from winter storms that last only a few days and are separated by relatively long periods of clear weather.

As shown by the difference in rainfall values between the Newhall-Soledad and NCWD rain gages, rainfall varies across the basin according to elevation differences and the locations of surrounding mountain ranges. Figure 2-5 shows lines of equal precipitation (rainfall isohyets), based on long-term mean annual precipitation data compiled from the U.S. Geological Survey (USGS), DWR, and California Division of Mines maps and data. The source maps consist primarily of U.S. Weather Service data for approximately 800 precipitation stations, but in the Los Angeles and San Francisco Bay areas the

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[1] Annual rainfall values for the Newhall-Soledad gage are based on monthly records reported by the National Climate Data Center (NCDC) and LADPW.

U.S. Weather Service data have been supplemented by county and local agency precipitation data. The precipitation isohyets shown on Figure 2-5 display the average annual rainfall during the period from 1900 through 1960. (See the internet site http://gis.ca.gov/meta.epl?oid=286 for more information.)

2.3 Geology

Figure 2-6 presents a geologic map of the Santa Clarita Valley, as reported by RCS (2002). The geologic units shown on the map include water-bearing sediments and non-water-bearing bedrock.

The Santa Clarita Valley is underlain and bounded by non-water-bearing bedrock units that are Miocene, Oligocene, and pre-Tertiary in geologic age. These units yield little water and are not considered viable for groundwater development.

Where the bedrock units are not exposed at the ground surface, they are overlain by younger geologic units. The Pliocene-age to Pleistocene-age Saugus Formation (map symbol, QTs) overlies the bedrock in much of the basin. At the far western and eastern ends of the basin, and in the upper reaches of some of the canyons, the Saugus Formation is absent and the bedrock units are overlain by a blanket of unconsolidated alluvium of Quaternary geologic age (map symbol, Qal). Where present, the alluvium overlies the Saugus Formation within much of the Santa Clarita Valley. In some areas where the alluvium is absent, the Saugus Formation is overlain by scattered outcrops of Quaternary-age Terrace deposits (map symbol, Qt). Groundwater is present in much of the alluvium and the Saugus Formation. However, the terrace deposits do not contain significant water resources because they are typically situated at elevations above the regional water table.

2.3.1 Non-Water-Bearing Bedrock

Underlying the water-bearing sediments in the Santa Clarita Valley are a series of consolidated, older, cemented sedimentary and crystalline rocks of Tertiary geologic age or older. For the most part, the sedimentary rocks are exposed along the flanks of the hills and mountains that border the Santa Clarita Valley, while the geologically older crystalline metamorphic and igneous rocks crop out in the upper watershed areas of the Sierra Pelona and San Gabriel Mountains.

Geologically older sedimentary rocks underlie the base of the Saugus Formation and are exposed in the hills beyond the exterior boundary line for the mapped surface limits of the Saugus Formation. The older rocks lying immediately below the Saugus Formation are: (1) the Pico Formation, composed of siltstone and shale, which underlies the Saugus Formation in the region southwest of the San Gabriel fault; and (2) the Castaic Formation and the Mint Canyon Formation, mainly siltstone and shale, which underlie the Saugus Formation in areas northeast of the San Gabriel fault. These sedimentary rock formations are generally fine grained, have low permeability, and do not yield substantial quantities of water to wells. In the project area, these rocks are considered barriers to groundwater flow.

2.3.2 Water-Bearing Sediments

Water-bearing sediments in the Santa Clarita Valley consist of:

a. Alluvial and valley fill deposits that underlie the Santa Clara River and its tributaries

b. Partially consolidated, older sediments of the Saugus Formation, including the Sunshine Ranch Member, that underlie the alluvium and are also exposed in the hillsides surrounding the main portion of the valley

2.3.2.1 Alluvium

The alluvial sediments are composed of extensively interlayered and interfingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. In general, alluvium in the main river valley ranges from medium-grained sand to sandy gravel and cobbles. Drillers' logs indicate the presence of discrete sand zones and discrete gravel zones in many areas of the alluvium. Due to its unconsolidated to poorly consolidated condition, and its lack of cementation, the alluvium has relatively high permeability and porosity.

The alluvial sediments lie within and along the course of the Santa Clara River and its main tributaries. The maximum thickness of the alluvium varies along the Santa Clara River, but generally is considered to be 200 feet. Typically, the alluvium tends to be thickest near the central portion of the river, and thins or pinches out near the flanks of the adjoining hills.

The alluvium overlies the Saugus Formation in much of the valley. However, in the eastern part of Soledad Canyon, the Saugus Formation is absent, and instead the alluvium overlies Miocene-age terrestrial sediments of the Tick Canyon and Mint Canyon Formations. In the upper reaches of some tributaries to the Santa Clara River, the alluvium overlies these or other Miocene-age sediments, such as the Pico and Castaic Formations. At the west end of the valley, the alluvium overlies the Pico Formation.

2.3.2.2 Saugus Formation

The Saugus Formation is present throughout the main portion of the Santa Clarita Valley and extends to the surrounding foothills. The Saugus Formation contains lenticular and interfingered beds of poorly- to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. These terrestrial sediments were deposited in stream channels, floodplains, and alluvial fans by the ancestral drainage system in the valley. The coarser-grained materials in the Saugus Formation were deposited in the main channels of the ancestral drainage system, and the locations of these channels changed throughout the approximately 3-million-year period of deposition of the Saugus Formation. Recent interpretations of geophysical electric log data indicate that the coarse-grained channel deposits (the primary water-bearing strata) are thicker and more numerous in some areas than in other locations in the valley. Although the Saugus Formation displays a considerable amount of lateral variability in lithology and grain size, some thicker stratigraphic packages can be traced through portions of the valley, primarily on the west (downthrown) side of the San Gabriel Fault (RCS, 2002).

The deeper and older portion of the Saugus Formation, the Sunshine Ranch Member, was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone. The Sunshine Ranch Member has a maximum thickness of approximately 3,500 feet in the central part of the valley. It is present at or very close to ground surface at the margins of the valley. Geophysical (electric) logging indicates that the groundwater in much of the Sunshine Ranch Member may be somewhat brackish in quality and is not useful for municipal water supply purposes.

2.3.3 Geologic Structure

Faulting and folding of the rocks in the region have caused the sedimentary rocks, including the Saugus Formation, to form a bowl-shaped structure. The Saugus Formation and the underlying bedrock dip generally toward the center of the "bowl" from all locations along the bottom (basal) contact of the Saugus Formation.

Dominating the geologic structure in the valley is the southeast-northwest-trending San Gabriel fault. The fault is a northeast-dipping reverse fault. The vertical displacement of the Saugus Formation on each side of the fault varies along the length of the fault and ranges from 100 feet to 2,600 feet within the valley (RCS, 1988). The Saugus Formation is thickest south of the fault, and this is the area where all significant Saugus production wells are located. North of the San Gabriel fault, the Saugus Formation is older, thinner, and finer grained than south of the fault. Little groundwater development has occurred north of the San Gabriel Fault.

A spur from this fault, referred to as the Holser fault, trends west through the valley. Cross sections prepared by RCS (1988, 2002) show that marker beds are offset by approximately 100 to 200 feet across the Holser Fault, which is substantially less than the offset across the San Gabriel Fault. Another spur fault called the Whitney Canyon fault extends south from the San Gabriel Fault in the southeastern corner of the valley.

2.4 Groundwater Occurrence, Recharge, and Discharge

Groundwater is present in the alluvium under generally unconfined conditions. Saugus Formation groundwater is thought to be present under unconfined conditions in the shallowest water-bearing zones where the Alluvial Aquifer is absent, and under semi-confined and confined conditions at greater depths. Figure 2-1 is a schematic cross-sectional representation of the groundwater flow patterns in the Santa Clarita Valley, including the predominant recharge and discharge mechanisms for the two aquifer systems. These are discussed in detail below.

2.4.1 Alluvium

Natural sources of recharge to the alluvium include deep percolation (infiltration) of direct precipitation within the valley; percolation of stream runoff flowing into the valley along the Santa Clara River and its tributaries; subsurface inflow from the adjoining (upgradient) portions of the Alluvial Aquifer to the north and east of the valley; and discharge of groundwater from the Saugus Formation to the Alluvial Aquifer, primarily on the west side of the Santa Clarita Valley.

Manmade sources of recharge to the Alluvial Aquifer include infiltration of irrigation water; infiltration of stormwater runoff from urban areas; infiltration of surface flow and underflow from Castaic Dam within the Castaic Creek area; infiltration of water released by the Los Angeles Department of Water and Power from its reservoir facilities in upper San Francisquito Canyon and upper Bouquet Canyon; and infiltration of water reclamation plant (WRP) discharges to the Santa Clara River from two Los Angeles County Sanitation District (LACSD) WRPs in the valley (Plant No. 26 near Bouquet Canyon and Plant No. 32 near Valencia).

Groundwater discharge is significant in the western portion of the Alluvial Aquifer, where it occurs primarily as discharge to the Santa Clara River and ET by the riparian vegetation growing along the river corridor. Groundwater discharge from the west end of the basin also occurs as subsurface outflow through the Alluvial Aquifer to the downstream Piru Basin. Other groundwater discharge mechanisms in the Santa Clarita Valley are pumping for agricultural and municipal uses and seepage to underlying permeable portions of the Saugus Formation, particularly in the eastern portion of the basin.

According to RCS (1986), groundwater present within the Alluvial Aquifer flows from east to west roughly coincident with the direction of surface water flow. Figure 2-7 displays a groundwater elevation contour map for the Alluvial Aquifer, using water level data collected during the spring of 2000.

RCS (2002) estimated that the amount of groundwater in storage in the Alluvial Aquifer has historically fluctuated between approximately 100,000 and 200,000 acre-feet. Table 2-1 summarizes the well-by-well historical annual groundwater pumping from the Alluvial Aquifer from 1980 through 2000. Historical groundwater production rates during this period averaged 29,700 acre-feet per year (AF/yr) and ranged from approximately 20,300 to 43,500 AF/yr. As discussed later in Section 2.6.2, these pumping rates are at or below pumping rates during the 1950s and 1960s, when groundwater was used primarily for agricultural purposes.

2.4.2 Saugus Formation

The Saugus Formation is recharged by two principal sources: (1) infiltration of precipitation in the exposed portions of the Saugus in the highlands surrounding the valley, and (2) seepage from the Alluvial Aquifer along the Santa Clara River and its tributaries, particularly in the eastern and central portions of the Santa Clarita Valley. Minor recharge may also occur in limited areas through irrigation seepage, where the land overlying the Saugus is cultivated. In the eastern part of the Santa Clarita Valley, the Saugus Formation is underlain by older rocks of the Castaic Formation and Mint Canyon Formation, which surround the bowl-shaped Saugus structure. Little, if any, groundwater exchange occurs between these formations and the Saugus Formation.

Discharge from the Saugus Formation occurs in part as groundwater pumping from wells as deep as 2,000 feet. Discharge from the Saugus Formation also occurs at the west end of the valley, west of the I-5 bridge, where Saugus groundwater is thought to discharge to the Alluvial Aquifer. The older and relatively impermeable rocks of the Pico Formation, that underlie and form the western boundary of the Saugus Formation, form a barrier to groundwater flow and force Saugus groundwater to discharge upwards into the Alluvial Aquifer in the area extending between two miles and six miles upstream of the county line (refer to Figure 2-1). The Saugus is not present at Blue Cut, which is approximately three miles downstream of the Saugus/Pico Formation contact and approximately one mile downstream of the county line.

Because the Saugus Formation and underlying bedrock units tilt downward from the edges of the valley to the center of the valley, the permeable sand layers within the Saugus Formation near the margins of the valley are thought to be oriented so that they are in direct connection with the overlying Alluvial Aquifer. Consequently, recharge to the Saugus Formation from the Alluvial Aquifer is thought to be greatest in these areas, particularly on the east side of the valley. Also, discharge from the Saugus Formation to the Alluvial Aquifer is thought to be enhanced where permeable sand layers of the Saugus are contacting the Alluvial Aquifer on the western end of the valley where the Saugus Formation discharges.

The available water level data, which are concentrated in localized areas, indicate that the direction of groundwater flow in the Saugus is toward the center of the valley from the highlands. The data indicate that Saugus groundwater flows toward the western end of the Santa Clara Valley where it discharges naturally into the Alluvial Aquifer. Figure 2-8 displays a groundwater elevation contour map for the Saugus Formation, using water level data collected during the fall of 2000 (RCS, 2002).

Although few wells have been drilled into the Saugus Formation at or north/northeast of the San Gabriel fault, there is evidence of limited Saugus groundwater flow across the fault. Data that suggest this limited hydraulic connection between the two fault blocks are as follows:

a. Geologic and geophysical logging of former exploratory oil wells indicates that the Saugus Formation is much thinner north of the San Gabriel Fault than south of it (see geologic cross section E-E′ in RCS, 1988). Preliminary interpretations of recent geologic and geophysical logging at multi-port monitoring wells on the Whittaker-Bermite property also suggest the Sunshine Ranch Member is present at much shallower depths on the upthrown fault block, north/northeast of the fault, than on the downthrown block, south/southwest of the fault. Together, these data indicate that the older and fine-grained Sunshine Ranch Member of the Saugus Formation predominates in the area north of the fault.

b. Water level monitoring on the Whittaker-Bermite property shows groundwater elevations in multi-port monitoring well MP-3, on the upthrown side of the fault, are approximately 100 to 150 feet higher than in the other multi-port wells, which are on the downthrown side of the fault. Additionally, the three monitoring wells on the downthrown side (MP-1, MP-2, and MP-4) that have been monitored since January 2003, show responses to seasonal pumping of nearby water supply wells, whereas the monitoring well on the upthrown side (MP-3) shows no such response. (See Figure 2-3 for the locations of these wells, and Figure 2-9 for plots of groundwater elevations over time at each of these wells.)

In contrast, recent drilling, well construction, and pump testing work has indicated that the Holser Fault does not act as a barrier to groundwater flow. In early 2003, well MP-5 was installed in the Saugus Formation, located just north of the fault. This is a multi-port monitoring well that measures water levels at four discrete depths as great as 965 feet in the Saugus Formation. During March 2004, a deep Saugus production well south of the Holser Fault (VWC-205, located 4,700 feet away) was pumped for 72 hours under controlled conditions that included allowing no pumping to occur from other Saugus wells in the area.

The test was performed in part to evaluate the Holser Fault's hydraulic influence in the Saugus Formation. During pumping at VWC-205, measurable drawdown was observed at the two deepest ports at MP-5, which are situated at depths (795 feet and 965 feet) that correspond with the depths of the upper portion of the screen of VWC-205. Water level recovery monitoring conducted when VWC-205 was shut down showed rising water levels in these same two ports at MP-5. These observations are consistent with previous indications that the Holser Fault is not a significant barrier to groundwater flow in the Saugus Formation.

RCS (2002) estimated that the amount of groundwater in storage in the freshwater-portion of the Saugus Formation is approximately 1.65 million acre-feet. Historical groundwater production rates since 1980 have ranged from approximately 3,000 to nearly 15,000 AF/yr. Table 2-2 summarizes the well-by-well historical annual groundwater pumping from the Saugus Formation from 1980 through 2000.

2.5 Aquifer Physical Properties

2.5.1 Alluvium

Available groundwater elevation data and aquifer test data from Alluvial wells indicate that the Alluvial Aquifer is unconfined (i.e., is under water table conditions). Transmissivity values range from 4,700 square feet per day (ft^2/day), or 35,000 gallons per day (gpd) per foot (gpd/ft) to over 100,000 ft^2/day, or 750,000 gpd/ft. Specific yield values range from approximately 0.09 to 0.16 (RCS, 1986, 2002).

The transmissivity values are estimated (indirectly calculated) from pumping plant efficiency (specific capacity) tests conducted on a number of alluvial water wells over the years by the Southern California Edison Company. The transmissivity estimates that are calculated from these tests vary widely over short distances, and in some cases they vary substantially over time at individual wells. This is because the drawdown data that are collected during these tests are solely from the pumping wells themselves. Consequently, the use of water level drawdown data from pumping wells may provide transmissivity estimates that are strongly influenced (potentially biased low) by the condition of the well's screen or perforations and the gravel pack, particularly in the case of older wells. Nonetheless, these estimates can be useful for identifying substantial spatial variations in aquifer permeability if one selects the highest transmissivity values that are calculated for each given well (those values least impacted by well structure or well-related issues). Table 2-3 summarizes the results of the interpretations of the specific capacity data. Appendix B contains detailed tables of the testing data and the calculations of transmissivity and hydraulic conductivity, along with a comparison of these values to parameter values used in the regional model.

2.5.2 Saugus Formation

Available aquifer test data from Saugus wells located near the center of the valley where the Saugus is thickest indicate that the Saugus is semi-confined to confined (under pressure). In areas where the Saugus crops out, the uppermost saturated zones are partially unconfined because the permeable beds are folded upwards. In the highlands, the Saugus beds are exposed at the ground surface, and in the valley the Saugus beds are in contact with the Alluvial Aquifer.

Transmissivity values range from approximately 400 to 25,000 ft^2/day (3,000 to 180,000 gpd/ft), but are typically between 5,500 and 11,000 ft^2/day (40,000 and 80,000 gpd/ft). Storativity values are on the order of 10^{-3} to 10^{-4}. These aquifer parameter values have been estimated from well performance tests and from the Saugus Formation ASR study conducted in 2000 (RCS, 2001, 2002). Table 2-4 summarizes this parameter data.

The ASR study consisted of a three-phase field test:

a. Phase 1: Injection of approximately 24 million gallons of treated drinking water into well VWC-205 at three injection rates (500, 800, and 1,100 gallons per minute [gpm]). Injection at each rate was performed for 7 days, for a total injection period of 21 days.

b. Phase 2: Recovery of 33 million gallons of water by pumping well VWC-205 at an average rate of 2,300 gpm for a period of 10 days. This pumping began 13 days after injection had ended.

c. Phase 3: Pumping 35 million gallons of water from nearby well VWC-201 at an average rate of 2,400 gpm for a period of 10 days. This pumping began 24 days after pumping had stopped at well VWC-205.

Water levels were monitored in nearby non-pumping Saugus Formation wells, including a Saugus monitoring well located 35 feet from well VWC-205, and in a newly installed Alluvial Aquifer monitoring well located 40 feet from well VWC-201. Monitoring began 22 days prior to Phase 1 and continued 3 days beyond the completion of Phase 3. Testing and monitoring details are provided in the report titled *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001). The ASR test indicated that it is hydrogeologically feasible to inject and recover significant volumes of water from a well completed in the Saugus Formation. The data also indicated that there was no measurable effect on water levels at the alluvial monitoring well during the monitoring period.

The ASR testing data also indicated that wells VWC-201 and VWC-205 have specific capacities between 10 and 20 gpm per foot (gpm/ft), which is intermediate in value between those of nearby wells. NCWD's wells to the south have specific capacities ranging from approximately 2 to 10 gpm/ft. To the north, wells that are owned by VWC and SCWC show specific capacities ranging from approximately 25 to 50 gpm/ft. Although these data suggest the possible existence of slightly more permeable zones in the center of the basin than along the southern edge, the apparent difference may also be caused by differences in well construction and well efficiency. Analyses of the ASR test data, including numerical model calibration runs, indicate that the bulk permeability of the Saugus Formation at wells VWC-201 and VWC-205 is approximately 6.5 feet per day (ft/day) (CH2M HILL, 2001).

2.6 General Hydrology and Hydrologic Cycle

The major sources of surface water in the Santa Clarita Valley include precipitation, return flows of urban and agricultural irrigation water, and treatment plant discharges to the Santa Clara River from two WRPs which were built in 1962 and 1967. Another significant source of surface water is the increased importing of SWP water, which is stored in Castaic Lake and Castaic Lagoon, then treated and delivered by CLWA to the retail water purveyors in the Santa Clarita Valley. In some years, DWR releases flood flows from Castaic Dam/ Lagoon into Castaic Creek during the winter or spring months. Further details regarding the operation of the SWP system and its effect on the valley's hydrology and water supply are provided in Section 2.6.3 below.

Before 1970, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 AF/yr. Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr until 1993. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. In response to statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available. The water management practices of the purveyors call for maximizing the use of Alluvial Aquifer and SWP water. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. Consequently, since 1995, Saugus pumping has ranged between approximately 4,000 and 8,500 AF/yr.

The remainder of this section describes the hydrology of the Santa Clarita Valley, historical hydrologic trends, and the operation of the SWP system and its influence on local hydrology and water supplies.

2.6.1 Basin Hydrology

The natural surface water features in the basin are the Santa Clara River and the tributaries that flow into it from canyons lying north and south of the river (Figure 2-10). Flows in the tributary canyons, and in the reach of the Santa Clara River that lies upstream of San Francisquito Canyon, are ephemeral, or intermittent. In these ephemeral streams, flow is limited to short-term runoff periods during storm events. The reach of the Santa Clara River west of San Francisquito Canyon is a perennially flowing river that obtains its flow from natural discharge of Alluvial Aquifer groundwater and from discharge of treated water from two WRPs. The other significant surface water feature is Castaic Lake, an SWP reservoir that lies at the north end of Castaic Creek in the northwestern portion of the valley. Like other tributaries to the Santa Clara River, the flows in Castaic Creek are ephemeral.

Figure 2-1 is a schematic diagram showing the hydrologic cycle for the Santa Clarita Valley. Table 2-5 lists the components of the hydrologic cycle for the basin. The components are classified in the table as one or more of the following:

a. Surface water recharge
b. Surface water discharge

c. Groundwater recharge
d. Groundwater discharge

These four elements of the hydrologic cycle have an important influence on the availability of surface water and groundwater resources in the basin. Time-series plots were constructed to show the relative magnitudes and trends of the various components of the hydrologic cycle in recent years. The time-series plots also illustrate the interrelationships of the hydrologic system components and their relationships to trends in groundwater levels in the Alluvial Aquifer and the Saugus Formation. The time-series analyses are discussed below.

2.6.2 Historical Hydrologic Trends

Long-term water level data have been collected over the years at purveyor-owned wells in the City of Santa Clarita and along the South Fork Santa Clara River. The data have been collected in pumping wells, and the hydrographs of these wells are steep at certain times, suggesting that some water levels are influenced by pumping at the well. Nonetheless, the data show some general trends over time and are useful for assessing general relationships between groundwater elevation trends and changes in groundwater recharge and pumping over time. Following are discussions of the observed hydrologic trends in the basin during the 50-year period from 1950 through 1999, as well as a comparison of hydrologic trends locally and in the SWP system.

2.6.2.1 Historical Trends in Rainfall

Figure 2-11 shows the annual precipitation along with the cumulative departure from the average annual precipitation since 1950. Cumulative departure refers to the cumulative amount of rainfall that is greater than or less than the long-term average rainfall. The slope of the cumulative departure plot shows the temporal trends in rainfall over successive years. The figure shows the following trends in precipitation within the Santa Clarita Valley:

a. 1950 through 1964: Dry conditions except for single wet years in 1952, 1957, 1958, and 1962 (a nearly continual decrease in cumulative departure values)

b. 1965 through 1970: Wet conditions (increase in cumulative departure values)

c. 1971 through 1977: Average to dry conditions (flat or declining cumulative departure values)

d. 1978 through 1983: Wet conditions (increase in cumulative departure values)

e. 1984 through 1991: Dry conditions (decrease in cumulative departure values)

f. 1992 through 1999: Highly variable conditions from year to year, but overall increase in cumulative departure values

2.6.2.2 Historical Trends in Alluvial Groundwater Elevations

Figure 2-12 shows trends in groundwater elevations in two Alluvial Aquifer wells located near the mouth of the South Fork Santa Clara River (VWC-N and NLF-S) and two Alluvial Aquifer wells near the western end of the basin (NLF-C5 and NLF-C7). The figure also shows trends in the following other components of the hydrologic cycle:

a. Precipitation at the Newhall-Soledad rain gage (plotted as the cumulative departure from the average precipitation)

b. Annual pumping volumes from the Alluvial Aquifer and the Saugus Formation

c. Total discharges from the WRPs to the Santa Clara River

d. Measured flow volume in the Santa Clara River during the lowest flow month of each year

Observations from Figure 2-12 are as follows:

a. Alluvial Aquifer groundwater elevations show greater variability over time within the basin interior (wells VWC-N and NLF-S) than near the basin outlet (wells NLF-C5 and NLF-C7). The range in water levels during the 50-year period of record is approximately 100 feet at the interior wells but only 20 to 30 feet in the two wells near the basin outlet.

b. The effect of reduced pumping from the Alluvial Aquifer from 1967 through 1989 was to minimize seasonal fluctuations in Alluvial Aquifer water levels near the aquifer's regional discharge zone at the western end of the valley. In this area, fluctuations in Alluvial pumping over time affected Alluvial groundwater elevations only seasonally; year-to-year variations in groundwater elevations were small. This indicates that water levels in this area are controlled less by pumping than by the discharge of Alluvial Aquifer groundwater to the Santa Clara River in the area downstream of I-5.

c. As with the western portion of the Alluvial Aquifer, the central portion of the Alluvial Aquifer has not shown long-term water level declines. During the 1950s and early 1960s, total pumping from the Alluvial Aquifer ranged between 35,000 AF/yr and 44,000 AF/yr during all but one year, and long-term (year-to-year) groundwater elevations were relatively stable (see the hydrographs for wells VWC-N, and NLF-S). When pumping from the Alluvial Aquifer decreased beginning in 1967, Alluvial groundwater elevations in this area quickly rose and have been relatively stable since about 1970, despite an increase in Alluvial Aquifer pumping during the 1990s. The hydrographs indicate that after an extended drought and high rates of pumping, Alluvial Aquifer groundwater elevations recover very quickly when normal or above normal rainfall patterns return.

d. The seasonal low flow in the Santa Clara River at the County Line gage has shown a long-term increase since the mid-1970s and, to some degree, during the late 1960s. The figure shows that this increase in flow coincides with increases in the annual discharges of treated water to the Santa Clara River from the two WRPs. Although Alluvial Aquifer pumping increased during the 1980s and 1990s, the seasonal low river flow did not show a long-term decrease during this period. The increases in WRP and Santa Clara River flows and the fluctuations in Alluvial Aquifer pumping have not caused long-term changes in Alluvial Aquifer groundwater elevations at the two wells near the basin outlet.

2.6.2.3 Historical Trends in Saugus Groundwater Elevations

Figures 2-13 and 2-14 compare groundwater elevation trends in the Saugus near the Santa Clara River, below the mouth of the South Fork Santa Clara River, with the same hydrologic components displayed on Figure 2-12. Figure 2-13 shows this information for the period 1950 through 1999, and Figure 2-14 shows this information during the 1990s, when groundwater levels rose in the Saugus Formation. Figures 2-15 and 2-16 show the same information, but for groundwater elevations at Saugus Formation wells located farther away from the Santa Clara River, along the tributary valley containing the South Fork Santa Clara River.

In examining the four Saugus figures, it is difficult to distinguish between the influences of precipitation and pumping trends on changes in Saugus water levels. Although a slight rise in water levels may have occurred at VWC-157 and VWC-160 during the late 1960s and early 1970s, it appears to follow the trends in Saugus pumping volumes more closely than the precipitation trends. The data at VWC-157 also suggest that a succession of above-normal precipitation years (e.g., 1978 through 1983) or a year of precipitation that is substantially above normal (e.g., 1983) may have some influence on Saugus water levels. However, the data are limited, and the periods of increased precipitation tend to coincide with periods of decreased pumping, making it difficult to identify the effect of precipitation or pumping on Saugus water levels.

Another observation is that the rise in Saugus water levels in the late 1960s and early 1970s occurred despite an increase in annual pumping volumes from the Alluvial Aquifer. This indicates that Saugus water levels are controlled by precipitation and/or Saugus pumping trends, and not by Alluvial pumping trends.

2.6.2.4 Comparison of Historical Trends in Alluvial and Saugus Groundwater Elevations

Figure 2-17 compares groundwater elevations at Alluvial and Saugus wells located near each other along the Santa Clara River, just below the mouth of the South Fork Santa Clara River. At this location, the trends in Alluvial groundwater elevations show no clear relationship with the trends in Saugus groundwater elevations. A moderate overall increase in groundwater elevations is observed in both the Alluvial Aquifer and the Saugus Formation during the late 1960s. However, this similarity in the water level trends may be a coincidence arising from reduced pumping in both aquifers. During the early 1970s, water levels in Saugus well VWC-157 decreased while water levels in the nearby Alluvial Aquifer well (VWC-N) generally increased. During the 1990s, the Alluvial Aquifer groundwater elevations at well VWC-N were generally stable despite (1) increased basinwide alluvial pumping and (2) a sharp decrease, then increase, in Saugus groundwater elevations, which correlated with the trends in Saugus pumping. In summary, although there may be a relationship between Alluvial and Saugus groundwater elevations near the margins of the Santa Clara Valley, where folding of Saugus beds has brought permeable zones in contact with the alluvium, Figure 2-17 indicates that there is general independence between the Alluvial and Saugus water level trends at this location, which is near the center of the bowl-shaped Saugus Formation structure discussed in Section 2.3.3.

2.6.2.5 Historical Trends in Santa Clara River Baseflow

Hydrograph separation techniques were applied to the daily streamflow data for the County Line gage to estimate historical groundwater discharges (baseflow) to the Santa Clara River within the Santa Clarita Valley. The hydrograph separation was performed for calendar years 1953 through 1999 using the following five steps:

1. For each day, the average daily flow at the County Line gage in cubic feet per second (cfs) was converted to acre-feet of volumetric flow for the day.
2. The daily flows from Castaic Dam and at the Castaic Creek South gage (located near the mouth of Castaic Creek) were subtracted from the flow at the County Line gage. These data reflect surface water flow from tributaries. Data from the Castaic Creek South gage were used through June 1977. Beginning in July 1977, operational data for Castaic Lagoon, presented in annual reports by DWR, were used to estimate surface flow contributions from Castaic Creek.
3. The discharges of treated effluent from WRPs owned by LACSD were subtracted. This was performed for calendar years 1975 and later, as 1975 was the first year that such records were available.
4. The resulting day-to-day trends in streamflows were scrutinized for days when notably elevated flows occurred suddenly. These days were assumed to be dominated by storm flow. In some cases, the elevated flows lasted for only 2 to 5 days. In other cases, flows remained elevated for several days but showed steady declines, indicating that only the beginning of the elevated-flow period was dominated by surface runoff.
5. On all other days, storm flow was considered to be minimal or zero, and the flow values calculated for days not dominated by storm flow were assumed to represent river base-flow (that is, groundwater discharge to the river). For each month, an average flow was calculated for these non-storm days. The average flow was then converted to a total flow for the month, and the monthly flow volumes were summed to come up with the total flow for each year.

Table 2-6 presents the annual calculations from the hydrograph separation analysis. Table 2-7 presents summary statistics for the entire 47-year period that was analyzed, as well as for shorter time frames. Tables 2-8 and 2-9 show dry-year, normal-year, and wet-year statistics for the entire period of record and the shorter time frames. The shorter time frames are:

a. Calendar years 1953 through 1965, which were years of primarily agricultural water use prior to urbanization and construction of WRPs. This 13-year period was also characterized by 5 years of below-normal rainfall.

b. Calendar years 1975 through 1999, which represent 25 years of significant urbanization, including SWP water importation and WRP operations. This 25-year period was characterized by 6 years of below-normal rainfall, though rainfall volumes in general were somewhat higher (19.4 inches per year [in/yr] average, versus 15.5 in/yr average for 1953 through 1965).

c. Calendar years 1953 through 1999, but excluding 8 years (1966 through 1974) when WRP discharges occurred but were not recorded.

The daily streamflow data and the hydrograph separation technique indicate the following:

a. Summary statistics in Table 2-7 for all types of rainfall years (dry, normal, and wet) show that average groundwater discharges to the river from 1953 through 1965 were approximately 2,500 AF/yr (3.5 cfs). Groundwater discharges to the river were typically

14,000 to 22,000 AF/yr (19 to 31 cfs) from 1975 through 1999 because of more rainfall, increasing urbanization, and increasing importation of water from outside the valley.

b. For normal rainfall years only, median and average groundwater discharges to the river were approximately 12,500 and 14,300 AF/yr (17 and 20 cfs), respectively, during 1975 through 1999 (Table 2-8); approximately 8,600 and 10,000 AF/yr (12 and 14 cfs), respectively, for the entire historical record (Table 2-9); and approximately 4,000 and 3,600 AF/yr (5.5 and 5.0 cfs), respectively, from 1953 through 1965 (Table 2-8).

c. For drought years only, Table 2-8 shows that groundwater discharges to the river ranged from 400 to 4,900 AF/yr (0.5 to 7 cfs) between 1953 and 1965, and from 5,200 to 14,500 AF/yr (7 to 20 cfs) between 1975 and 1999. Table 2-8 also shows that median and average groundwater discharges to the river during drought years were 600 and 1,700 AF/yr (1 and 2 cfs), respectively, from 1953 through 1965, and typically 9,600 and 10,200 AF/yr (13 and 14 cfs), respectively, from 1975 through 1999.

2.6.3 State Water Project Operations and Hydrology

The import of SWP water is an important aspect of the local hydrologic system, particularly for water supplies. Following is a summary of the SWP system's operations and history in the Santa Clarita Valley, the amount of SWP water available to the valley, and a comparison of the timing of wet-dry rainfall cycles in the SWP system and in the Santa Clarita Valley.

2.6.3.1 State Water Project Operations and History

SWP water is transported to the Santa Clarita Valley by the California Aqueduct and is stored in Castaic Lake prior to use. Castaic Lake is one of several facilities that store SWP water that is transported to Southern California by the California Aqueduct and other aqueducts. The designated uses of Castaic Lake are recreation and storage of SWP water intended for eventual municipal use.

The stored SWP water is delivered by CLWA, which was formed in 1962 to provide a supplemental supply of imported water to the retail water purveyors in the valley. CLWA treats this water at two facilities, the Earl Schmidt Filtration Plant and the Rio Vista Water Treatment Plant, then wholesales this water to each of the retail water purveyors through an extensive transmission pipeline system. The CLWA service area covers approximately 195 square miles (124,800 acres), including the City of Santa Clarita and the surrounding unincorporated communities.

In 1966, CLWA signed a contract with DWR that established a contract amount of 41,500 acre-feet of SWP water. CLWA subsequently purchased 12,700 AF/yr from a Kern County water district during the 1980s, and recently purchased an additional 41,000 AF/yr from a member agency of the Kern County Water Agency, for a current total of 95,200 AF/yr of Table A SWP water. From 1980, when SWP water was first imported into the Santa Clarita Valley, through 1999, the total amount of SWP water delivered to the CLWA service area was approximately 298,972 acre-feet.

The SWP water is combined with local groundwater to meet both residential and non-residential interior and exterior water demands. Ultimately, a substantial portion of the municipal water supply reaches the local existing WRPs in the valley. Historically, the treated water has been discharged from these WRPs to the Santa Clara River, where it contributes significantly to the natural surface water and groundwater flows reaching Ventura County. As discussed previously, stream gage data at the county line (USGS Gage No. 11108500)[2] demonstrate an increase in annual flow since the import of SWP water and the operation of the WRPs began, even during dry years. This is expected to continue in the future because increased urbanization will increase CLWA water deliveries, which in turn will increase inflows and outflows at LACSD's two WRPs (LACSD, 1998; CH2M HILL, 2002). However, over time, a portion (up to 17,000 AF/yr) of the future increases in flows into the WRPs will become reclaimed water that is used for outdoor irrigation, rather than being discharged into the river.

2.6.3.2 State Water Project Water Availability

The current CLWA Table A contract amount of 95,200 AF/yr of SWP water is affected by a number of factors, including hydrologic conditions; the status of SWP facilities construction; environmental requirements; and evolving policies for water resources management in the San Francisco Bay and Sacramento Delta system, which help route SWP water. While several programs may improve the reliability of SWP water imports to Southern California, such as Interim Delta Improvements and future improvements called the Full Delta Fix and South of Delta Storage, water planning efforts in the Santa Clarita Valley have conservatively assumed that future SWP water supplies will be equal to the SWP supply available under existing conditions. (See the Urban Water Management Plan 2000 [S.A. Associates et al., 2000] for details.)

The DWR has created a model of the SWP system and its allocations. The results from the model, called the DWRSIM model, are used by water agencies in the Santa Clarita Valley as planning numbers for SWP deliveries. The planning numbers for annual SWP water imports to the Santa Clarita Valley, based on CLWA's current Table A contract amount, are as follows:

a. Average years = 56,800 AF/yr (59.7 percent of the 95,200 AF/yr Table A contract amount)

b. Wet years = 66,300 AF/yr (69.6 percent of the 95,200 AF/yr Table A contract amount)

c. Multiple dry years = 37,900 AF/yr (39.8 percent of the 95,200 AF/yr Table A contract amount)

d. Multiple critical years = 19,000 AF/yr (20.0 percent of the 95,200 AF/yr Table A contract amount)

The DWRSIM model also indicates that a dry year allocation occurs, on average, once every 10 years, and that 3 consecutive years of drought occur, on average, once every 20 years. A separate DWR study (Roos, 1992) also concluded that droughts in excess of 3 years are rare in Northern California. Consequently, because of the availability of storage in the SWP

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[2] Until October 1996, this gage was located just downstream of the county line at Blue Cut, an area where the valley becomes substantially narrower in width and the river begins to bend toward the southern side of the valley. See Figure 1-1 for this location. This gage continued operation through October 21, 1996, at which time it was permanently taken out of service. A new gage (USGS Gage No. 11109000) was put into service beginning on October 1, 1996 approximately 2.5 miles downstream, near Piru Junction, at the Las Brisas Bridge.

system, DWR and the water agencies in the Santa Clarita Valley use the dry year allocation of 37,900 AF/yr to plan for single dry years, and also for droughts lasting up to 3 years.

2.6.3.3 Local and State Water Project Historical Hydrology

Table 2-10 compares the historical hydrologic pattern for the SWP system with the local basin hydrology since 1944. The SWP hydrologic pattern is affected by the hydrology of Northern and Central California and is specifically mentioned in the Sacramento Four Rivers Unimpaired Runoff Index in Volume 1 of *Bulletin 160-98: The California Water Plan Update* (DWR, 1998). This index provides a general indication of SWP water delivery patterns, though it only describes runoff into the SWP system and does not account for system storage and other factors that affect actual SWP deliveries. The local hydrologic pattern shown in Table 2-10 is based on the long-term rainfall record at the Newhall-Soledad rain gage. Table 2-10 shows the following:

a. Critically low runoff years occurred in the SWP system during the 2-year period 1976 through 1977; during 1988; during the 3-year period 1990 through 1992; and again during 1994.

b. The period 1980 through 1999 shows primarily extreme hydrologic conditions (wet, dry, or critical), with moderate hydrologic conditions occurring only twice, above-normal years in 1980 and 1993.

c. Hydrologic conditions in the SWP system are often different from local hydrologic conditions. Below-normal years in the SWP system often do not coincide with local droughts, and only some critical SWP years, 1990 and 1994, coincide with local drought. Likewise, historical SWP hydrology has varied considerably during years of local droughts.

The Regional Model was calibrated to time-varying hydrologic conditions for the historical time period 1980 through 1999 (see Section 4 for more details on Regional Model calibration). Table 2-11 compares SWP hydrology, SWP allocations, and local hydrology for the period 1980 through 1999. Based on the historical cycle and the goals listed above, the hydrologic cycle relating to the availability of SWP water during that period was as follows:

a. Years 1 through 5 (water years [WY] 1980 through 1984): normal or above-normal availability

b. Year 6 (WY 1985): 1-year drought (below-normal availability)

c. Years 7 through 10 (WYs 1986 through 1989): normal or above-normal availability

d. Years 11 through 13 (WYs 1990 through 1992): 3-year drought (below-normal availability)

e. Year 14 (WY 1993): normal or above-normal availability

f. Year 15 (WY 1994): 1-year drought (below-normal availability)

g. Years 16 through 20 (WYs 1995 through 1999): normal or above-normal availability

Although SWP hydrology was dry or critical during water years 1987 through 1989, the DWRSIM model indicates that the storage volume in the SWP would have provided normal water deliveries to the Santa Clarita Valley (S.A. Associates et al., 2000).

2.6.3.4 Availability of Castaic Creek Flood Flows

As provided through agreement with DWR, CLWA has access to approximately 4,700 acre-feet of storage in Castaic Lake. This water is stormwater that flows into Castaic Lake from its upstream watersheds. Prior to completion of Castaic Dam in 1972, the LACWWD, Newhall Land & Farming Company (NLF), NCWD, and UWCD, which together constitute the Downstream Water Users, had certain rights to the stormwater flowing in Castaic Creek. On October 24, 1978, DWR entered into agreements with the Downstream Water Users regarding their rights to this water. Under the terms of the agreement, DWR would release the first 100 cfs of inflow. At the time of the agreement, flows in excess of 100 cfs were believed to be wasted to the ocean. When the local inflow to Castaic Reservoir exceeds 100 cfs, the excess of 100 cfs inflow is retained in the reservoir. Until May 1 of each year, the Downstream Water Users can receive 75 percent of this retained water by paying specified storage charges. If the Downstream Water Users request this water, it is delivered by releasing water into Castaic Lagoon, and then Castaic Creek. These releases are called Castaic Creek Flood Flows. If the Downstream Water Users do not request this water on or before May 1, any retained water becomes the property of DWR.

The allocation of stored water among the Downstream Water Users is specified in a separate agreement. Under that agreement, UWCD receives 48 percent of the delivered flood flows, while the three Santa Clarita Valley entities, NLF, NCWD, and LACWWD, together receive 52 percent.

The Castaic Creek flood flows available to the group of four Downstream Water Users averaged 15,700 AF/yr during water years 1977 through 2000. (See Table 2-12.) However, the magnitudes of these flows varied greatly from year to year, as shown on Figure 2-18. No flood flows were stored or delivered in 5 of these years, and the median flow was 2,800 AF/yr (only 18 percent of the average flow). The highest flood flow was 67,400 AF/yr, in water year 1978, and the flood flow exceeded the average flow in only 7 of these 24 years. The Regional Model simulated these historical flows, as described in Appendix C.

2.7 Previous Studies

Several prior studies have been important in developing a general understanding of the valley's geology and hydrology and in developing and calibrating the Regional Model.

2.7.1 1986 Alluvial Aquifer Study

In 1986, RCS studied the alluvial sediments in the Santa Clarita Valley to estimate the amount of groundwater in storage and the amount of recharge that occurs over the long-term, and also to evaluate the feasibility of artificially recharging these sediments (RCS, 1986). This was the first published report detailing the hydrogeologic characteristics of the Alluvial Aquifer system, water well construction and testing information, and magnitudes and changes in groundwater elevation and groundwater quality. Prior studies in the Santa Clarita Valley focused on oil development, and therefore evaluated the regional geology with an emphasis on the subsurface geologic conditions in the hills and mountains surrounding the valley.

The 1986 study identified 650 water wells that had been drilled in the valley up to that time, all but 22 of which were drilled in the alluvium to depths less than 250 feet. The study examined geologic logs, well testing (specific capacity) records, long-term water level data, and water quality records. The study concluded that the coarse-grained, permeable sediments comprising this aquifer system are subjected to seasonal and year-to-year variations in water levels and groundwater in storage due to highly variable rainfall and streamflow patterns. In addition to describing the hydrogeology of the Alluvial Aquifer, the study mapped and identified the watersheds contributing to streamflows in the Santa Clara River and its tributaries, and estimated the amount of runoff from these watersheds that is potentially available as recharge to the Alluvial Aquifer. The study also concluded that it would be feasible to artificially recharge portions of the Alluvial Aquifer using spreading basins, primarily along the Santa Clara River in the area east of the mouth of Bouquet Canyon.

2.7.2 1988 Saugus Aquifer Study

In 1988, RCS conducted a study of the Saugus Formation that was similar in scope to the 1986 study of the Alluvial Aquifer (RCS, 1988). The scope of work included conducting 24-hour, constant discharge aquifer tests in five different Saugus Formation wells, including monitoring water level recovery rates. Six regional geologic cross-sections were also constructed from geologic and geophysical logs that had been compiled prior to this study at water wells and numerous oil wells within and around the Santa Clarita Valley.

The study concluded that the Saugus Formation is discretely layered, with groundwater production occurring from discrete sand and gravel zones that exist throughout much of the total thickness of the formation. The study also concluded that it is hydrogeologically feasible to develop additional groundwater supplies from the Saugus Formation as long as wells are properly sited and constructed, and that the groundwater-yielding capability of the Saugus Formation is likely greater south of the San Gabriel fault than north of the fault.

2.7.3 2002 Aquifer Study Update

In 2002, RCS updated the 1986 and 1988 studies with more recent data and prepared a report for both the Alluvial and Saugus Formation aquifers (RCS, 2002). As part of this work, a GIS and digital database were constructed. Field activities conducted during the study included surveying water well locations and elevations using a global positioning system (GPS) survey and water level data collected at Alluvial and Saugus wells.

The report concluded that groundwater levels in the Alluvial Aquifer and Saugus Formation have fluctuated over time, but have shown no long-term progressive declines in the amount of groundwater storage that could be considered indicative of overdraft conditions. From the long-term pumping and water level data, the report concluded that the Alluvial Aquifer can be pumped at rates between 30,000 and 40,000 AF/yr over the long-term, and suggested that pumping be between 30,000 and 35,000 AF/yr during dry years. For the Saugus Formation, the study concluded that pumping can occur at rates between 7,500 and 15,000 AF/yr on a long-term basis, with short-term increases to as much as

35,000 AF/yr during the end of a multi-year drought period. These pumping rates for the Alluvial and Saugus aquifer systems were referred to in the 2002 study as the operational yields of both aquifers.[3]

2.7.4 Newhall Ranch ASR Impact Evaluation

The Newhall Ranch Company performed analyses of potential impacts resulting from development of the proposed Newhall Ranch Specific Plan, including implementation of an ASR program. Findings were documented in the following reports:

a. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001).

b. *Newhall Ranch ASR Impact Evaluation* (CH2M HILL, 2001).

c. *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002).

The study consisted of the following work:

a. An ASR field test was conducted by RCS in the Saugus Formation at VWC-205 in July 2000. The objective of the test was to determine the feasibility of injecting water into the Saugus Formation and later extracting the stored water. Approximately 24 million gallons of treated drinking water were injected into the well at a rate of up to 1,100 gpm for 21 days (RCS, 2001). The stored water was then recovered at a rate of 2,300 gpm for 10 days. Water levels were monitored in nearby Saugus Formation wells and in a newly installed Alluvial Aquifer monitoring well. This test demonstrated that ASR is indeed feasible in the Saugus Formation. Also, there was no measurable effect on water levels during the injection or pumping phase at the Alluvial monitoring well.

b. A pumping test was conducted by RCS in the Saugus Formation at VWC-201 to further demonstrate the limited hydraulic connection between the Saugus Formation and the Alluvial Aquifer. Well VWC-201 was pumped at 2,400 gpm for 10 days and water levels were monitored at an Alluvial Aquifer well located less than 50 feet away. Again, no response to Saugus Formation pumping was discernible at the Alluvial monitoring well.

While the ASR field test demonstrated that ASR is feasible in the Saugus Formation and that there is limited effect on the Alluvial Aquifer, it was necessary to conduct additional

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[3] The concept of operational yield was described in the RCS report as follows (RCS, 2002):

"One of the disadvantages of utilizing perennial yield as a basis for managing the pumpage from an aquifer system is that it represents a long-term average value for annual yield. There is a potential for the perennial yield value to be interpreted as a "not-to-exceed" volume, with a related potential for pumping above the perennial yield value in any give year to be incorrectly interpreted as "overdraft." A recently advanced concept intended to deal with such misinterpretations is that of operational yield. Operational yield can be defined as a fluctuating value of pumpage that may be above or below the perennial (or average) yield in any given year, and that varies as a function of the availability of other water supplies. The basic intent of the operational yield value is that it should not exceed the perennial yield of the groundwater basin over multi-year wet and dry cycles."

"The operational yield concept includes flexibility of groundwater use by allowing increased pumping during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is available in wet/normal rainfall periods. The operational yield protects the aquifer by helping to assure that groundwater supplies are adequately replenished on a long-term basis from one wet/dry cycle to the next. In the Valley, historical groundwater data demonstrate that the alluvium has been, and continues to be, developed within its long-term sustainability (i.e., no continuous lowering of water levels, no notable trend toward degradation of groundwater quality, etc.)"

analysis to extrapolate the results of RCS's well field testing to a full-scale, long-term ASR operation. This additional analysis was designed to address the following questions:

a. Can 4,500 AF/yr of water be stored in the Saugus Formation for withdrawal during drought years?

b. Will storage of water in the Saugus Formation increase the rate of natural groundwater discharge to the Alluvial Aquifer and to the Santa Clara River, and, if so, by how much?

c. Will pumping Saugus Formation ASR wells during a drought period reduce groundwater elevations in the Alluvial Aquifer and, subsequently, flows in the Santa Clara River?

d. Will the ASR program result in water quality changes within the Saugus Formation, the Alluvial Aquifer, and the Santa Clara River?

e. Will the ASR program cause spreading of perchlorate that is present in the Saugus Formation?

To answer these questions, CH2M HILL prepared a numerical groundwater flow model of the western and central portions of the Santa Clarita Valley. The model simulated the groundwater flow in the Saugus Formation and the Alluvial Aquifer, accounting for the inflows and outflows to and from the Alluvial Aquifer, the Saugus Formation, and the Santa Clara River under historical conditions. The model was also used to simulate the changes in the groundwater flow system that would arise from operation of the ASR system. Of particular interest was the model's simulation of changes in subsurface groundwater flow out of the valley and changes in groundwater discharge into the Santa Clara River that would arise from ASR operations under a historical climatic cycle (wet and dry hydrologic conditions) observed during the 1980s and 1990s. These two groundwater discharge mechanisms were evaluated in detail with the model to estimate the potential changes in flow to Ventura County from the ASR system. The western limit of the model was placed at the county line, and the eastern limit of the Saugus Formation was established as the eastern limit of the model domain.

The primary findings from the analysis were:

a. On the basis of the historical timing of drought years, the proposed ASR system would provide long-term benefits to the river and the groundwater system. ASR pumping cycles would cause small (less than 1 foot) declines during drought years, and long-term operation of the ASR system would not cause long-term groundwater elevation declines in the Alluvial Aquifer, where riparian habitat is present along the river.

b. The combined influence of the proposed ASR program and the other water resource attributes[4] of Newhall Ranch would result in an overall increase in river flows over the long term.

c. The continued increase in water supplies to meet the water demands arising from a combination of growth outside Newhall Ranch and development of the Newhall Ranch

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[4] Direct discharges of treated effluent into the river from the Newhall Ranch WRP, and the redistribution of irrigation demands (rates and locations) associated with conversion of water use from agricultural to municipal demands.

project would further enhance the long-term flows to the river, compared with present conditions. The occurrence of increased annual river flows during drought and nondrought years alike, compared with present conditions, is consistent with historical records, showing that continued urbanization and associated importation of water from areas outside the valley would increase river flows gradually over time.

Tables

TABLE 2-1

Annual Groundwater Pumping from the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NCWD	Castaic1	244	257	253	189	251	274	295	450	520	478	444	561	515	458	496	401	385	535	166	426	118
	Castaic2	124	48	0	0	0	0	380	535	324	678	0	0	0	477	518	380	327	268	257	331	289
	Castaic3	0	108	136	172	240	301	0	0	324	0	660	532	488	0	0	0	0	0	0	0	0
	Castaic4	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	95	57	6	7
	Pinetree1	346	326	355	242	148	273	8	0	2	152	0	47	16	247	154	79	64	89	227	403	245
	Pinetree2	58	84	209	112	154	113	206	309	351	348	31	0	283	326	218	165	70	0	0	0	0
	Pinetree3	398	527	225	432	753	655	719	756	758	672	801	724	682	450	607	595	624	812	716	505	494
	Pinetree4	0	0	0	0	3	28	234	77	4	0	0	0	10	19	232	55	333	510	338	5	355
NLF	161	317	370	271	223	314	220	170	0	0	0	120	82	401	753	791	0	0	0	0	123	106
	B10	0	0	0	0	0	0	0	0	0	0	0	291	1,225	452	1,406	894	1,045	930	1,244	1,155	990
	B11	186	217	159	133	184	138	60	0	0	127	445	311	0	136	51	127	151	30	250	212	182
	B5	1,218	1,423	1,041	858	1,208	772	1,178	1,002	1,481	1,928	1,893	1,880	860	989	1,950	1,921	1,649	1,756	1,273	1,748	1,500
	B6	858	1,002	733	604	850	543	946	788	165	96	137	263	615	283	808	1,359	1,421	1,602	1,572	2,133	1,830
	B7	0	0	0	0	0	0	60	0	0	127	0	0	400	180	581	373	56	286	176	444	381
	C	723	845	618	510	717	575	660	387	418	557	338	226	756	1,024	417	1,324	715	1,126	598	716	614
	C3	196	229	168	138	195	140	254	63	130	71	134	48	197	259	582	333	397	355	378	619	531
	C4	260	304	222	183	258	196	137	25	30	7	213	225	166	12	108	150	293	483	609	819	703
	C5	459	536	392	323	455	359	328	191	198	154	147	250	428	414	394	472	676	894	628	685	588
	C6	203	237	174	143	201	166	161	103	117	77	59	123	0	0	0	360	229	226	128	154	132
	C7	575	671	491	405	570	354	195	192	318	337	339	220	427	279	625	778	582	779	779	1,167	1,001
	C8	0	0	0	0	0	0	0	0	0	0	0	0	126	254	166	199	458	432	179	236	202
	E	2,067	2,416	1,767	1,457	2,051	3,342	1,842	1,180	812	624	965	498	1,325	1,513	1,022	1,366	2,542	1,949	1,522	2,506	2,150
	E2	174	203	149	123	173	138	103	0	0	251	1,284	830	560	584	555	115	669	525	426	138	118
	E3	0	0	0	0	0	0	0	0	0	0	0	0	0	15	138	0	0	0	0	0	0
	E4	1,011	1,181	864	712	1,003	639	716	83	566	392	553	284	376	16	0	381	140	339	80	281	241
	E5	0	0	0	0	0	0	0	0	0	0	0	0	65	274	0	142	514	598	42	0	0
	E7	0	0	0	0	0	0	0	0	0	0	0	0	116	80	105	88	79	2	0	0	0
	E9	96	113	82	68	96	78	117	288	476	411	339	596	252	187	435	319	12	142	170	42	36
	G45	324	378	277	228	321	179	153	98	123	99	143	146	165	82	144	137	159	180	144	231	198
	Q	441	515	377	311	438	159	360	382	312	185	15	0	0	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	205	0	0	0	0	0	0	0	0	0	0	0	0	0
	R2	159	186	136	112	158	71	104	47	0	0	0	87	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S2	293	342	250	206	290	95	0	958	0	0	503	0	0	0	0	0	0	0	0	276	237
	S3	655	765	560	461	649	327	124	0	0	0	29	37	52	99	87	109	97	55	10	3	0
	Topco 1	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0
	Topco 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W4	303	354	259	213	300	138	60	1	0	300	157	252	1	0	36	5	128	29	20	3	3
	W5	553	646	472	389	548	191	315	205	308	192	0	175	0	0	0	0	0	0	0	21	18
	X3	260	304	222	183	258	508	244	314	497	308	412	215	350	135	205	222	8	108	22	112	96
SCWC	Clark	303	228	131	137	194	200	208	342	248	301	407	542	662	635	572	662	1,027	873	697	878	747
	Guida	1,058	795	457	477	677	698	221	569	158	530	676	801	978	895	942	744	1,252	1,479	1,274	1,556	853
	Honby	594	447	257	268	381	392	193	391	462	216	930	893	731	1,393	476	553	352	814	532	1,162	815
	Lost Canyon 2	1,083	814	468	489	693	714	765	923	787	588	601	404	465	692	669	773	678	792	757	946	708
	Lost Canyon 2A	0	0	0	0	0	0	0	0	0	0	293	832	1,284	1,080	1,383	1,230	1,370	1,055	973	890	998
	Methodist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mitchell	1,189	893	515	537	761	785	444	582	485	435	264	3	474	663	564	610	598	633	482	913	439
	N.Oaks Central	488	367	211	220	313	322	304	361	153	329	525	704	701	1,403	1,313	965	851	870	1,490	1,682	1,145
	N.Oaks East	601	451	260	271	385	396	863	972	776	914	454	194	588	1,233	1,473	1,295	900	1,033	1,407	695	1,483
	N.Oaks West	643	483	278	290	412	424	874	465	842	413	275	78	634	866	972	795	663	952	934	1,894	1,663
	Sand Canyon	721	542	312	325	461	477	514	466	498	1,115	458	49	661	918	781	842	1,211	1,533	1,622	1,629	1,317
	Sierra	2,780	2,089	1,202	1,255	1,780	1,834	856	220	459	730	772	719	1,050	1,413	1,433	1,092	1,034	597	814	1,158	640
	Stadium	0	0	0	0	0	0	167	291	211	214	328	374	60	825	418	656	509	637	444	338	721

TABLE 2-1

Annual Groundwater Pumping from the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
VWC	D	289	269	164	163	240	41	0	305	588	614	510	680	239	173	494	403	454	1,134	1,209	921	880
	I	214	200	122	121	177	181	95	0	91	132	73	108	1	0	1	0	0	0	0	0	0
	K2	0	0	0	0	0	0	0	0	0	0	0	982	1,134	1,708	2,089	1,155	1,305	1,076	1,489	1,420	861
	L2	9	8	5	5	7	91	0	0	0	0	0	838	526	996	1,236	818	961	308	190	532	494
	N	1,475	1,376	840	833	1,223	1,093	1,472	1,420	1,473	1,177	792	976	697	66	0	24	263	808	768	1,036	935
	N3	0	0	0	0	0	0	0	0	0	0	0	10	999	1,536	29	943	1,325	1,034	1,093	1,057	778
	N4	5	5	3	3	4	65	0	0	0	0	0	847	248	133	911	1,329	1,328	1,185	772	894	710
	Q2	440	411	251	248	367	461	838	893	512	1,483	1,398	1,783	335	548	1,348	1,126	1,385	1,462	1,655	1,288	1,387
	S6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	515
	S7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111
	S8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79
	T2	621	580	354	351	515	704	894	913	1,007	1,030	643	662	379	0	3	280	733	837	941	726	984
	T4	160	150	91	91	133	54	167	0	0	0	0	163	687	3	1	975	1,258	804	523	892	625
	U3	1,476	1,378	841	834	1,225	1,278	1,033	638	323	823	1,254	1,199	369	1	2	765	987	851	560	702	1,126
	U4	1,306	1,220	744	738	1,084	665	668	606	696	567	551	584	42	3	2	7	742	789	529	828	1,073
	W6	0	0	0	0	0	0	0	146	145	0	0	217	260	204	224	365	615	493	355	416	445
	W9	0	0	0	0	0	0	0	0	0	0	11	902	699	444	507	508	1,077	915	627	1,111	1,176
WHR	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,229	1,376	772	1,104	1,204	1,352	760	614	1,229	1,131	1,010
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	137	137	137	137	137	137	137	137	137	137	91	102	57	82	89	100	56	46	91	84	75
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	680	762	427	612	666	748	421	340	680	627	559
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pumping (NCWD)		1,170	1,350	1,178	1,147	1,549	1,644	1,842	2,127	2,283	2,367	1,936	1,864	1,994	1,977	2,225	1,675	1,803	2,309	1,761	1,676	1,508
Total Pumping (NLF)		11,331	13,237	9,684	7,983	11,237	9,328	8,287	6,512	5,951	6,243	8,225	7,039	8,938	8,020	10,606	11,174	12,020	12,826	10,250	13,824	11,857
Total Pumping (SCWC)		9,460	7,109	4,091	4,269	6,057	6,242	5,409	5,582	5,079	5,785	5,983	5,593	8,288	12,016	10,996	10,217	10,445	11,268	11,426	13,741	11,529
Total Pumping (VWC)		5,995	5,597	3,415	3,387	4,975	4,633	5,167	4,921	4,835	5,826	5,232	9,951	6,615	5,815	6,847	8,698	12,433	11,696	10,711	11,823	12,179
Total Pumping (WHR)		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	2,240	1,256	1,798	1,959	2,200	1,237	1,000	2,000	1,842	1,644
Total Pumping (All Purveyors)		30,956	30,293	21,368	19,786	26,818	24,847	23,705	22,142	21,148	23,221	23,376	26,687	27,091	29,626	32,633	33,964	37,938	39,099	36,148	42,906	38,717
Total Pumping (Others)		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	932	953	890
Total Alluvial Aquifer Pumping		31,456	30,793	21,868	20,286	27,318	25,347	24,205	22,642	21,648	23,721	23,876	27,187	27,591	30,126	33,133	34,464	38,438	39,599	37,080	43,859	39,607

Notes:
N. = north
WHR = Wayside Honor Rancho, owned by LACWWD
All pumping volumes are listed in acre-feet.

Data source: Luhdorff and Scalmanini, Consulting Engineers. April 2003. *Santa Clarita Valley Water Report 2002.* Prepared for the Castaic Lake Water Agency, Los Angeles County Waterworks District #36, Newhall County Water District, and Valencia Water Company.

TABLE 2-2

Annual Groundwater Pumping from the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NCWD	7	404	396	350	348	355	384	271	260	332	242	242	274	180	268	321	364	332	288	280	172	0
	4	440	449	319	385	315	369	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	119	227	115	138	1	0	5	1	1	0	4	1	1	0	1	0	0
	10	790	906	1,287	1,300	1,007	997	731	888	613	453	644	343	351	61	0	1	0	0	2	0	0
	11	729	870	716	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0	0
	12	0	0	0	0	0	0	0	0	1,830	2,713	2,603	3,342	2,807	1,956	1,918	2,264	2,140	1,798	1,909	1,155	1,767
	13	0	0	0	0	0	0	0	0	0	0	0	0	1,393	2,053	2,246	1,623	2,045	3,001	2,351	1,295	419
NLF	156	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374
SCWC	Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0	0
	Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0	0
VWC	157	635	604	529	239	387	314	581	483	1,223	1,146	635	1,005	570	436	616	403	46	80	0	0	0
	159	0	0	0	0	0	0	0	0	0	0	3	63	65	74	147	68	3	0	0	0	0
	160	1,571	1,725	368	372	467	571	846	822	1,077	1,326	839	1,325	580	920	957	585	206	401	133	95	776
	201	0	0	0	0	0	0	0	0	0	57	2,039	2,249	1,170	752	845	530	71	35	16	11	172
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59
Total Pumping (NCWD)		2363	2621	2672	2787	2955	3255	3548	3657	4041	4688	4746	4994	5160	5068	5103	4775	4871	5168	4557	2622	2186
Total Pumping (NLF)		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374
Total Pumping (SCWC)		0	0	0	0	0	0	0	0	63	0	40	4781	2913	2901	3863	1726	2176	1068	0	0	0
Total Pumping (VWC)		2206	2329	897	611	854	885	1427	1305	2300	2529	3516	4642	2385	2182	2565	1586	326	516	149	106	1007
Total Pumping (All Purveyors)		4,589	4,970	3,589	3,418	3,829	4,160	4,995	4,982	6,424	7,237	8,322	14,437	10,478	10,171	11,551	8,107	7,639	7,197	5,132	3,207	3,567
Total Pumping (Others)		0	0	501	434	620	555	490	579	504	522	539	480	446	439	474	453	547	548	423	509	513
Total Saugus Formation Pumping		4,589	4,970	4,090	3,852	4,449	4,715	5,485	5,561	6,928	7,759	8,861	14,917	10,924	10,610	12,025	8,560	8,186	7,745	5,555	3,716	4,080

Note:

All pumping volumes are listed in acre-feet.

Data source: Luhdorff and Scalmanini, 2003.

TABLE 2-3

Summary of Selected Tests and Estimated Parameter Values for the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Area	Well Owner-Name	Estimated T (ft^2/day)	Model T (ft^2/day)	Estimated K (ft/day)	Model K (ft/day)	Model Zone
West of I-5	NLF-B5	80,000 to 150,000	60,500	750 to 1,400	550	C1c
	NLF-B6	40,000 to 70,000	60,500	100 to 600	550	C1c
	NLF-C4	20,000 to 35,000	60,500	100 to 300	550	C1b
	NLF-E5	40,000 to 55,000	71,500	100 to 400	550	C1a
Between I-5 and Soledad Canyon	VWC-I	30,000 to 45,000	22,500	250 to 350	375	B1b2
	VWC-K2	60,000 to 90,000	54,375	400 to 600	375	B1a
	VWC-N3	55,000 to 80,000	79,750	375 to 550	550	B1a
	VWC-N4	75,000 to 100,000	54,375	500 to 750	375	B1a
	VWC-Q2	35,000 to 50,000	79,750	250 to 350	550	B1a
	NLF-R2	50,000 to 105,000	22,050	600 to 1,200	245	B1a
	NLF-S	35,000 to 85,000	54,375	250 to 600	375	B1a
	NLF-S3	35,000 to 55,000	79,750	250 to 350	550	B1a
Lower Soledad Canyon	SCWC-Stadium	85,000 to 150,000	63,250	950 to 1,650	550	A1e1
	VWC-U3	90,000 to 170,000	63,250	800 to 1,500	550	A1e2
	VWC-U4	65,000 to 135,000	63,250	550 to 1,200	550	A1e2
	SCWC-Honby	30,000 to 50,000	49,500	300 to 550	550	A1d1
Upper Soledad Canyon	SCWC-N.Oaks West	35,000 to 55,000	49,500	400 to 600	550	A1d4
	SCWC-N.Oaks Central	85,000 to 120,000	49,500	900 to 1,350	550	A1d4
	SCWC-N.Oaks East	50,000 to 70,000	49,500	500 to 800	550	A1d4
	SCWC-Sierra	80,000 to 145,000	49,500	900 to 1,600	550	A1c1
	SCWC-Mitchell	40,000 to 60,000	49,500	450 to 650	550	A1c2
	SCWC-Sand Canyon	35,000 to 125,000	36,000	400 to 1,400	400	A1c3
	NCWD-Pinetree 3 and 4	30,000 to 50,000	31,500	300 to 550	350	A1b1
Castaic Valley	VWC-D	30,000 to 50,000	35,000	300 to 500	350	C2b
	NLF-E	60,000 to 90,000	35,000	600 to 900	350	C2b
	NLF-E2	45,000 to 100,000	35,000	450 to 1,000	350	C2b
	WHR Wellfield	40,000 to 75,000	35,000	400 to 750	350	C2a and C2b
Northern Canyons	NLF-W4	25,000 to 35,000	10,500	250 to 350	105	B4c
	VWC-W6	25,000 to 40,000	10,500	250 to 400	105	B4c
	SCWC-Guida	45,000 to 65,000	12,600	500 to 700	140	B2b
	SCWC-Clark	55,000 to 80,000	22,050	650 to 900	245	B2c

Note:
See Section 4.3.1 for a discussion of the model zones.

TABLE 2-4

Summary of Selected Tests and Estimated Parameter Values for the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Name	Date	Type of Test	Pumping or Injection Rates (gpm)	Length of Test (minutes)	Well Monitored	Specific Capacity (gpm/ft)[a]	T (gpd/ft)	T (ft^2/day)	Storativity	Model Zone
NCWD-7	03/04/1987	Drawdown	341	1,440	NCWD-7	3.1	26,400	3,530		F
NCWD-7	03/05/1987	Recovery		1,500	NCWD-7		23,300	3,110		F
NCWD-10	03/11/1987	Drawdown	364	1,440	NCWD-10	8.3	28,500	3,810		F
NCWD-10	03/11/1987	Drawdown	364	1,440	NCWD-12 (160 feet away)		57,700	7,710	9.10E-04	F
NCWD-10	03/11/1987	Recovery		1,480	NCWD-10		38,400	5,130		F
NCWD-10	03/11/1987	Recovery		1,490	NCWD-12 (160 feet away)		61,500	8,220	7.60E-04	F
NCWD-9	03/17/1987	Drawdown	256	1,460	NCWD-9	1.9	3,700	490		A
NCWD-9	03/17/1987	Recovery		1,500	NCWD-9		3,000	400		A
VWC-160	03/24/1987	Drawdown	2,562	720	VWC-160	49.8	163,000	21,790		E
VWC-160	03/24/1987	Recovery		850	VWC-160		182,000	24,330		E
VWC-205	07/01/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-205M (40 feet)	12.2	41,370	5,530	8.88E-04	E
VWC-205	07/02/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-201 (2,400 feet)		50,450	6,740	7.56E-04	E
VWC-205	07/03/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-157 (4,100 feet)		54,880	7,340	6.45E-04	E
VWC-205	08/01/2000	Pumping	2,273	12,960 / 14,440	VWC-205	18.7				E
VWC-205	08/01/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-205M (40 feet)	18.7	78,910	10,550	9.48E-04	E
VWC-205	08/02/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-201 (2,400 feet)		76,410	10,220	1.37E-03	E
VWC-205	08/03/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-157 (4,100 feet)		65,880	8,810	1.36E-03	E
VWC-201	10/01/2000	Pumping	2,439	14,440 / 2,880	VWC-201	30	65,100	8,700	5.75E-04	E
VWC -201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-157 (1,900 feet)		44,230	5,910	1.17E-03	E
VWC-201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-205M (2,360 feet)		57,210	7,650	8.49E-04	E
VWC-201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-205 (2,400 feet)		47,890	6,400	6.75E-04	E
SCWC-Saugus1	07/01/1988	Pumping	2,941	1,440	SCWC-Saugus1	30.2	69,300	9,260		E
SCWC-Saugus1	07/01/1988	Recovery	2,941	480	SCWC-Saugus1		59,700	7,980		E
SCWC-Saugus2	09/01/1988	Pumping	2,531	2,880	SCWC-Saugus2	24.1	53,500	7,150		E
SCWC-Saugus2	09/01/1988	Recovery	2,531	1,320	SCWC-Saugus2		55,700	7,450		E
SCWC-Saugus2	09/01/1988	Pumping	2,531	2,880	SCWC-Saugus1		71,500	9,560	3.60E-04	E
SCWC-Saugus3	09/01/1988	Recovery	2,531	1,320	SCWC-Saugus1		60,200	8,050		E

[a] gpm/ft of drawdown

Note:

See Section 4.3.1 for a discussion of the model zones.

Data source: RCS, 2002 (except model zones)

TABLE 2-5
Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Recharge	Discharge
Surface Water	
Direct runoff of precipitation	Evapotranspiration of precipitation
Precipitation runoff from upstream watershed areas	Santa Clara River flow to Ventura County
Castaic Lake/Lagoon releases into Castaic Creek	Streamflow seepage to the Alluvial Aquifer
WRP discharges into the Santa Clara River	Evapotranspiration of applied irrigation water
Groundwater seepage into the Santa Clara River	
Irrigation return flows (agricultural and urban)	
Groundwater	
Infiltration of precipitation	Pumping
Infiltration of outdoor applied water (agricultural and urban)	Evapotranspiration of Alluvial Aquifer groundwater by riparian vegetation
Alluvial Aquifer subsurface inflow (Castaic Dam)	Alluvial Aquifer subsurface outflow (western study area boundary)
Streamflow seepage to Alluvial aquifer	Groundwater seepage into the Santa Clara River

Notes:

The two sources of water for agricultural and municipal water uses in the basin are groundwater pumping and imported water from the SWP.

Because SWP water is stored in Castaic Lake, which is outside the limits of the Alluvial and Saugus aquifers, it is not considered to be a part of the valley's hydrologic cycle while it is still in storage. However, SWP water that is land-applied or that is discharged from a WRP qualifies as a component of the hydrologic cycle. In addition, subsurface groundwater flow occurs into the Santa Clarita Valley beneath Castaic Creek due to water seepage beneath Castaic Dam.

TABLE 2-6
Estimated Annual Groundwater Discharge to the Santa Clara River
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Total Gaged Flow at Mouth of Castaic Creek (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[a]	Local Rainfall Condition[b]
1953	0	4,986	4,943	0	4,943	4.88	Dry
1954	977	7,316	5,554	0	5,554	15.82	Normal
1955	134	4,795	4,122	0	4,122	13.91	Normal
1956	311	5,429	3,803	0	3,803	14.21	Normal
1957	559	4,782	2,410	0	2,410	22.85	Wet
1958	21,204	38,756	5,344	0	5,344	23.14	Wet
1959	473	3,277	2,206	0	2,206	9.81	Dry
1960	1	777	586	0	586	11.64	Dry
1961	79	804	410	0	410	8.82	Dry
1962	5,101	28,460	2,433	0	2,433	21.22	Wet
1963	32	1,884	1,058	0	1,058	12.79	Normal
1964	1	1,030	646	0	646	10.09	Dry
1965	3,702	35,614	996	0	996	32.28	Wet
1966	5,780	10,101	2,332	No data	---	14.57	Normal
1967	27,819	40,480	8,640	No data	---	23.23	Wet
1968	4,381	7,216	3,895	No data	---	6.90	Dry
1969	46,461	258,660	29,395	No data	---	32.42	Wet
1970	6,597	31,066	14,924	No data	---	23.19	Wet
1971	2,310	15,883	10,843	No data	---	13.75	Normal
1972	2,205	16,027	12,975	No data	---	4.15	Dry
1973	12,671	52,631	26,115	No data	---	19.79	Wet
1974	7,288	25,265	11,918	No data	---	18.04	Wet
1975	2,027	14,770	10,806	5,534	5,272	10.92	Dry
1976	156	10,162	9,754	6,095	3,659	14.02	Normal
1977	1,380	13,454	9,359	6,004	3,355	20.87	Wet
1978	35,378	129,187	60,955	6,982	53,973	42.17	Wet
1979	13,626	57,594	42,448	7,397	35,051	21.47	Wet
1980	16,785	95,211	57,593	7,372	50,221	27.00	Wet
1981	6,519	24,232	21,172	7,949	13,223	13.42	Normal
1982	9,102	36,488	32,531	8,436	24,095	20.20	Wet
1983	67,058	131,236	55,878	9,420	46,458	39.07	Wet
1984	13,787	39,279	35,215	9,512	25,703	12.86	Normal
1985	2,619	24,466	24,089	9,614	14,475	8.37	Dry
1986	4,945	48,024	31,327	10,822	20,505	18.02	Wet

TABLE 2-6
Estimated Annual Groundwater Discharge to the Santa Clara River
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Total Gaged Flow at Mouth of Castaic Creek (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[a]	Local Rainfall Condition[b]
1987	911	26,198	23,663	11,844	11,819	14.45	Normal
1988	2,415	36,611	24,934	12,363	12,571	16.92	Wet
1989	Unavailable	24,799	23,453	13,560	9,893	7.56	Dry
1990	0	23,472	21,772	14,006	7,766	6.98	Dry
1991	65	34,901	18,702	14,108	4,594	17.21	Wet
1992	4,450	68,577	23,601	15,703	7,898	32.03	Wet
1993	7,725	152,783	65,054	17,179	47,875	32.72	Wet
1994	Unavailable	32,039	31,239	16,946	14,293	10.27	Dry
1995	5,611	82,409	51,001	17,824	33,177	29.15	Wet
1996	5,632	47,930	36,366	16,831	19,535	15.88	Normal
1997	9,885	36,780	27,521	15,778	11,743	13.35	Normal
1998	47,803	205,139	81,744	17,695	64,049	30.73	Wet
1999	5,830	32,382	27,176	17,847	9,329	8.96	Dry

[a] Annual rainfall values are based on monthly records for this gage, as reported by NCDC and LADPW.

[b] Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-7
Statistics on Annual Groundwater Discharge to the Santa Clara River, All Years
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	311	4,795	2,410	0	2,410	13.91
Average	2,506	10,608	2,655	0	2,655	15.50
Maximum	21,204	38,756	5,554	0	5,554	32.28
Statistics for 1975 through 1999						
Minimum	0	10,162	9,359	5,534	3,355	6.98
Median	5,632	36,611	27,521	11,844	14,293	16.92
Average	11,466	57,125	33,894	11,873	22,021	19.38
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	3,161	30,250	22,613	11,844	8,613	15.14
Average	8,230	41,211	23,207	11,873	15,396	18.05
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	4,450	28,460	18,702	11,844	8,613	15.82
Average	9,151	43,050	21,338	11,873	15,396	17.92
Maximum	67,058	258,660	81,744	17,847	64,049	42.17

TABLE 2-8
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 vs. 1975 through 1999
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 5 Dry Years during 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	1	1,030	646	0	646	9.81
Average	111	2,175	1,758	0	1,758	9.05
Maximum	473	4,986	4,943	0	4,943	11.64
Statistics for 4 Normal Years during 1953 through 1965						
Minimum	32	1,884	1,058	0	1,058	12.79
Median	222	5,112	3,963	0	3,963	14.06
Average	363	4,856	3,634	0	3,634	14.18
Maximum	977	7,316	5,554	0	5,554	15.82
Statistics for 4 Wet Years during 1953 through 1965						
Minimum	559	4,782	996	0	996	21.22
Median	4,402	32,037	2,421	0	2,421	23.00
Average	7,641	26,903	2,796	0	2,796	24.87
Maximum	21,204	38,756	5,344	0	5,344	32.28
Statistics for 6 Dry Years during 1975 through 1999						
Minimum	0	14,770	10,806	5,534	5,272	6.98
Median	2,323	24,633	23,771	13,783	9,611	8.67
Average	2,619	25,322	23,089	12,918	10,171	8.84
Maximum	5,830	32,382	31,239	17,847	14,475	10.92
Statistics for 6 Normal Years during 1975 through 1999						
Minimum	156	10,162	9,754	6,095	3,659	12.86
Median	6,076	31,489	25,592	10,678	12,521	13.72
Average	6,148	30,763	25,615	11,335	14,280	14.00
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 13 Wet Years during 1975 through 1999						
Minimum	65	13,454	9,359	6,004	3,355	16.92
Median	7,725	68,577	42,448	10,822	33,177	27.00
Average	16,642	83,970	42,702	11,639	31,063	26.74
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-9
Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 13 Dry Years during 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	473	14,770	10,806	13,783	5,272	8.82
Average	1,601	14,311	12,630	12,918	6,347	8.41
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 12 Normal Years during 1953 through 1999						
Minimum	0	7,316	2,433	6,004	2,433	13.35
Median	5,101	26,198	21,172	11,844	11,743	16.92
Average	5,238	27,883	16,963	10,788	8,671	17.10
Maximum	12,671	52,631	27,521	15,778	13,223	21.22
Statistics for 22 Wet Years during 1953 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	7,507	44,252	25,525	10,822	20,505	23.17
Average	15,807	73,060	29,877	11,639	24,412	25.62
Maximum	67,058	258,660	81,744	17,824	64,049	42.17
Statistics for 11 Dry Years during 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	79	14,770	10,806	13,783	5,272	8.96
Average	1,226	14,800	13,393	12,918	6,347	8.94
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 10 Normal Years during 1953 through 1965 and 1975 through 1999						
Minimum	32	1,884	1,058	6,095	1,058	12.79
Median	944	17,197	15,463	10,678	8,649	13.97
Average	3,834	20,400	16,823	11,335	10,022	14.07
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 17 Wet Years during 1953 through 1965 and 1975 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	5,611	48,024	31,327	10,822	20,505	23.14
Average	14,524	70,543	33,312	11,639	24,412	26.30
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-10
Historical Hydrology in Northern California and the Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Hydrology[b]
1944	Dry	Wet
1945	Below Normal	Normal
1946	Below Normal	Wet
1947	Dry	Dry
1948	Below Normal	Dry
1949	Dry	Dry
1950	Below Normal	Dry
1951	Above Normal	Normal
1952	Wet	Wet
1953	Wet	Dry
1954	Above Normal	Normal
1955	Dry	Normal
1956	Wet	Normal
1957	Above Normal	Wet
1958	Wet	Wet
1959	Below Normal	Dry
1960	Dry	Dry
1961	Dry	Dry
1962	Below Normal	Wet
1963	Wet	Normal
1964	Dry	Dry
1965	Wet	Wet
1966	Below Normal	Normal
1967	Wet	Wet
1968	Below Normal	Dry
1969	Wet	Wet
1970	Wet	Wet
1971	Wet	Normal
1972	Below Normal	Dry
1973	Above Normal	Wet
1974	Wet	Wet
1975	Wet	Dry
1976	Critical	Normal
1977	Critical	Wet
1978	Above Normal	Wet
1979	Below Normal	Wet

TABLE 2-10
Historical Hydrology in Northern California and the Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Hydrology[b]
1980	Above Normal	Wet
1981	Dry	Normal
1982	Wet	Wet
1983	Wet	Wet
1984	Wet	Normal
1985	Dry	Dry
1986	Wet	Wet
1987	Dry	Normal
1988	Critical	Wet
1989	Dry	Dry
1990	Critical	Dry
1991	Critical	Wet
1992	Critical	Wet
1993	Above Normal	Wet
1994	Critical	Dry
1995	Wet	Wet
1996	Wet	Normal
1997	Wet	Normal
1998	Wet	Wet
1999	Wet	Dry

[a] Defined by water year, using the Sacramento Four Rivers Index (Figure 3-4 in Bulletin 160-98; DWR, 1998): wet = wettest; critical = driest.

[b] Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-11
Historical State Water Project Allocations and Local Hydrology, 1980 through 1999
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	SWP Hydrology[a]	SWP Allocations[b]	Local Hydrology[c]
1980	Above Normal	100%	Wet
1981	Dry	100%	Normal
1982	Wet	100%	Wet
1983	Wet	100%	Wet
1984	Wet	100%	Normal
1985	Dry	100%	Dry
1986	Wet	100%	Wet
1987	Dry	85%	Normal
1988	Critical	100%	Wet
1989	Dry	100%	Dry
1990	Critical	100%	Dry
1991	Critical	30%	Wet
1992	Critical	45%	Wet
1993	Above Normal	85%	Wet
1994	Critical	50%	Dry
1995	Wet	80%	Wet
1996	Wet	100%	Normal
1997	Wet	100%	Normal
1998	Wet	100%	Wet
1999	Wet	100%	Dry

[a] Defined by water year, using the Sacramento Four Rivers Index (Figure 3-4 in Bulletin 160-98; DWR, 1998): wet = wettest; critical = driest. SWP = State Water Project.

[b] Contractor demands, and therefore requests for water, have been increasing through the time period shown. Water allocations in the earlier part of the time period reflect that 100% of contractor requests were met. Those requests were for amounts of water less than the full SWP contract (i.e., Table A) amounts totaling 4.1 million acre-feet. In recent years, SWP contractors have been requesting nearly all of the 4.1 million acre-foot Table A amount contained in the 29 SWP contracts.

[c] Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-12

Castaic Creek Flood Flows

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

						Flood Flow Shares				Total
Water Year[a]	Natural Inflows	Flood Flows 10/1 - 4/30	Late Flood Flows[b] 5/1 - 9/30	Total Flood Flows	Net Flood Flows[c]	UWCD 48%	NLF 44.867%	LACWWD 4.471%	NCWD 2.662%	NLF/LACWWD/ NCWD Flood Flows
1977	752	0	0	0	0	0	0	0	0	0
1978	92,780	89,592	325	89,917	67,438	32,370	30,257	3,015	1,795	35,068
1979	31,440	19,641	0	19,641	14,731	7,071	6,609	659	392	7,660
1980	54,158	47,625	101	47,726	35,794	17,181	16,060	1,600	953	18,613
1981	6,186	628	0	628	471	226	211	21	13	245
1982	8,930	3,544	0	3,544	2,658	1,276	1,193	119	71	1,382
1983	78,010	74,287	3,020	77,307	57,981	27,831	26,014	2,592	1,543	30,150
1984	10,582	2,106	0	2,106	1,580	758	709	71	42	822
1985	3,361	0	0	0	0	0	0	0	0	0
1986	20,005	13,867	0	13,867	10,400	4,992	4,666	465	277	5,408
1987	1,212	0	0	0	0	0	0	0	0	0
1988	4,401	807	0	807	605	290	272	27	16	315
1989	919	0	0	0	0	0	0	0	0	0
1990	540	0	0	0	0	0	0	0	0	0
1991	6,719	4,375	0	4,375	3,281	1,575	1,472	147	87	1,706
1992	29,409	22,631	0	22,631	16,973	8,147	7,615	759	452	8,826
1993	81,264	77,722	0	77,722	58,291	27,980	26,154	2,606	1,552	30,312
1994	6,424	502	0	502	377	181	169	17	10	196
1995	57,914	53,363	0	53,363	40,022	19,211	17,957	1,789	1,065	20,812
1996	7,105	1,654	0	1,654	1,241	596	557	55	33	645
1997	9,028	3,918	0	3,918	2,938	1,410	1,318	131	78	1,528
1998	68,846	66,597	11,639	78,236	58,677	28,165	26,327	2,623	1,562	30,512
1999	7,793	238	0	238	179	86	80	8	5	93
2000	7,212	4,118	0	4,118	3,088	1,482	1,386	138	82	1,606
Totals	**594,990**	**487,215**	**15,085**	**502,300**	**376,725**	**180,828**	**169,025**	**16,843**	**10,028**	**195,897**
Average	**24,791**	**20,301**	**629**	**20,929**	**15,697**	**7,535**	**7,043**	**702**	**418**	**8,162**
Median	**8,362**	**3,731**	**0**	**3,731**	**2,798**	**1,343**	**1,255**	**125**	**74**	**1,455**

[a] A water year is from October 1 to September 30, but the flood flow water is generally available only from October 1 through April 30.

[b] Late flood flows are from May 1 through September 30.

[c] Net flood flows are 75% of total flood flows.

Note:

All flows are listed in acre-feet.

Figures

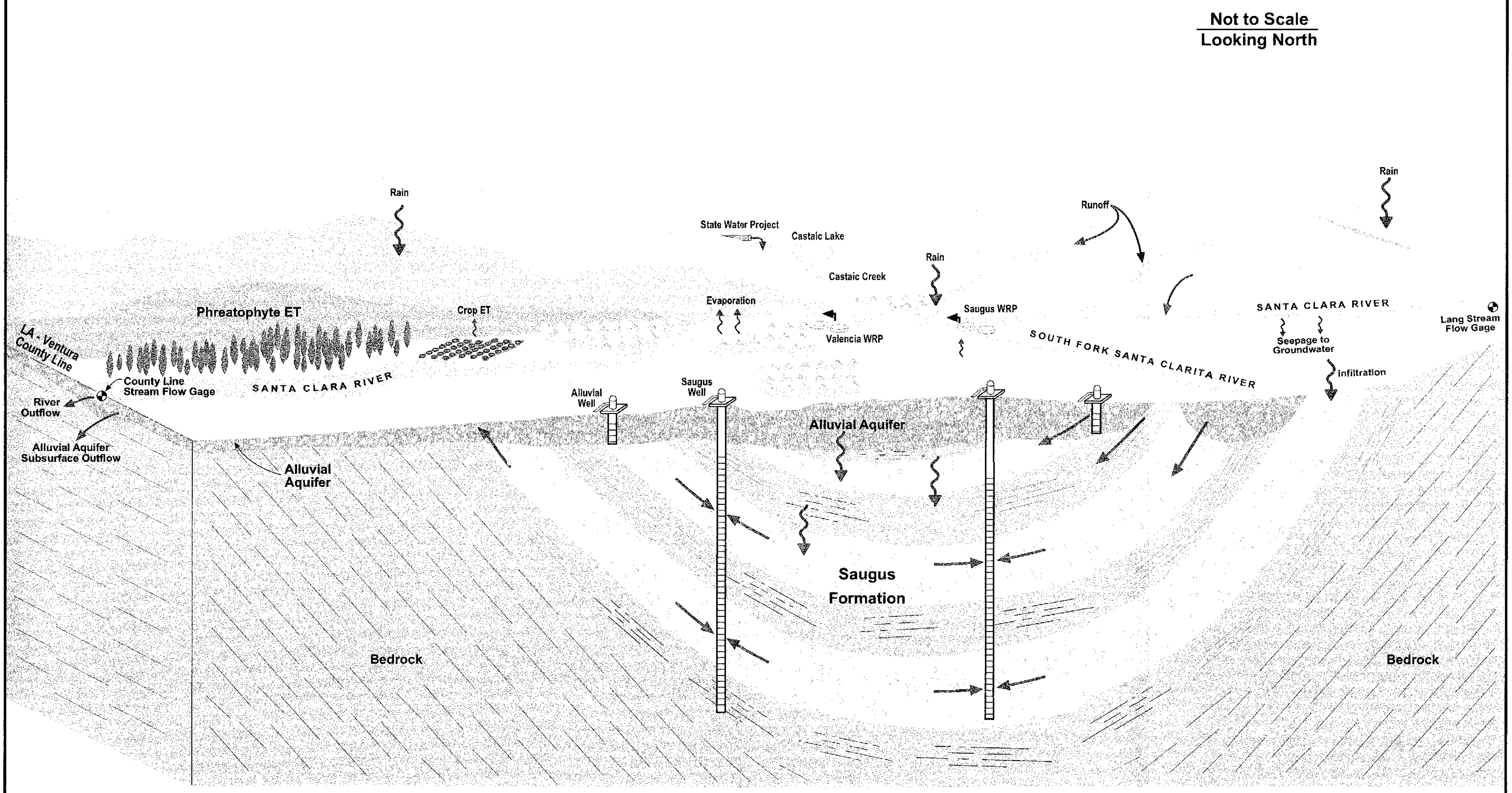

FIGURE 2-1
SANTA CLARITA VALLEY HYDROLOGY
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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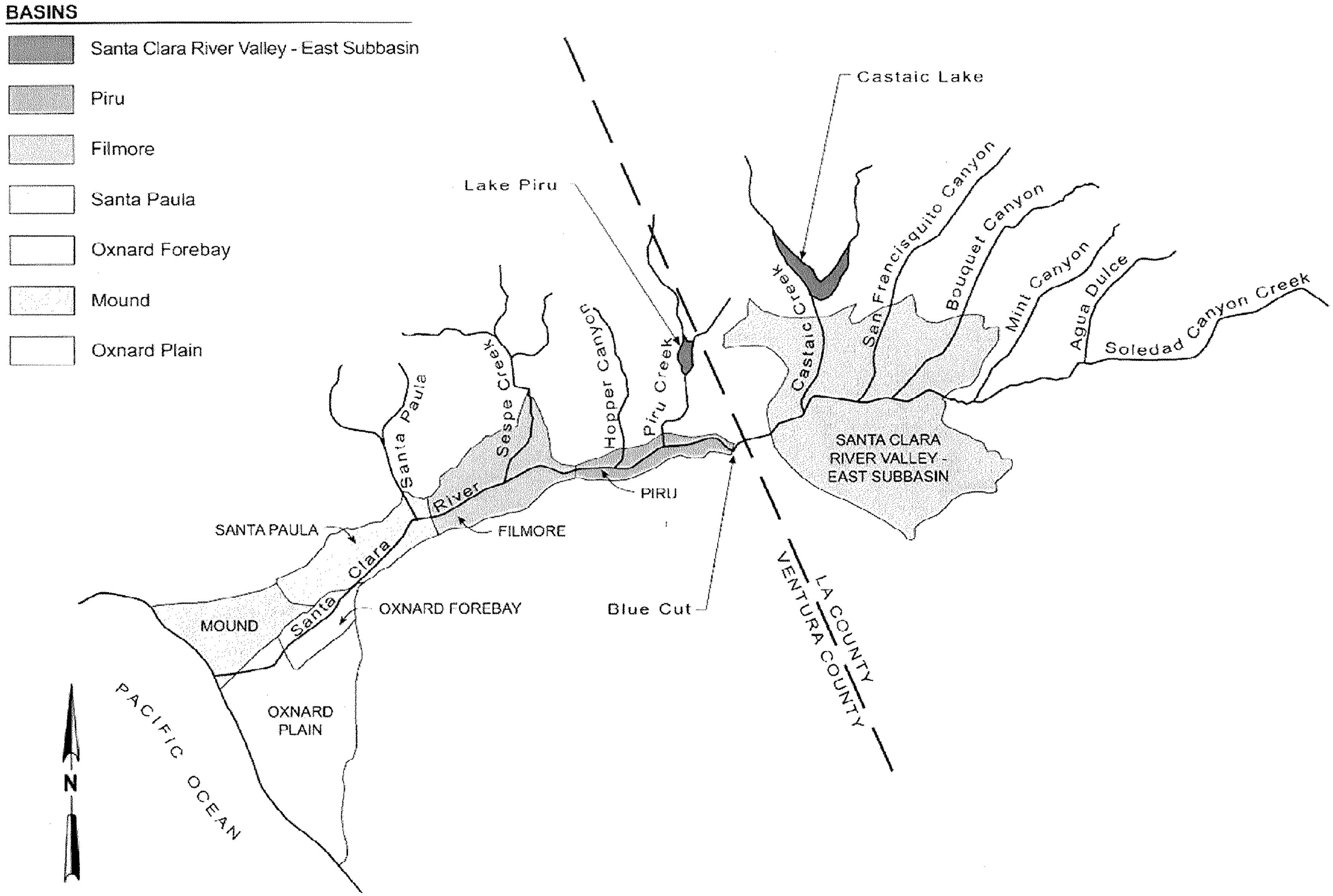

FIGURE 2-2
GROUNDWATER BASINS IN THE SANTA CLARA RIVER DRAINAGE

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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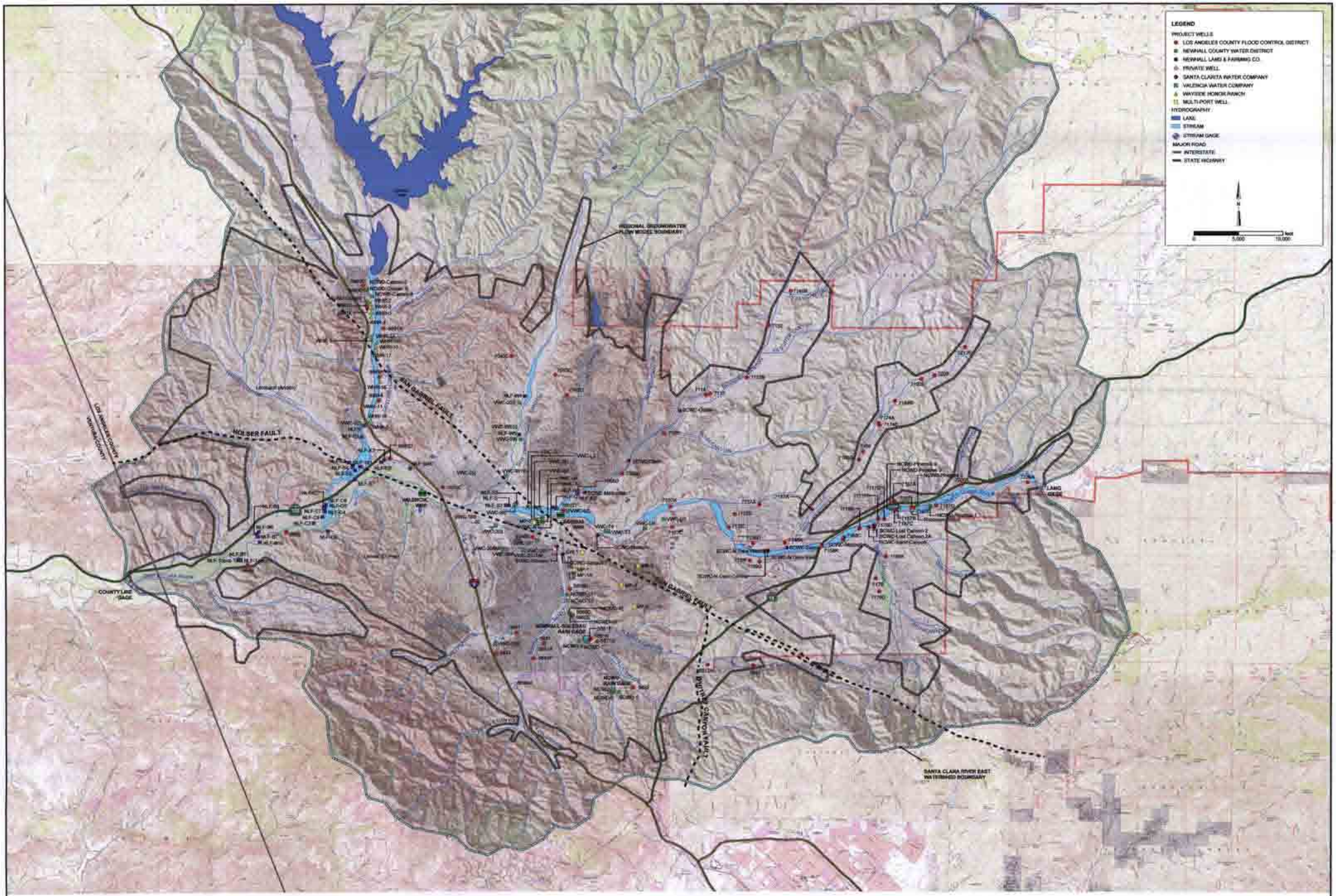

FIGURE 2-3
WELL LOCATIONS AND FEATURES MAP
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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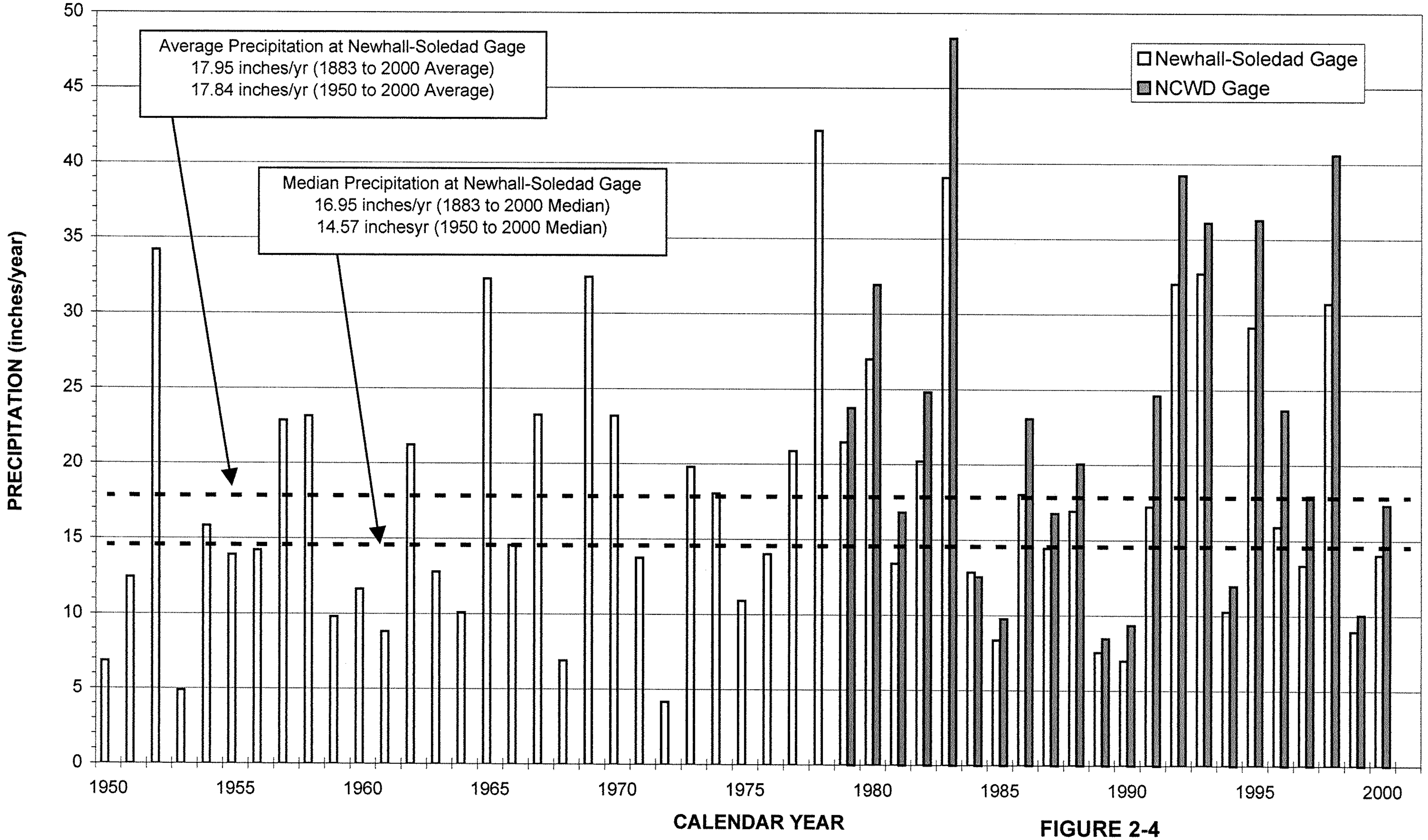

FIGURE 2-4
ANNUAL PRECIPITATION AT THE NEWHALL-SOLEDAD AND NCWD RAIN GAGES SINCE 1950

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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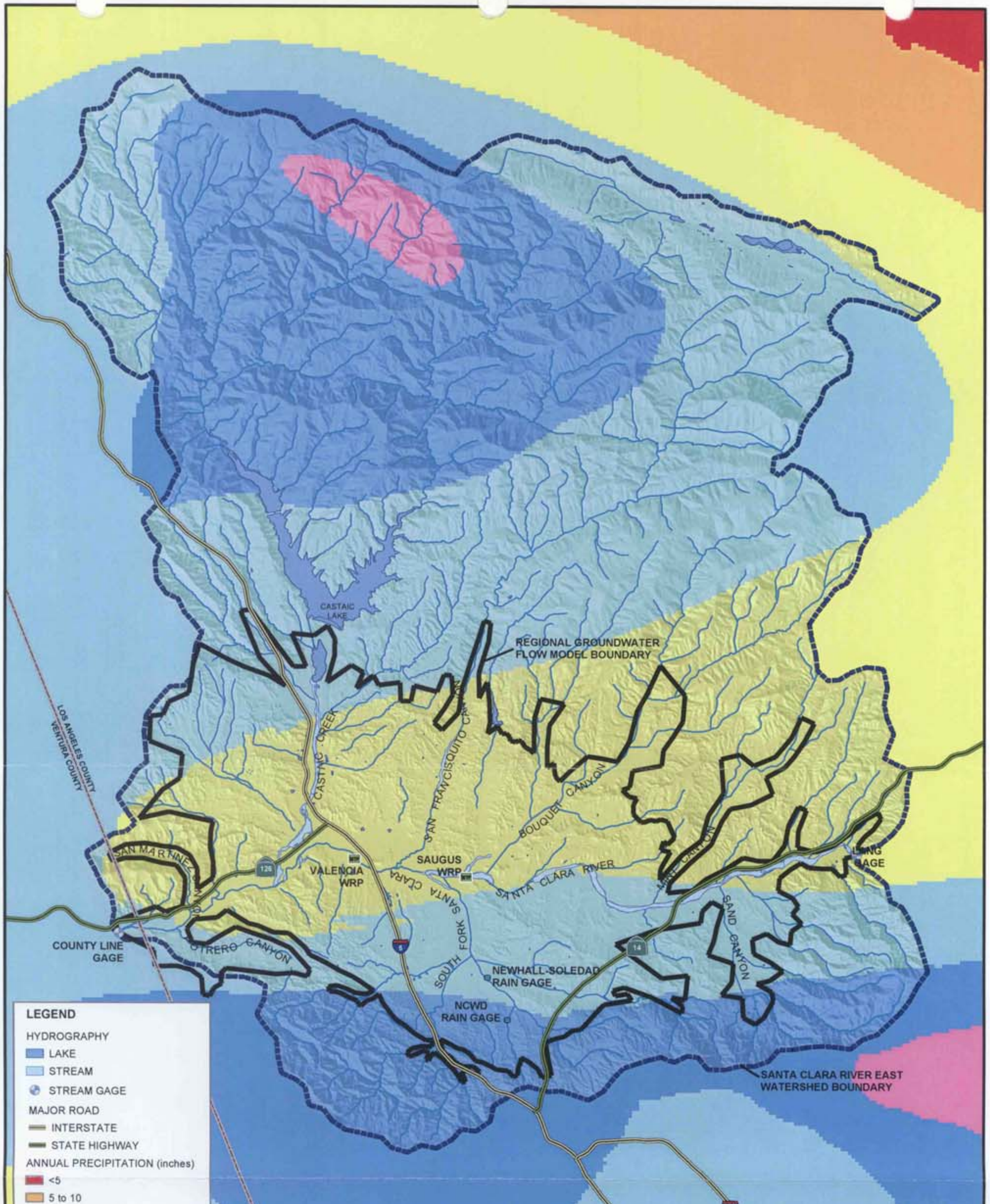

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

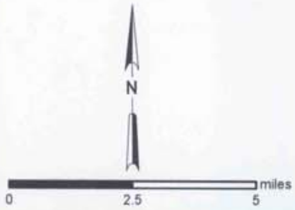

FIGURE 2-5
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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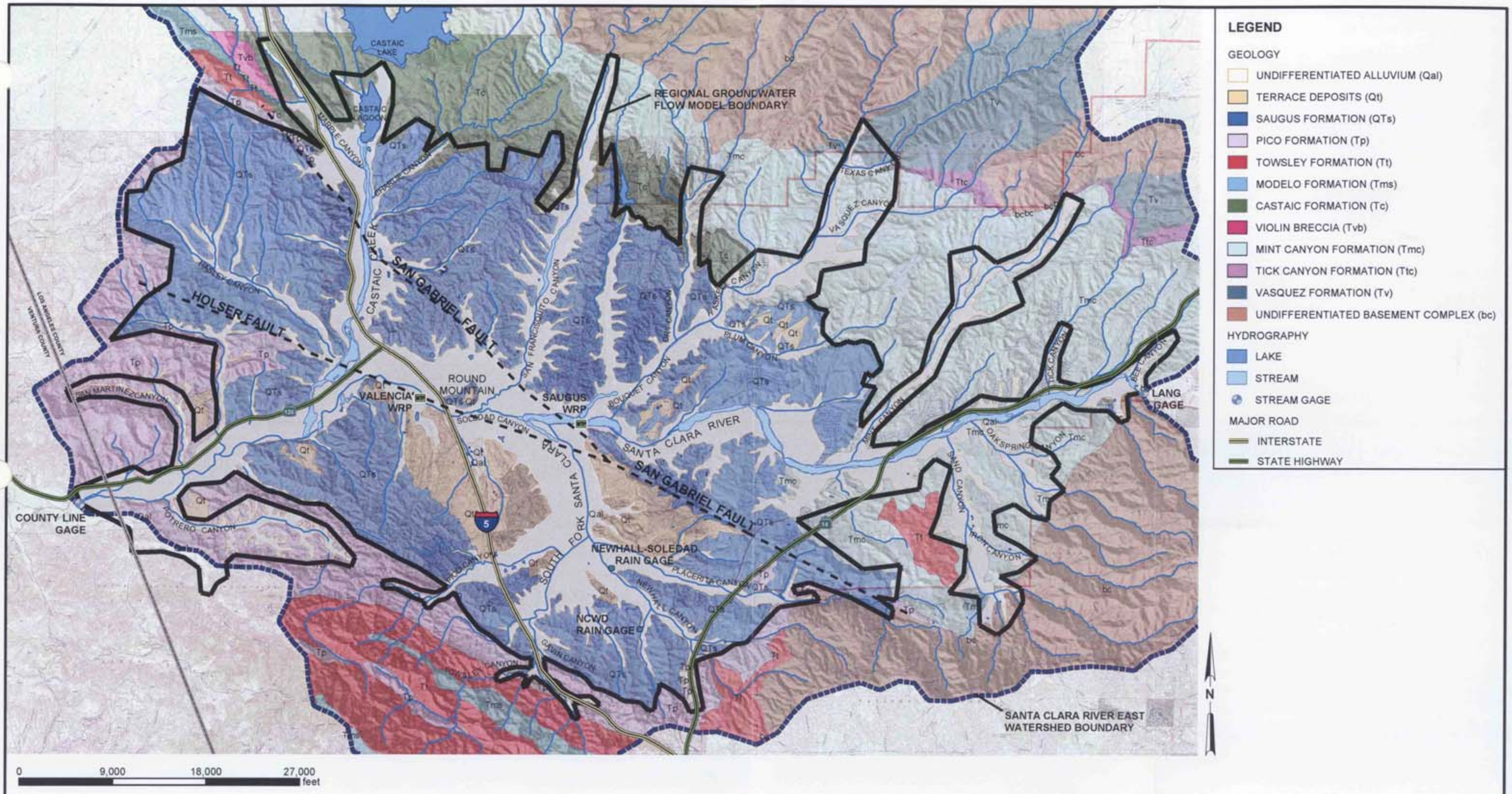
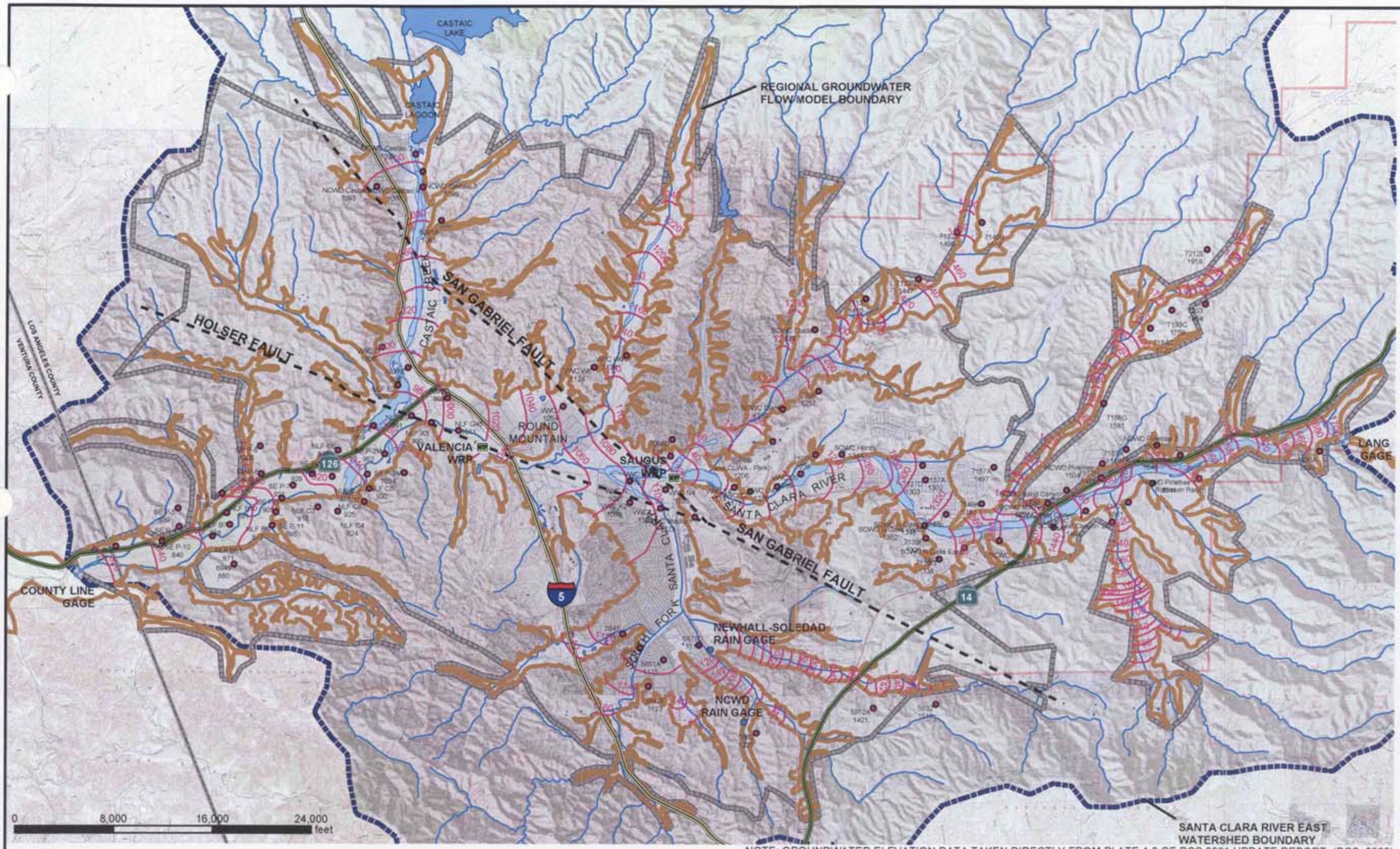


FIGURE 2-6
BASIN GEOLOGIC MAP
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA



NOTE: GROUNDWATER ELEVATION DATA TAKEN DIRECTLY FROM PLATE 4-3 OF RCS 2001 UPDATE REPORT. (RCS, 2002)

LEGEND

— CONTOUR OF SPRING 2000 GR0UNDWATER ELEVATION (feet MSL)

● SPRING 2000 GROUNDWATER ELEVATION (feet MSL)

▭ EXTENT OF ALLUVIUM

🟦 LAKE

🟦 STREAM

FIGURE 2-7
GROUNDWATER ELEVATION CONTOUR MAP FOR THE ALLUVIUM – SPRING 2000

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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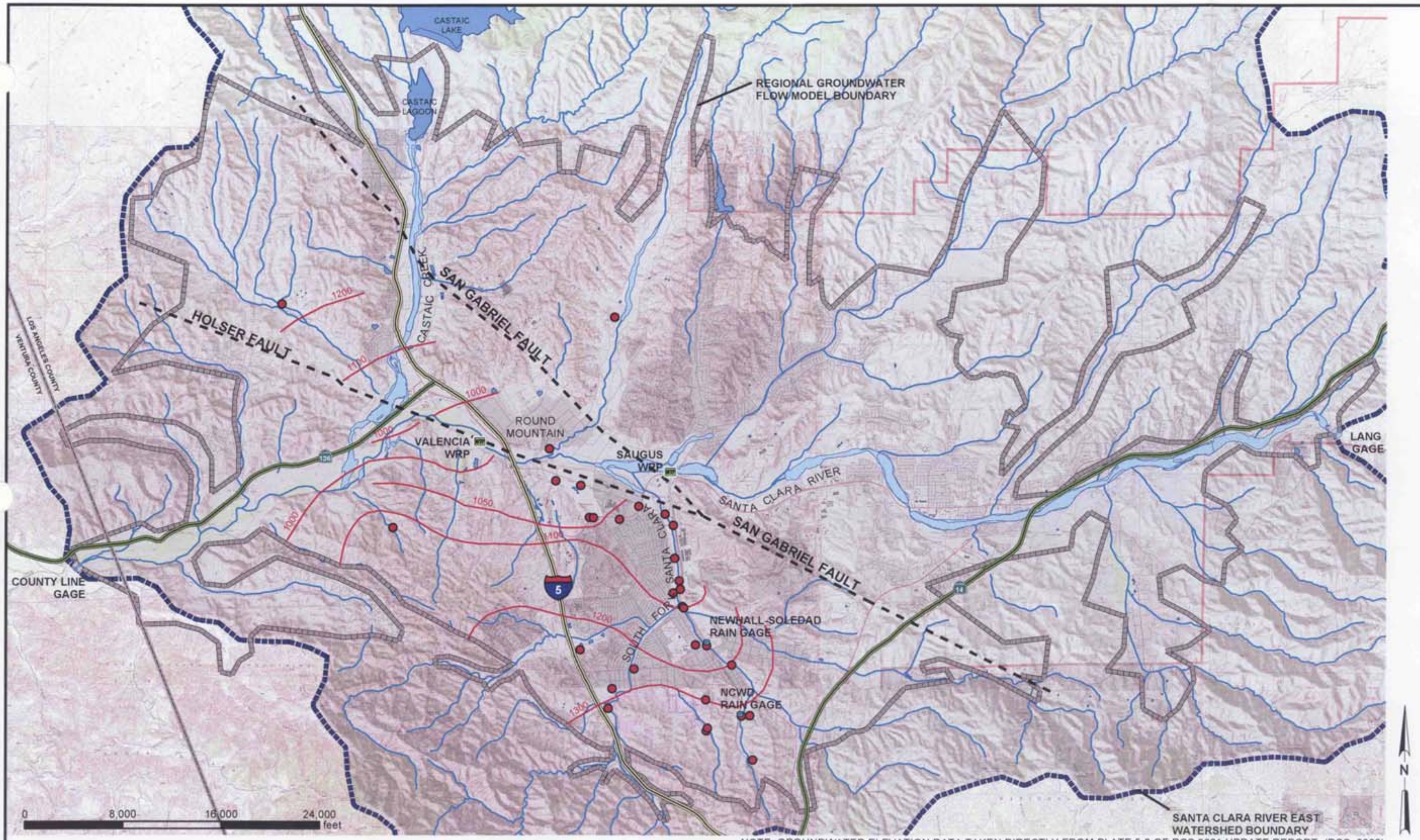

NOTE: GROUNDWATER ELEVATION DATA TAKEN DIRECTLY FROM PLATE 5-3 OF RCS 2001 UPDATE REPORT. (RCS, 2002)

LEGEND

- ● SAUGUS WELLS
- — CONTOUR OF FALL 2000 GROUNDWATER ELEVATION (feet MSL)
- ▆ LAKE
- ▆ STREAM

FIGURE 2-8
GROUNDWATER ELEVATION CONTOUR MAP FOR THE SAUGUS – FALL 2000

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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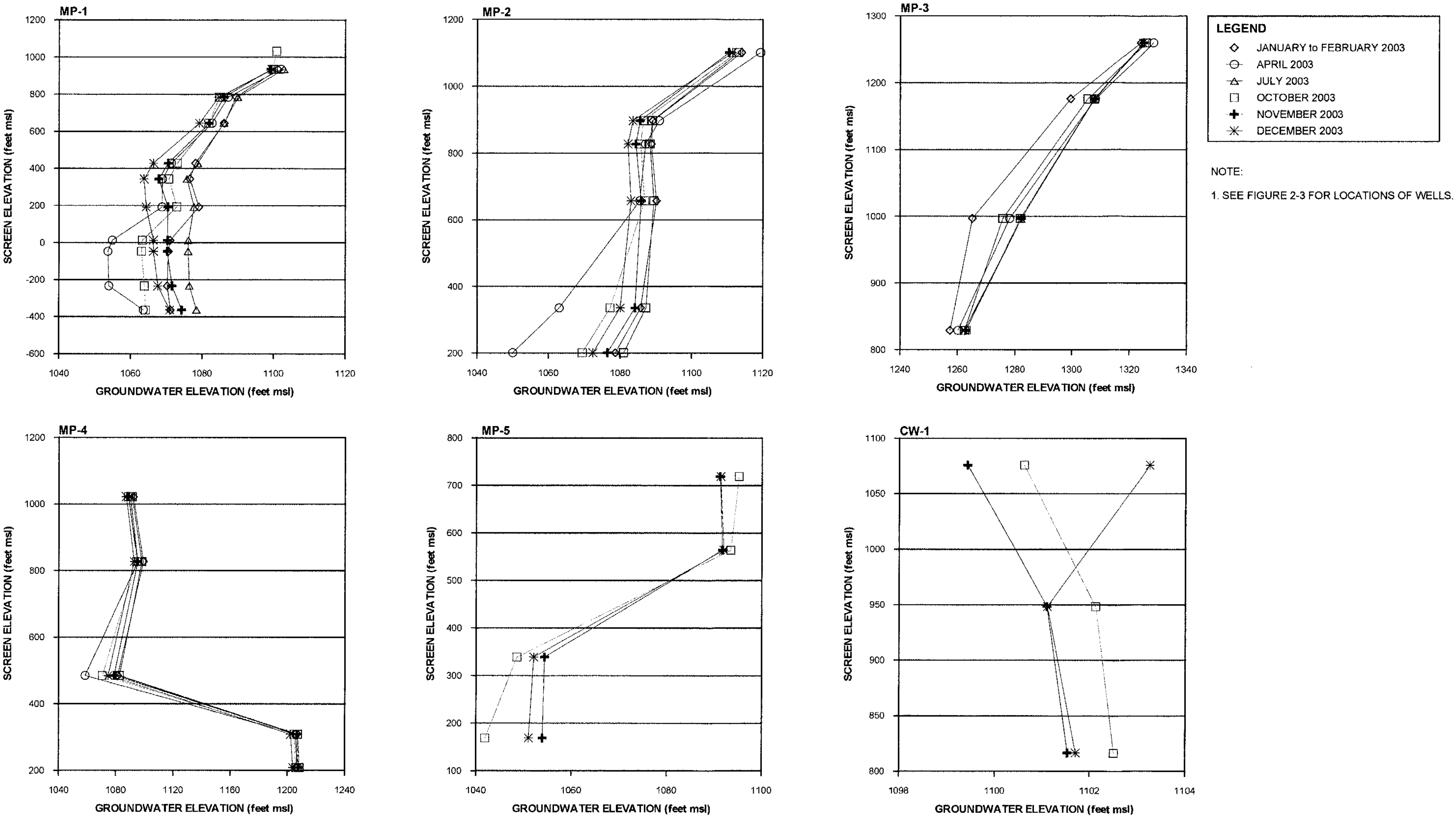

NOTE:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 2-9
GROUNDWATER ELEVATIONS IN MULTI-PORT SAUGUS FORMATION MONITORING WELLS JANUARY 2003 THROUGH DECEMBER 2003
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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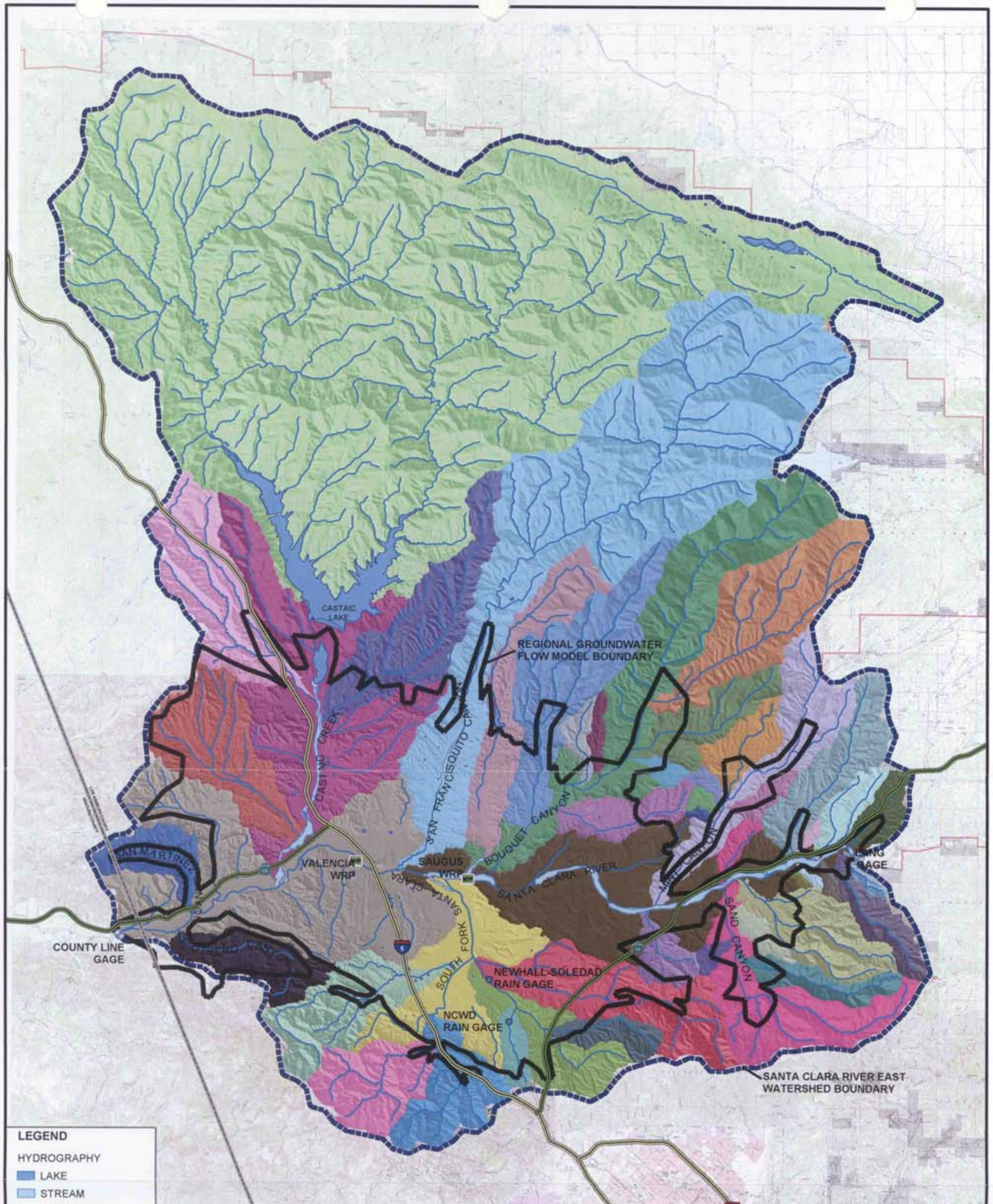

FIGURE 2-10
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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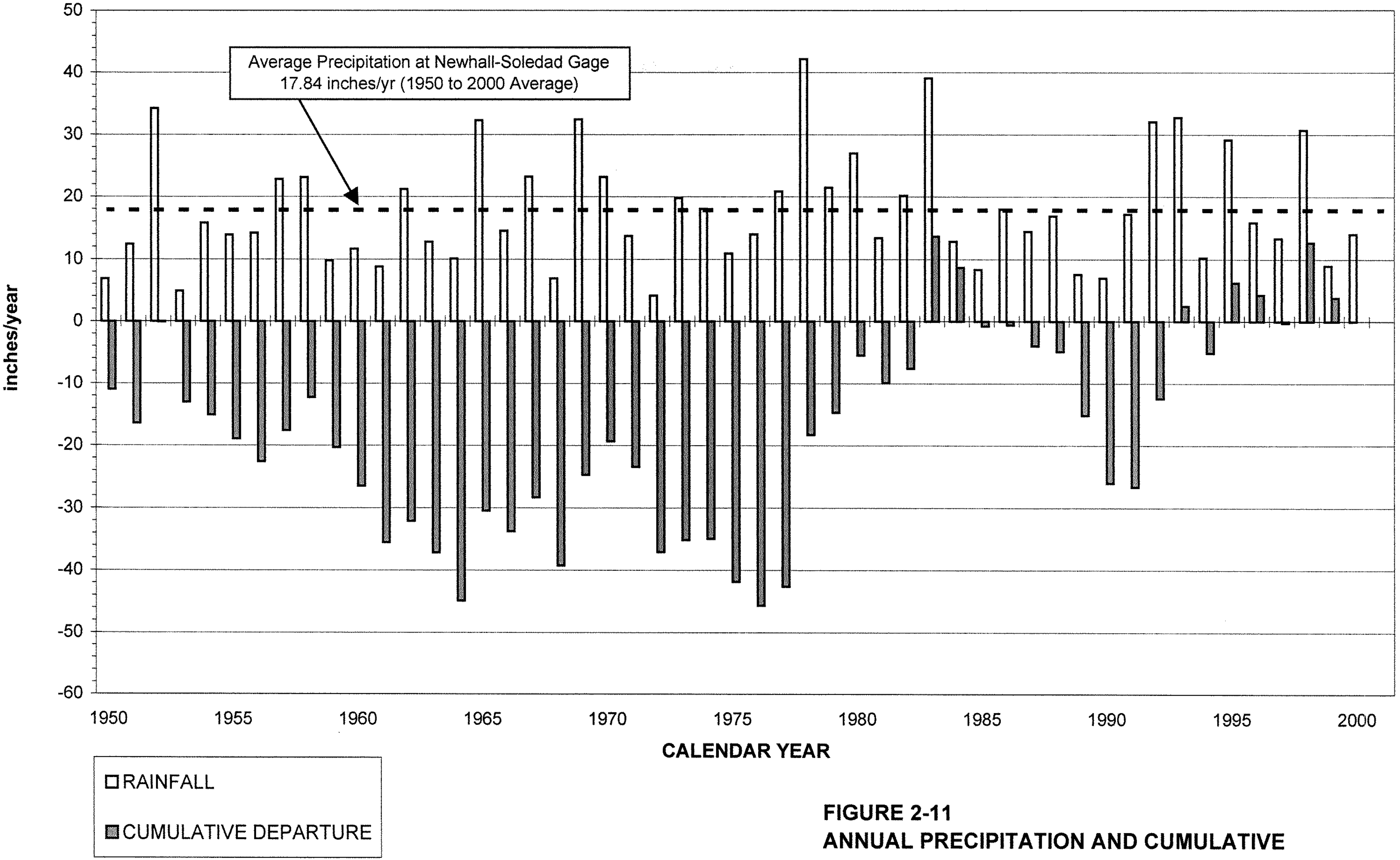

FIGURE 2-11
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 TO 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE SINCE 1950

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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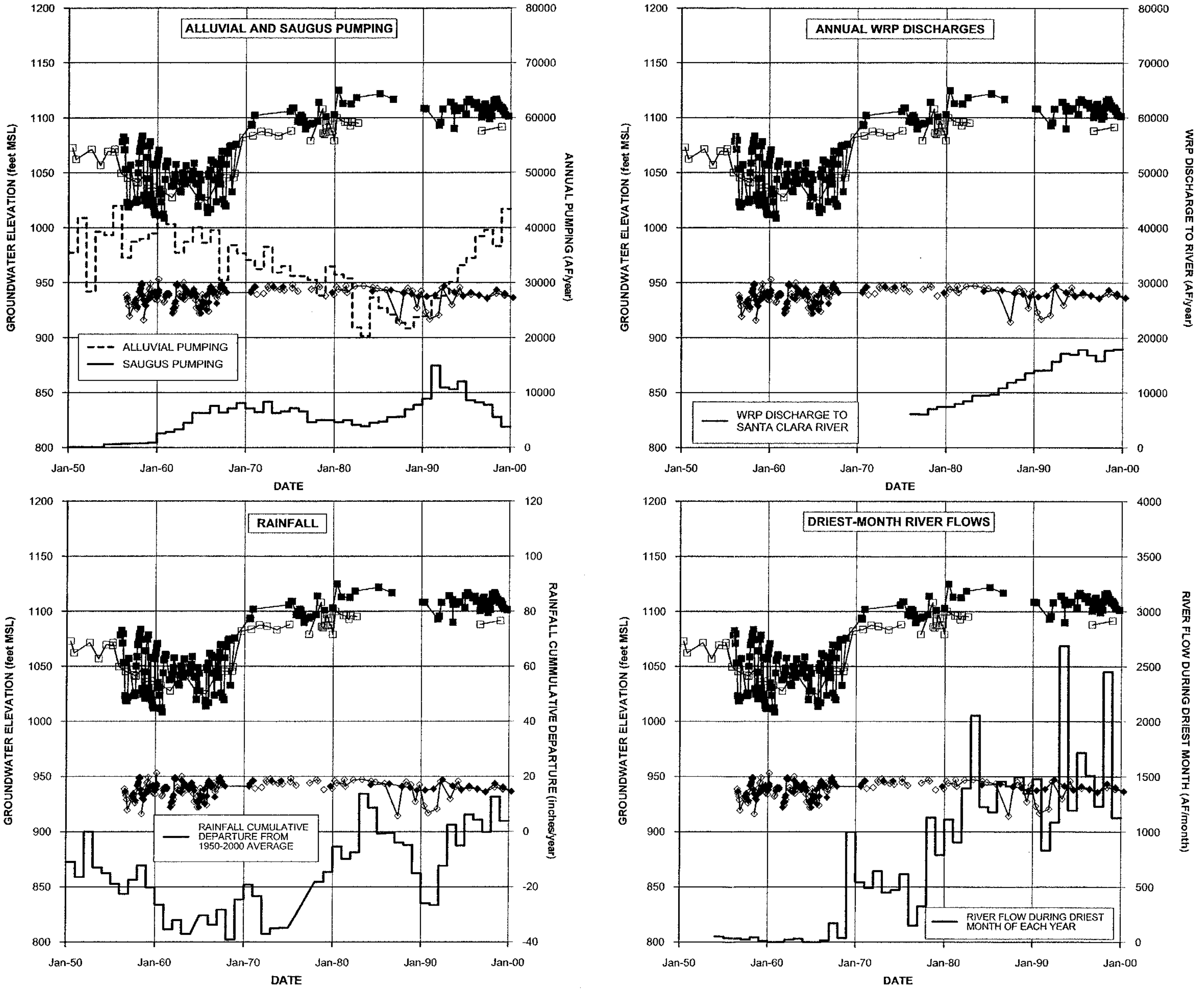

LEGEND

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-12
ALLUVIAL GROUNDWATER ELEVATIONS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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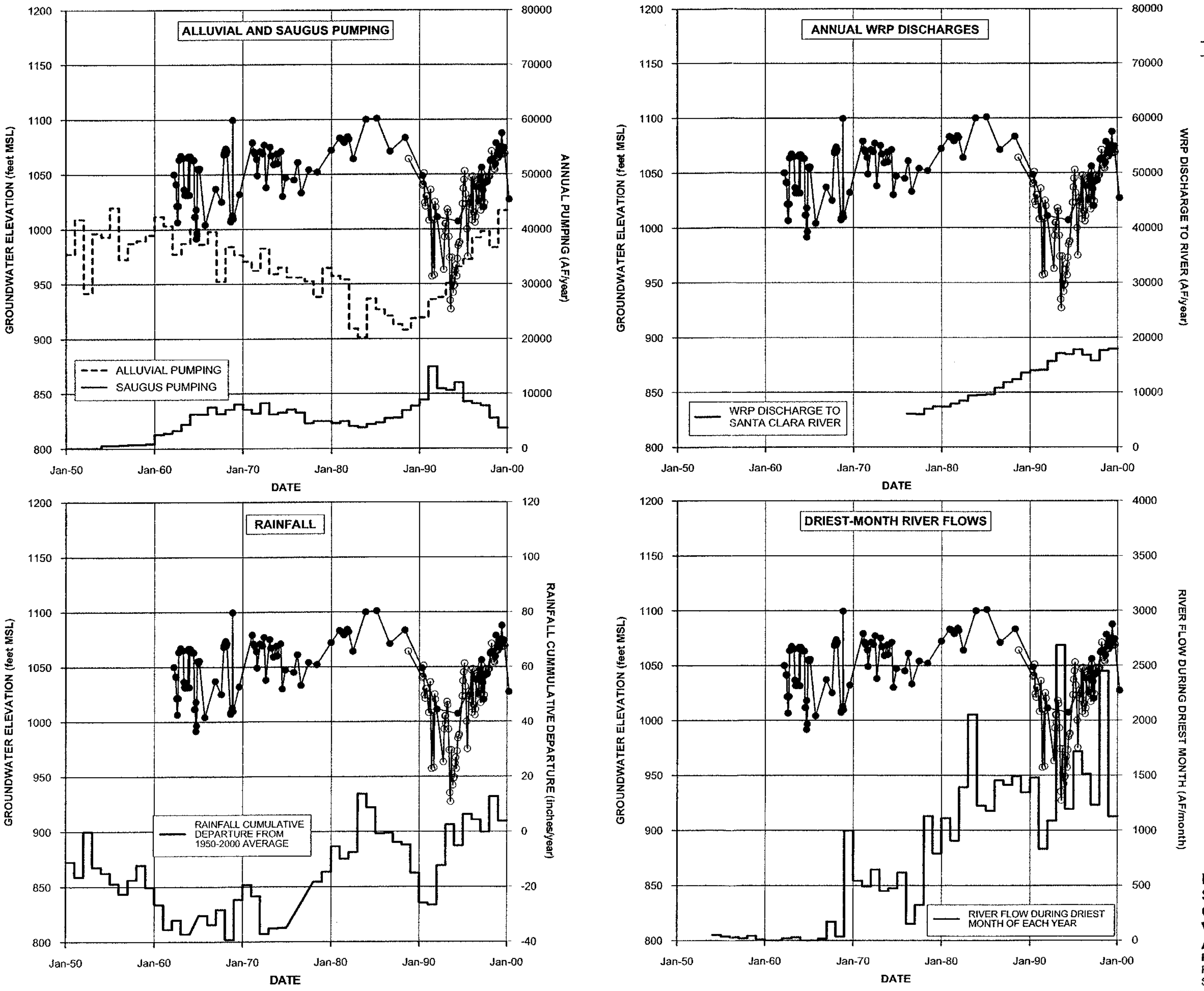

LEGEND

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-13
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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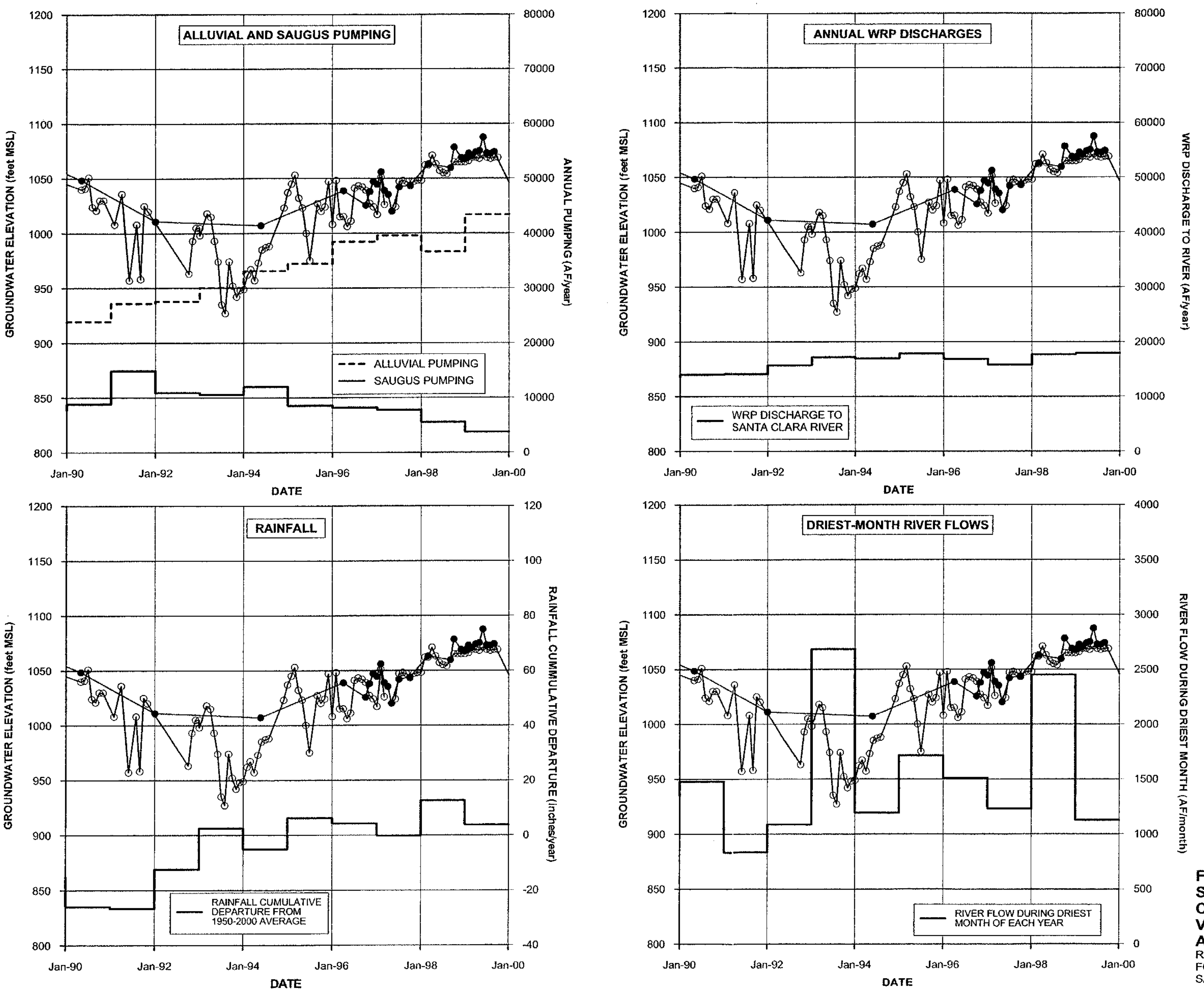

LEGEND

● ELEVATION OF GROUNDWATER IN VWC-157

○ ELEVATION OF GROUNDWATER IN SCWC SAUGUS 2

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-14
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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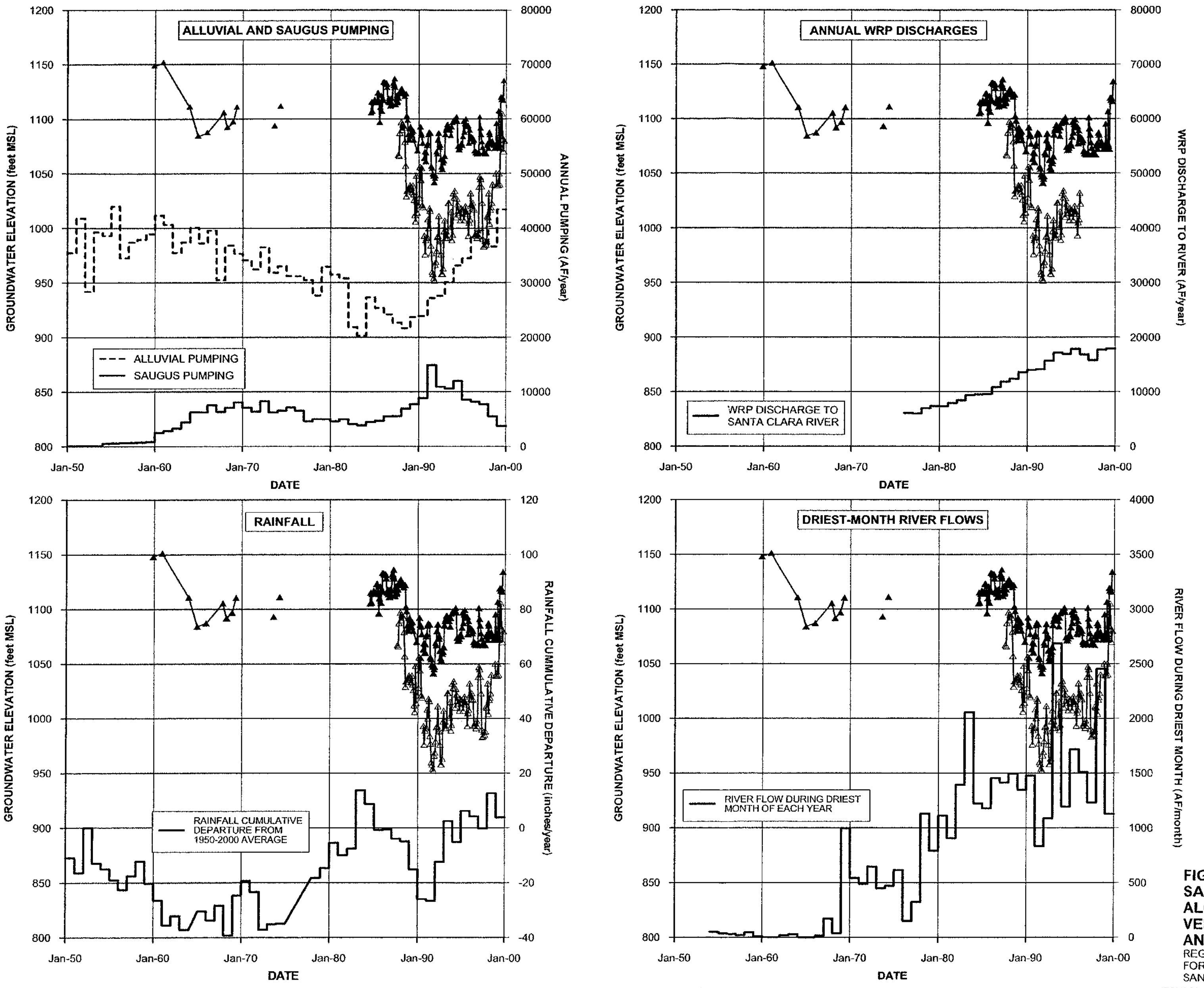

LEGEND

- ▲ ELEVATION OF GROUNDWATER IN NCWD-7
- △ ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-15
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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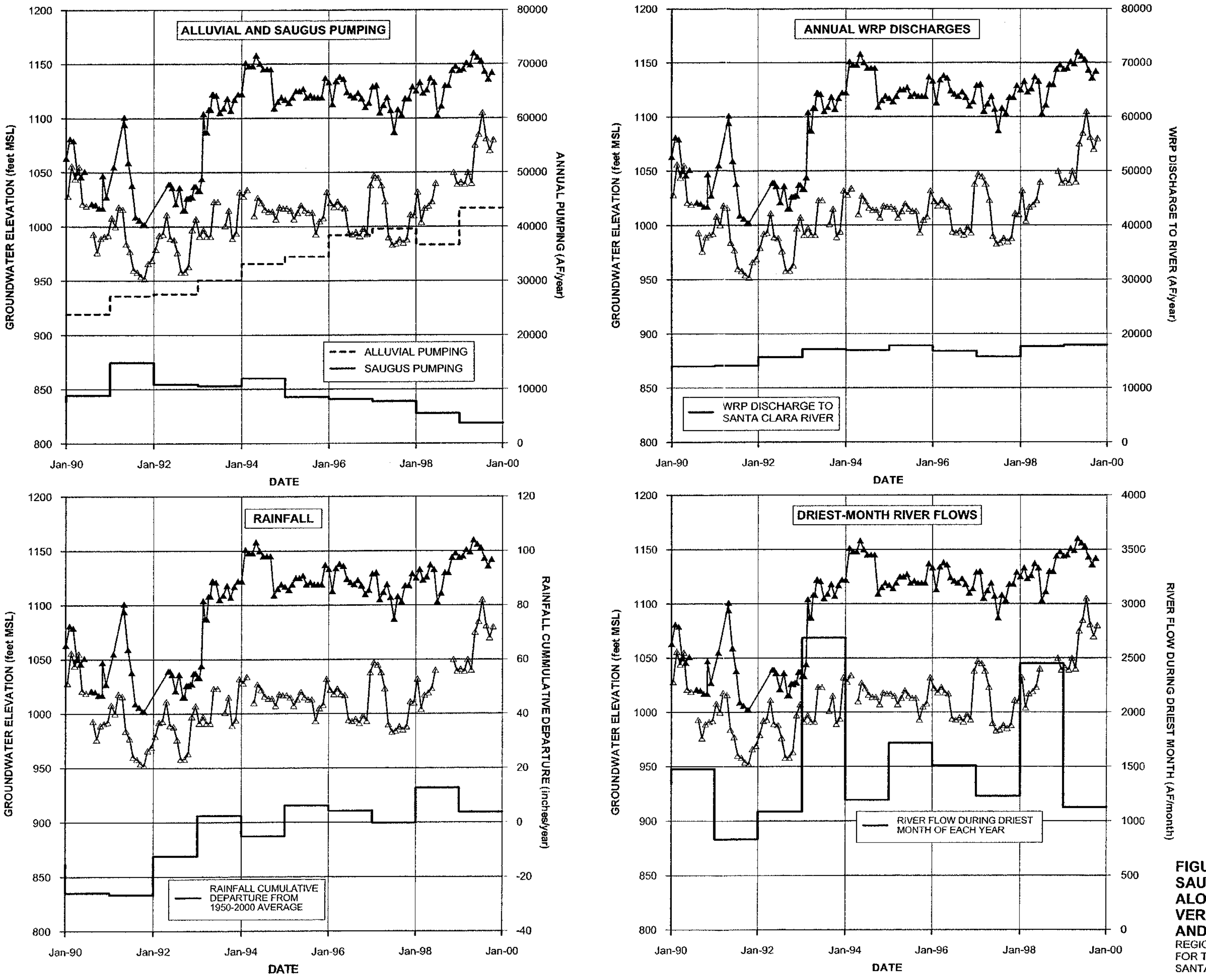

LEGEND

ELEVATION OF GROUNDWATER IN NCW-10

ELEVATION OF GROUNDWATER IN NCW-12

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-16
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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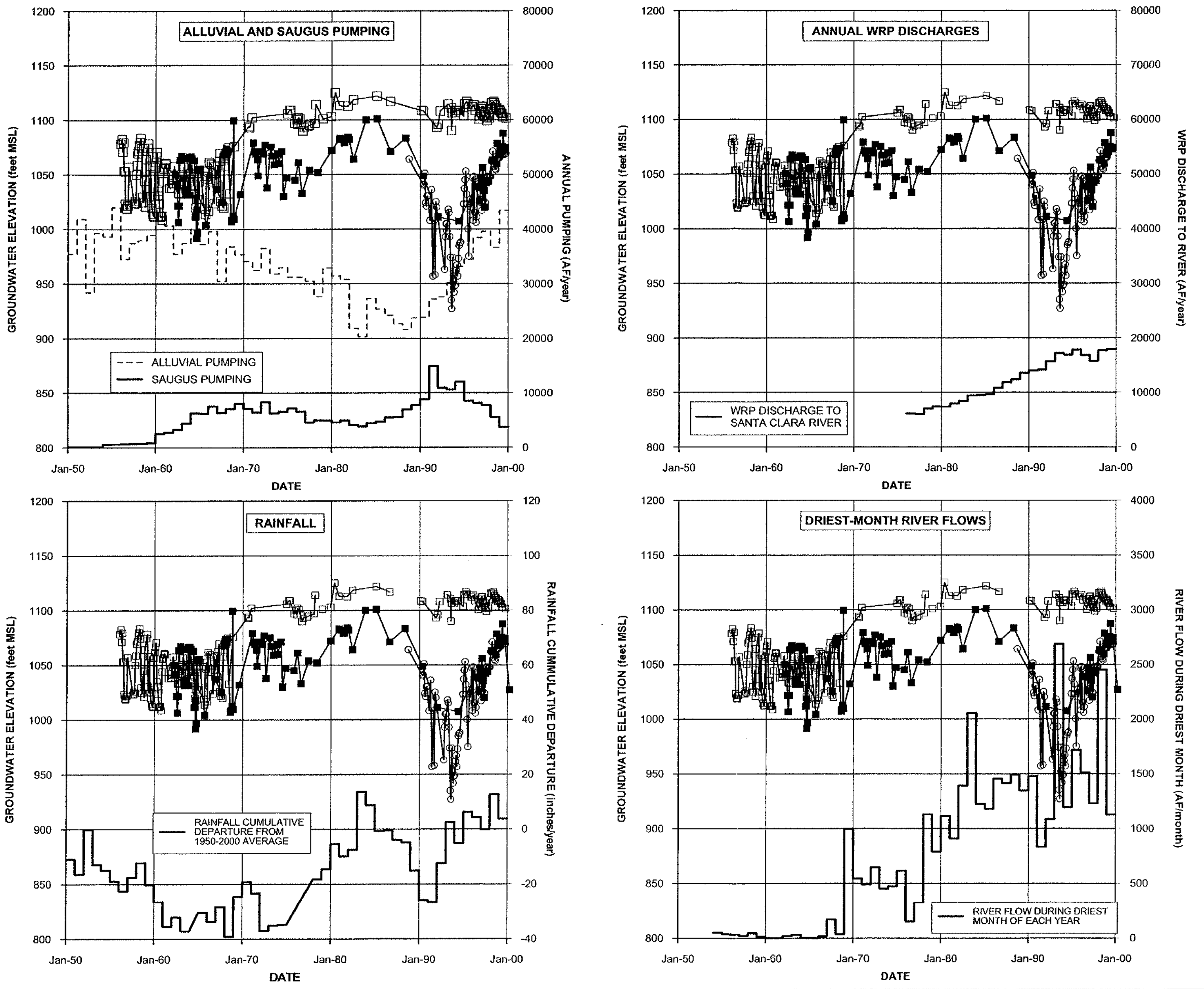

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-17
GROUNDWATER ELEVATIONS IN ADJACENT ALLUVIAL AND SAUGUS WELLS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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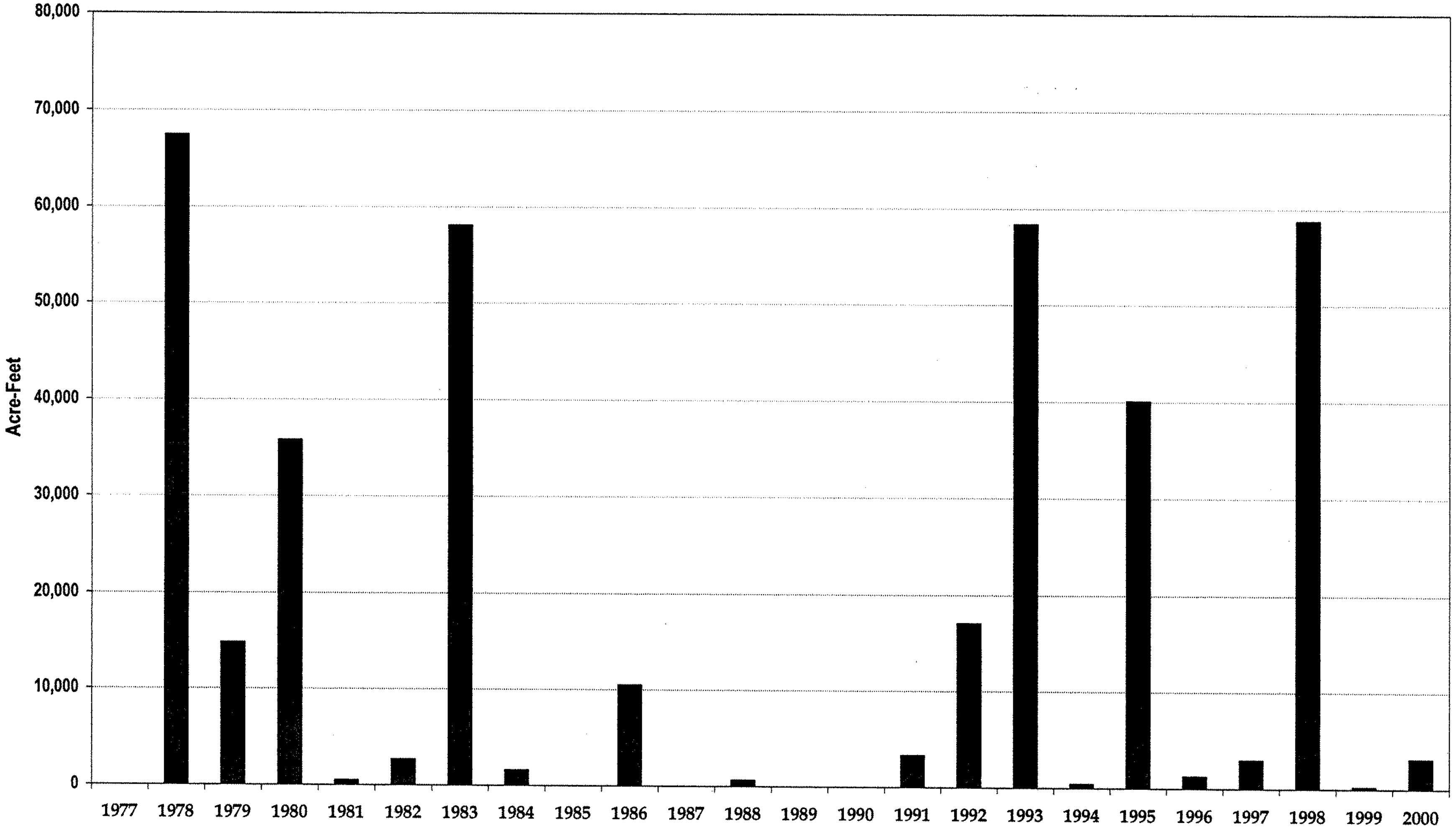

This chart shows the potential Flood Flows available during water years 1977 through 2000. Water Year 1977 is defined as October 1, 1976 through September 30, but the water is generally available only from October 1 through April 30.

FIGURE 2-18
NET CASTAIC CREEK FLOOD FLOWS AVAILABLE TO DOWNSTREAM USERS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 3

Model Construction

The Regional Model is a three-dimensional numerical model of groundwater flow in the Alluvial Aquifer and the Saugus Formation. The model simulates changes in groundwater flow and storage during the recent 20-year period from 1980 through 1999. This section of the report presents the overall approach to the construction of the Regional Model including the model software; model domain; grid design; layering scheme; boundary conditions; designation of subareas within the model domain; and the process for estimating the magnitudes of groundwater recharge and pumping terms required by the model.

3.1 Modeling Software

The Regional Model was constructed using the three-dimensional finite-element groundwater modeling software called MicroFEM® (Hemker and de Boer, 2003). MicroFEM® operates in a Windows™ environment and can be used to solve groundwater flow problems for unconfined, semi-confined, or confined aquifer systems. This software simulates steady-state or transient flow conditions in up to a 20-layer aquifer system; the finite-element mesh may contain as many as 50,000 nodes in each model layer. The software contains several different methods for simulating groundwater/surface water interactions. MicroFEM® is based on software developed in the Netherlands during the 1980s for use in evaluating the effects of groundwater pumping in areas with complicated meandering rivers. Further details regarding this software's design, capabilities, and functionality can be found on the Internet at www.microfem.com and in two reviews of the software by Diodato (1997, 2000).

3.2 Extent of the Model Domain

A finite-element mesh was designed that covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line gage area in the west. The northern and southern edges of the model domain are defined by the geologic contacts mapped by RCS (2002) for the Alluvial Aquifer and the Saugus Formation. Figure 2-10 shows the model domain, along with its location relative to the upstream watersheds that contribute runoff into the model study area.

3.3 Model Grid

Figure 3-1 shows the spacing of the individual nodes that comprise the grid. The mesh contains 17,103 nodes in each model layer. The nodes are connected by segments, forming 32,496 triangular elements. Calculations of all flow components (recharge and discharge), groundwater storage, and groundwater elevations are performed by the model for each node and segment.

The nodes are 500 feet apart in the majority of the modeled area. However, a finer node spacing (150 feet) was used along the Santa Clara River and its tributaries to allow a more exact simulation of surface water/groundwater exchanges. Additionally, specific nodes were placed within this regional grid at the locations of production and monitoring wells.

3.4 Layering

The groundwater system was represented in the Regional Model with seven layers. The layer representation is summarized schematically on Figure 3-2. The Alluvial Aquifer, where present, was modeled with a single layer, and the Saugus Formation was modeled with multiple layers to its total depth, which was defined as the base of the Sunshine Ranch Member of the Saugus Formation. Figures 3-3 through 3-9 show the assigned thicknesses in model layers 1 through 7. Figure 3-10 shows the total modeled saturated thickness of the Saugus Formation. Figures 3-11 through 3-17 show the elevations of the base of each model layer. Figure 3-18 shows the model layering in three cross-sectional views. Further details regarding model layering are presented below.

3.4.1 Alluvial Aquifer Layer

In 2002, RCS compiled and geographically grouped hydrogeologic data from Alluvial Aquifer wells to estimate the aquifer's saturated thickness during various historical periods. The saturated thickness was defined from the average base elevation of the aquifer and the water level elevations measured during the fall of 1985 and the spring of 2000, then typical saturated thicknesses for geographic subareas were defined. The spatial distribution of the Alluvial Aquifer's typical saturated thickness is shown on Figure 3-3. Along the Santa Clara River, the typical saturated thickness ranges between 110 and 130 feet west of I-5; is less than 100 feet near Round Mountain; ranges between 100 and 150 feet between Round Mountain and Soledad Canyon; and ranges between 80 and 90 feet in Soledad Canyon. The typical saturated thickness ranges between 80 and 100 feet in the Castaic Creek Valley and in the lower reach of Bouquet Canyon. Other tributary canyons to the Santa Clara River have typical saturated thicknesses of 60 feet or less, and the saturated thickness decreases significantly in the upstream direction within each canyon, particularly along the South Fork Santa Clara River, where all production wells are constructed in the Saugus Formation, rather than the alluvium (RCS, 2002).

3.4.2 Saugus Formation Layers

The Saugus Formation was simulated using 500-foot-thick model layers through the freshwater-bearing deposits, which are present in the basin at depths up to 2,500 feet (RCS, 1988, 2002). The model layers were specified at each node by importing digitized contours of the total thickness of the Saugus Formation's freshwater-bearing deposits (Plate 5 in RCS, 1988). Figure 3-4 is a contour fill map showing the total thickness of the Saugus Formation's freshwater-bearing deposits that was programmed into the model. As shown in the individual thickness maps for each model layer, the Saugus is present in the model at progressively fewer nodes with depth, due to the bowl-shaped structure of the unit and the underlying bedrock.

3.5 Boundary Conditions

The boundary conditions used in the Regional Model were the following:

a. **Specified flux for precipitation within the model grid.** Deep percolation of precipitation was simulated using the precipitation top-system package contained in MicroFEM®.

b. **Specified flux for irrigation.** Deep percolation of agricultural irrigation and urban irrigation in developed areas was simulated using the precipitation top-system package contained in MicroFEM®.

c. **Specified flux and head-dependent flux along ephemeral streams.** With respect to groundwater discharges to streams, the Santa Clara River was modeled as an ephemeral, predominantly losing stream at and upstream of the mouth of San Francisquito Canyon, and as a perennial, predominantly gaining stream downstream of San Francisquito Canyon. Although flows in the river are currently perennial below the mouth of Bouquet Canyon, because of discharges from the Saugus WRP, the river was perennial only below the mouth of San Francisquito Canyon in the 1960s, prior to WRP operations. The tributaries to the Santa Clara River were modeled as ephemeral streams, using the precipitation top-system package to specify stream leakage to groundwater. Aerial photos and historical observations indicate that under high water table conditions, groundwater can locally discharge into Castaic Creek and the ephemeral reach of the Santa Clara River wherever Alluvial groundwater levels rise above the riverbed elevation. Consequently, the drain package in MicroFEM® was used in these streams to allow drainage of any groundwater that was calculated to be above the riverbed elevation at each river node.

d. **Specified flux and head-dependent flux along perennial Santa Clara River.** In the perennial reach of the Santa Clara River, the river was modeled using the wadi top-system package contained in MicroFEM®. The wadi package allows groundwater to discharge to the river whenever groundwater elevations are higher than the specified river stage. When groundwater levels are below the river stage, the river recharges the Alluvial Aquifer. The rate of recharge is proportional to the difference between the river stage elevation and the model-calculated groundwater elevation. However, once the groundwater elevation drops below the streambed sediments, the rate of leakage from the stream is constant (i.e., does not vary as the groundwater elevation fluctuates). For the Regional Model, each node along the perennial reach of the Santa Clara River was assigned a river stage 1 foot higher than the mapped bed elevation of the river. The riverbed permeability, or conductance, which helps control the model-calculated groundwater/surface water exchange rates, was adjusted during model calibration by calibrating to streamflow data collected at the county line. (See Section 4.3 for further details on the use of the streamflow data during model calibration.)

e. **Specified flux for pumping.** Pumping rates and locations for wells completed in the Alluvial Aquifer and the Saugus Formation were directly imported into the Regional

Model from the Upper Santa Clara River Groundwater Basin database. Further information on how pumping was specified in the model is contained in Section 3.7.

f. **Specified flux at upgradient Alluvial Aquifer boundaries.** Where there is Alluvial groundwater flow into the study area from beneath Castaic Dam, the magnitude of the specified flux was adjusted during the model calibration process, using groundwater elevations and gradients published by RCS (1986 and 2002).

g. **Specified groundwater elevation in the Alluvial Aquifer at the county line.** The groundwater elevation (805 feet) was obtained from water level contour maps for the Alluvial Aquifer prepared by RCS (1986, 2002). (See Figure 2-7 for groundwater elevation contours during Spring 2000, as mapped by RCS [2002].)

h. **Head-dependent flux for evapotranspiration.** ET from the water table by riparian vegetation was simulated using the evaporation top-system package contained in MicroFEM®. This package requires specification of the maximum rooting depth for the riparian vegetation, the maximum potential ET rate, and the ground surface elevation.

i. **No-flow**. In general, the outermost line of nodes that form the model boundary and the bottom of the model are no-flow boundaries. The exceptions are the western model boundary (specified head) and the specified-flux nodes representing underflow into the Alluvial Aquifer from beneath Castaic Dam. Also, all nodes on the model boundary are assigned specified fluxes due to precipitation and, in some cases, ephemeral streamflow.

3.6 Estimation of Groundwater Recharge Rates

The groundwater recharge rates required by the model were derived from the following information sources:

a. Precipitation records

b. Watershed maps and topographic maps

c. Aerial photography (to identify vegetation patterns and areas of agricultural and urban irrigation)

Groundwater recharge was defined on a month-to-month basis for the transient calibration process. Groundwater recharge rates were assigned at all model nodes using the GIS for the valley and a Surface Water Routing Model (SWRM), which was written specifically for the Regional Model using the Visual Basic Editor within Microsoft® Excel 97. For each month during the transient calibration period, the SWRM estimated the following:

a. The amount of water potentially available to recharge the aquifer, which consisted of:
    1. Infiltration of direct precipitation within the model grid area
    2. Infiltration of urban irrigation water
    3. Infiltration of agricultural irrigation water
    4. The amount of stormwater yielded by upstream watersheds in each tributary to the Santa Clara River
    5. The amount of water entering the valley in the Santa Clara River at the Lang gage

6. The amount of water released into Castaic Creek by DWR
7. The locations and volumes of flow discharged into the Santa Clara River from the two LACSD WRPs

b. The amount of water in each stream that actually infiltrates to the aquifer, based on an assigned streambed leakage rate at each model node

c. The amount of water in each stream that does not infiltrate and therefore remains as surface water in the Santa Clara River at the west end of the valley, at the County Line gage

During model calibration, the SWRM was used to adjust the streambed conductance terms for Castaic Creek and the ephemeral reach of the Santa Clara River. These adjustments were made by examining the differences between measured and modeled groundwater elevations at wells located in the valleys where these ephemeral streams are present. In addition, the streambed conductance terms were allowed to vary from month to month because the conductance implicitly incorporates the streambed area, which is large during high river flows and smaller during low-flow periods.

A detailed discussion of the SWRM's design, operations, and input data is contained in Appendix C.

3.7 Assignment of Pumping Rates

Pumping rates were assigned in the Regional Model using the following information:

a. Water use records maintained by the Purveyors and other agencies in the valley. These records were available in the form of AF/yr of water use at each well.

b. Estimates of monthly water demand for urban water use and agricultural water use.

c. Well construction records, which were needed to determine which model layers at each individual well should be assigned pumping.

Tables 2-1 and 2-2 summarize annual pumping rates at each well and for each year during the transient model calibration period. All production wells in the Alluvial Aquifer were assigned pumping rates in model layer 1. For each production well completed in the Saugus Formation, the pumping assignments in each model layer were based on the total pumping rate, the percentage of the model layer in which the well was open, and the thickness and hydraulic conductivity of each model layer. Table 3-1 summarizes this information and shows the percentage of the total well yield that was derived from each model layer.

Table 3-2 summarizes the monthly distribution of the annual pumping volumes. Separate distributions were used for agricultural demands, which are exclusively for outdoor uses, and for urban demands, which are for both indoor and outdoor uses. The monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service. The monthly distribution of urban demand was determined by examining monthly flow records for the two LACSD WRPs and monthly demand distributions recorded by VWC during the past several years.

Tables

TABLE 3-1

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-7	3	520	974	454	2	908	100.0
NCWD-8	2	342	970	158	10	1,580	62.7
NCWD-8	3	342	970	470	2	940	37.3
NCWD-9	2	311	674	189	0.03371	6.37	59.4
NCWD-9	3	311	674	174	0.025	4.35	40.6
NCWD-10	3	780	1,544	220	2	440	28.8
NCWD-10	4	780	1,544	500	2	1,000	65.4
NCWD-10	5	780	1,544	44	2	88	5.8
NCWD-11	2	200	1,075	300	10	3,000	72.3
NCWD-11	3	200	1,075	500	2	1,000	24.1
NCWD-11	4	200	1,075	75	2	150	3.6
NCWD-12	2	485	1,280	15	10	150	8.8
NCWD-12	3	485	1,280	500	2	1,000	58.5
NCWD-12	4	485	1,280	280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
NCWD-13	3	420	750	250	2	500	38.5
NLF-156	2	320	1,800	180	10	1,800	21.8
NLF-156	3	320	1,800	500	6.5	3,250	39.4
NLF-156	4	320	1,800	500	4	2,000	24.2
NLF-156	5	320	1,800	300	4	1,200	14.5
SCWC-Saugus1	2	490	1,620	10	10	100	1.8
SCWC-Saugus1	3	490	1,620	500	6.5	3,250	59.9
SCWC-Saugus1	4	490	1,620	500	4	2,000	36.8
SCWC-Saugus1	5	490	1,620	20	4	80	1.5
SCWC-Saugus2	2	490	1,591	10	10	100	1.8
SCWC-Saugus2	3	490	1,591	500	6.5	3,250	56.9
SCWC-Saugus2	4	490	1,591	500	4	2,000	35.0
SCWC-Saugus2	5	490	1,591	91	4	364	6.4
VWC-157	3	586	2,008	414	6.5	2,691	40.2
VWC-157	4	586	2,008	500	4	2,000	29.9
VWC-157	5	586	2,008	500	4	2,000	29.9
VWC-159	3	662	1,900	338	0.025	8.45	27.3
VWC-159	4	662	1,900	500	0.025	12.5	40.4
VWC-159	5	662	1,900	400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.5
VWC-160	4	950	2,000	500	4	2,000	46.2
VWC-160	5	950	2,000	500	4	2,000	46.2

TABLE 3-1

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner -	Model	Depth to Open Interval (feet)		Length of Open Interval	Kh	T in Open	Percentage of Yield
Well Name	Layer	Top	Bottom	in Model Layer (feet)	(ft/day)	Interval (ft^2/day)	from Model Layer
VWC-201	3	540	1,670	460	6.5	2,990	52.7
VWC-201	4	540	1,670	500	4	2,000	35.3
VWC-201	5	540	1,670	170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
VWC-205	4	820	1,930	500	4	2,000	40.9
VWC-205	5	820	1,930	430	4	1,720	35.2

TABLE 3-2

Allocation of Pumping by Month for Agricultural and Urban Production Wells

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Month	% of Annual Water Use, Agricultural	% of Annual Water Use, Urban	% of May through October Water Use, Urban
January	3.8	5.2	
February	5.1	3.7	
March	6.6	5.2	
April	9.1	6.6	
May	10.6	8.7	13.2
June	11.4	10.4	15.8
July	14.1	13.0	19.7
August	12.9	13.6	20.6
September	10.2	10.9	16.5
October	7.5	9.3	14.1
November	5.0	7.1	
December	3.8	6.3	
Total	**100.0**	**100.0**	**100.0**

Figures

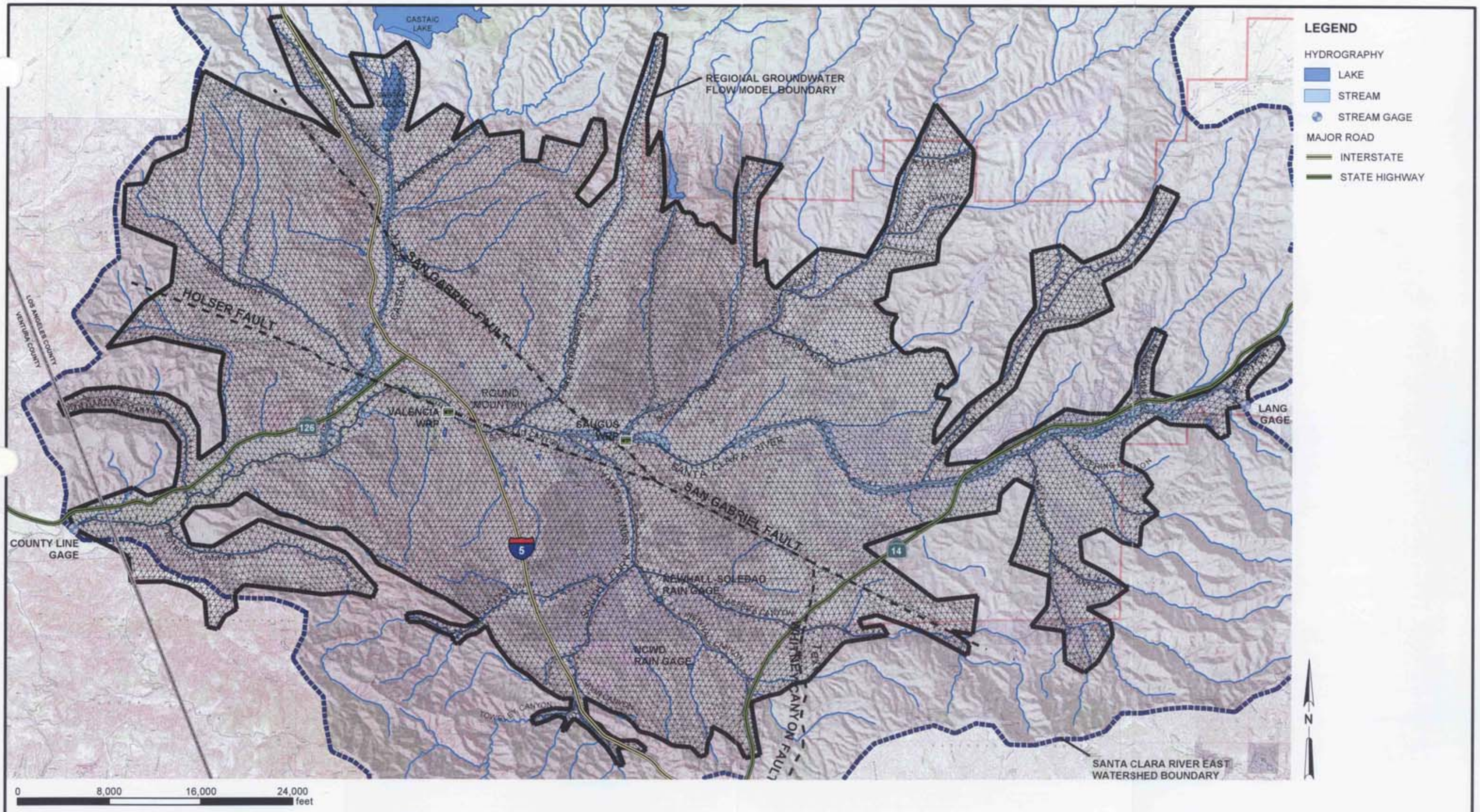

FIGURE 3-1
MODEL GRID

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0301.MXD FIG03-01.PDF 02/03/2004 09:40:41

Stratigraphy			Model Layer	Thickness (feet)
Saugus	Alluvium	Saugus	1	500
Saugus	Saugus	Saugus	2	
Saugus	Saugus	Saugus	3	500
Saugus	Saugus	Saugus	4	500
Saugus	Saugus	Saugus	5	500
Saugus	Saugus	Saugus	6	500
Sunshine	Sunshine	Sunshine	7	Variable

FIGURE 3-2
SHEMATIC DIAGRAM OF THE MODEL'S REPRESENTATION OF STRATIGRAPHY IN THE MIDDLE OF THE BASIN
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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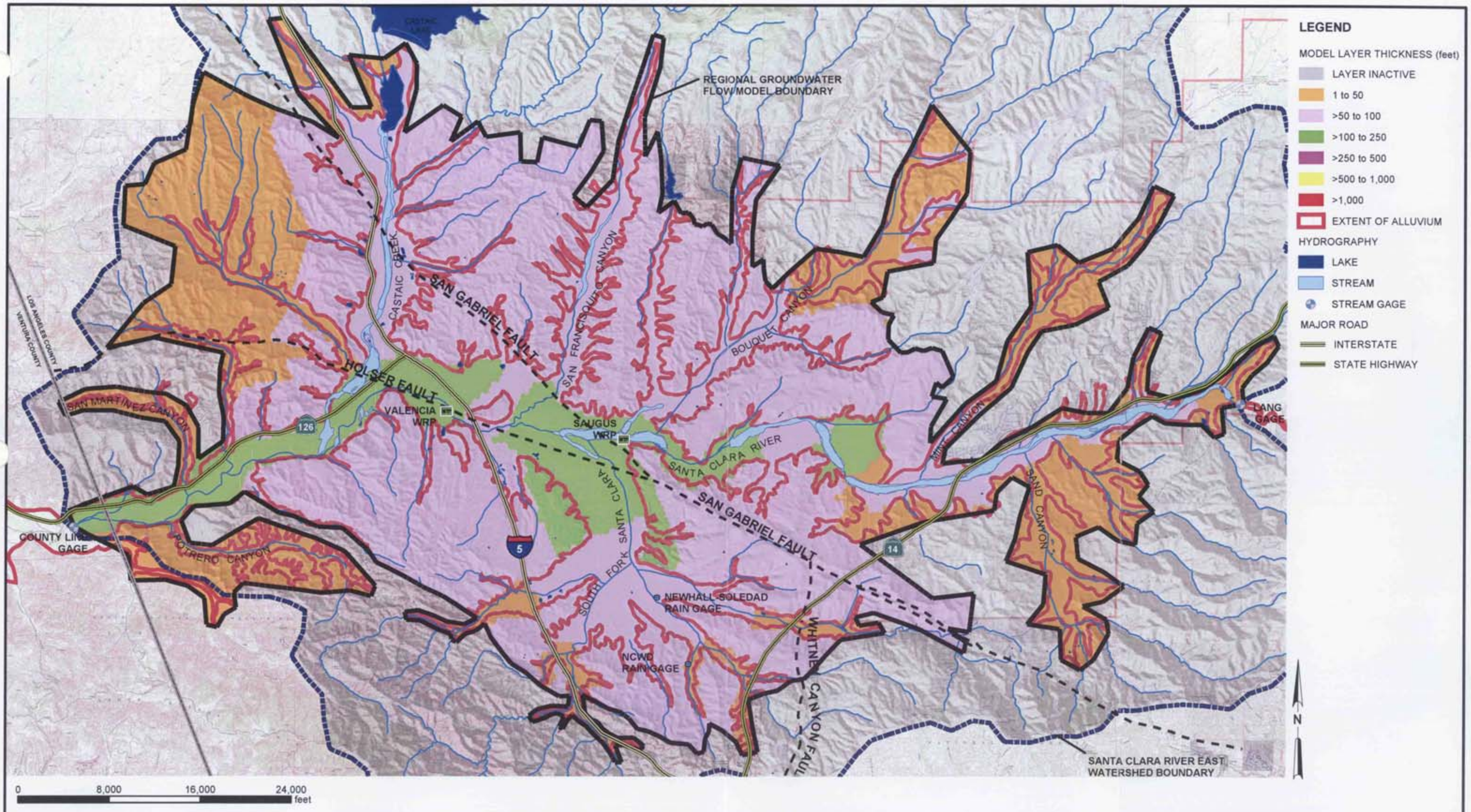

FIGURE 3-3
THICKNESS OF MODEL LAYER 1
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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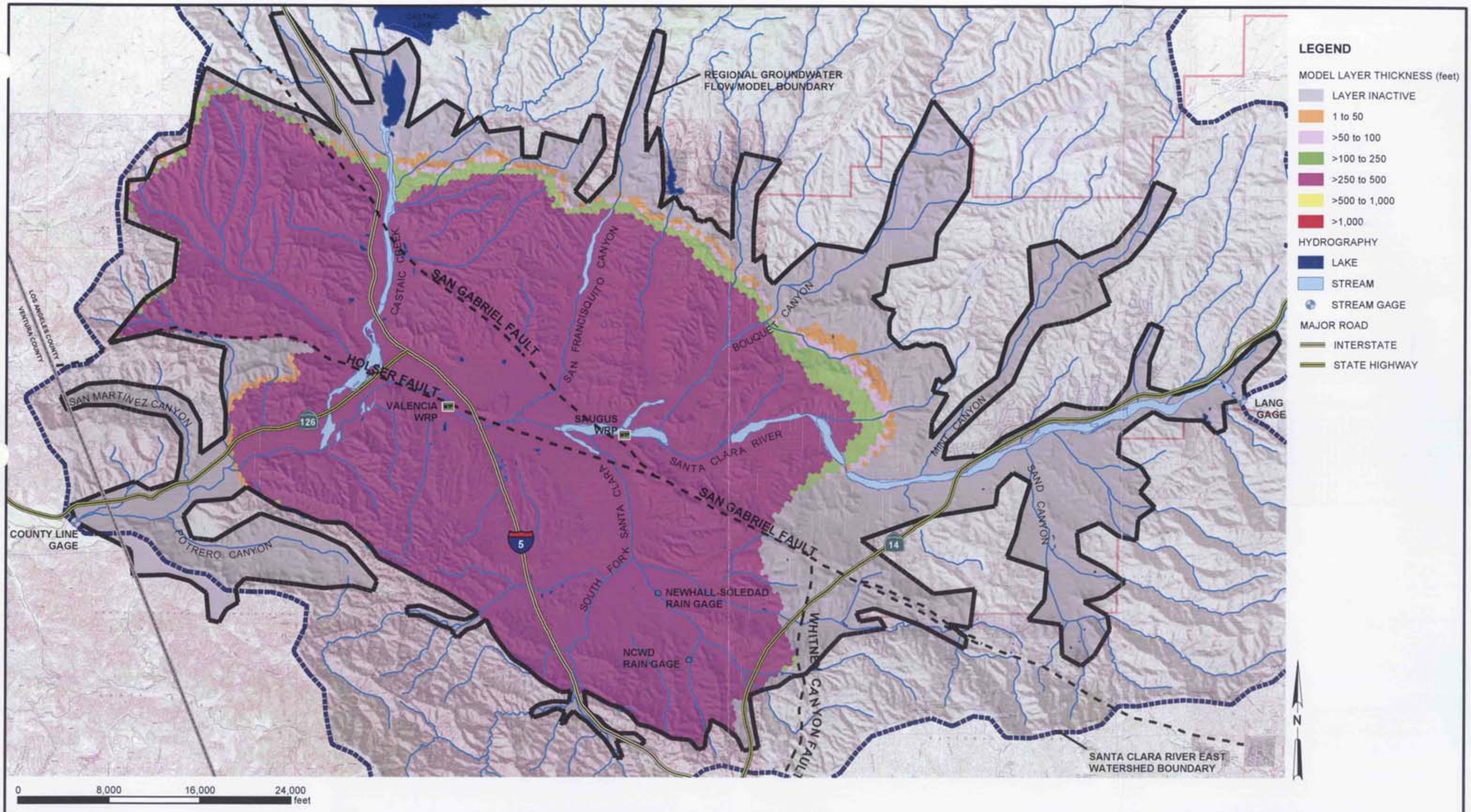

FIGURE 3-4
THICKNESS OF MODEL LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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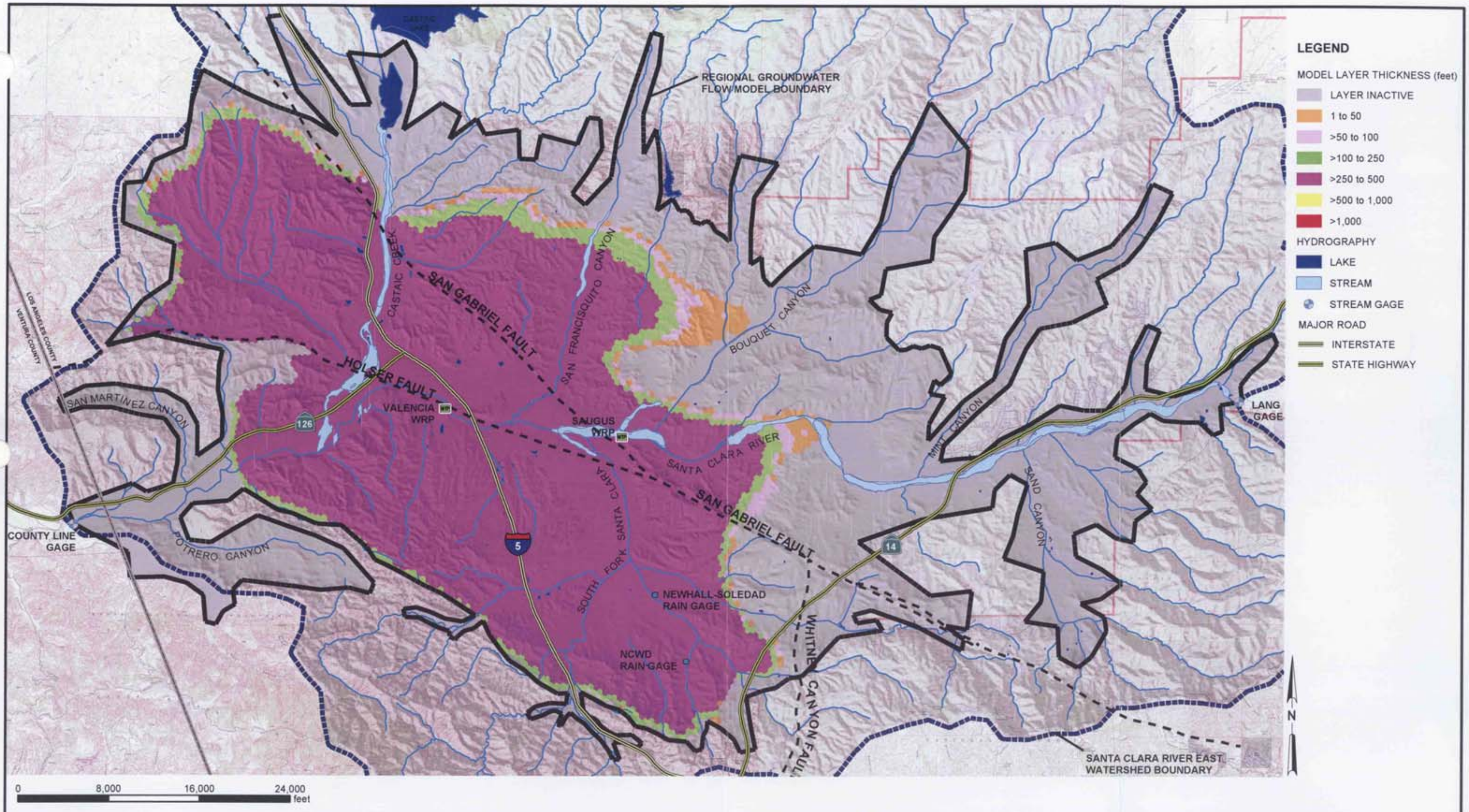

FIGURE 3-5
THICKNESS OF MODEL LAYER 3

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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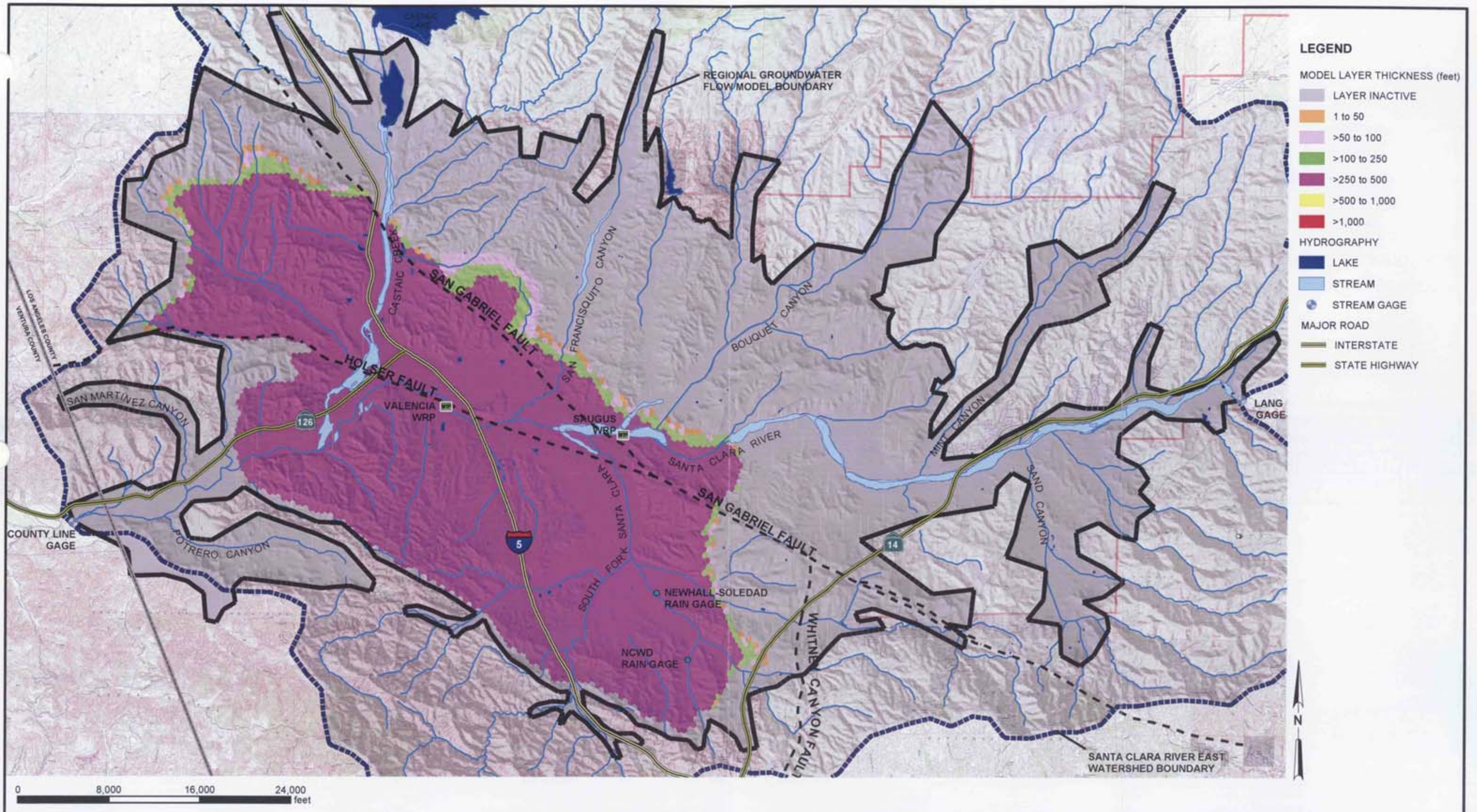

FIGURE 3-6
THICKNESS OF MODEL LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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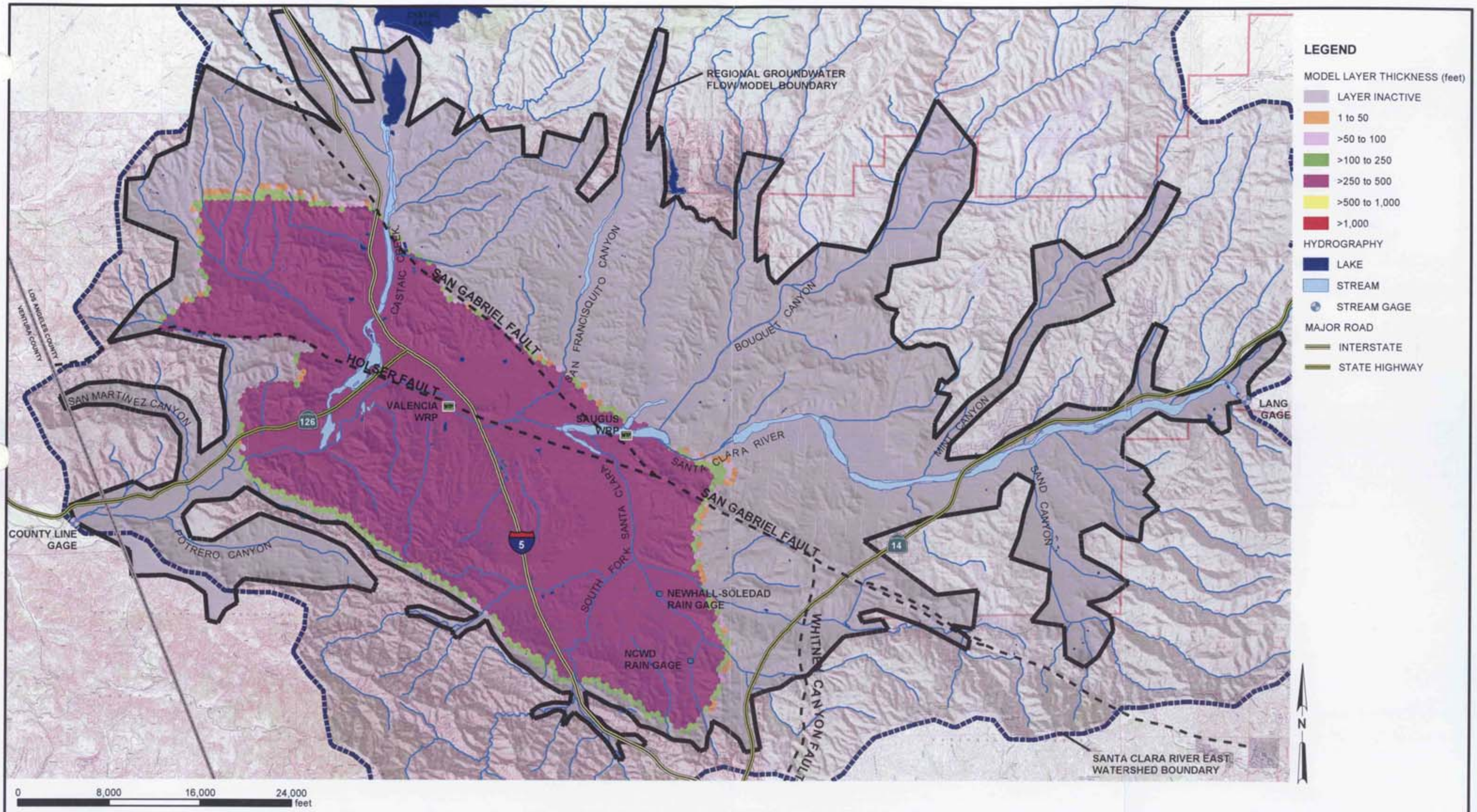

FIGURE 3-7
THICKNESS OF MODEL LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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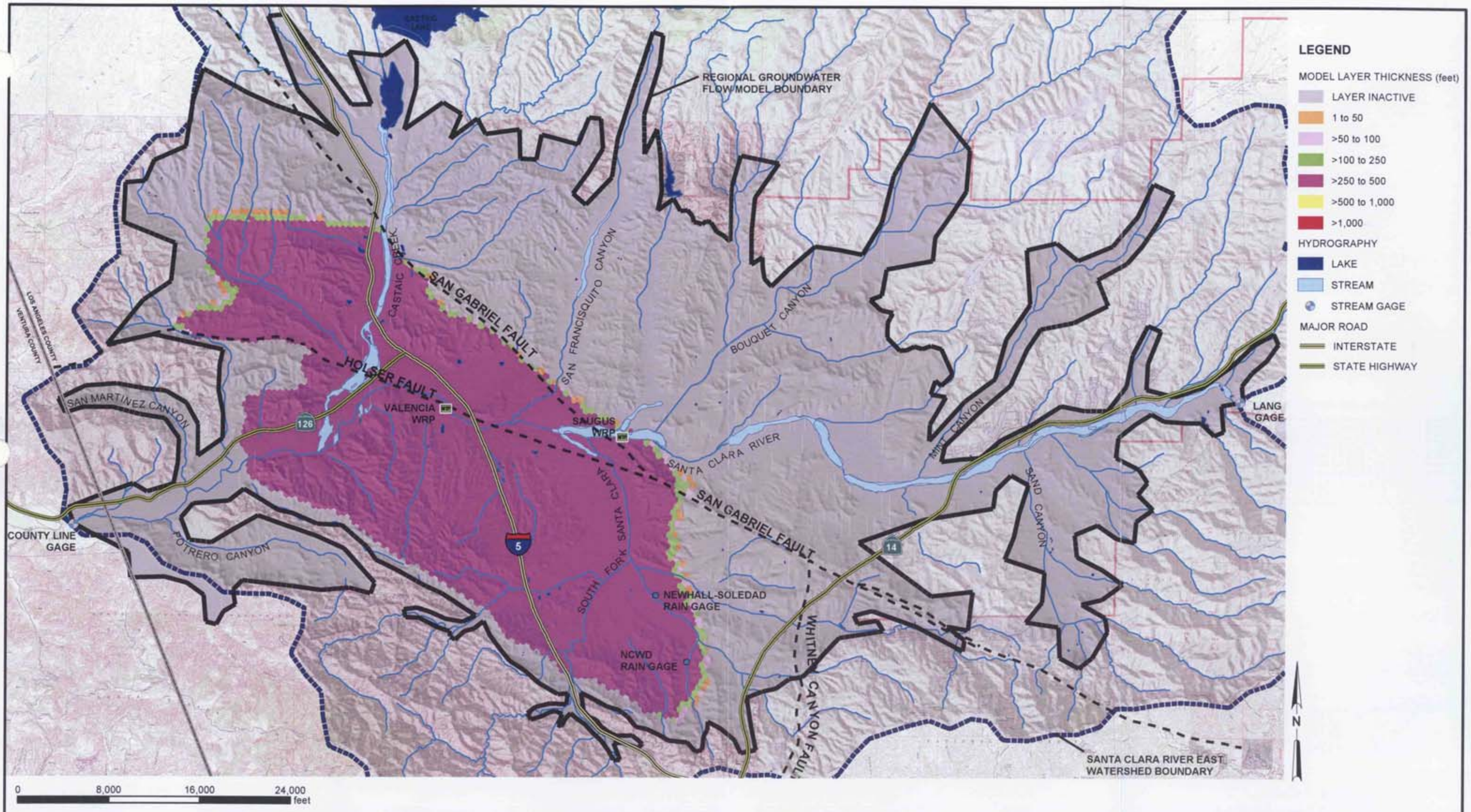

FIGURE 3-8
THICKNESS OF MODEL LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG025.MXD FIG03-08.PDF 02/04/2004 11:26:22

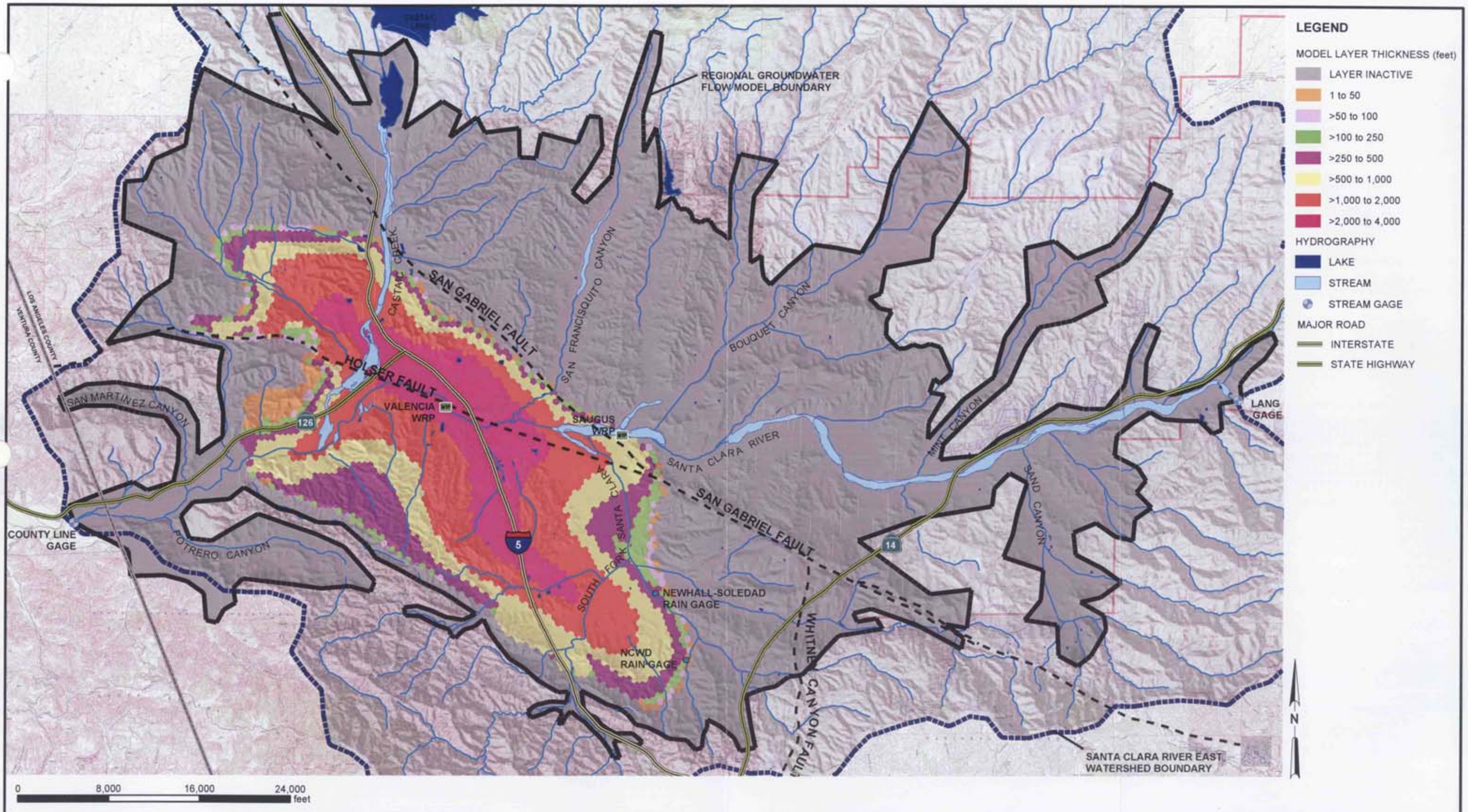

FIGURE 3-9
THICKNESS OF MODEL LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG026.MXD FIG03-09.PDF 02/02/2004 14:09:12

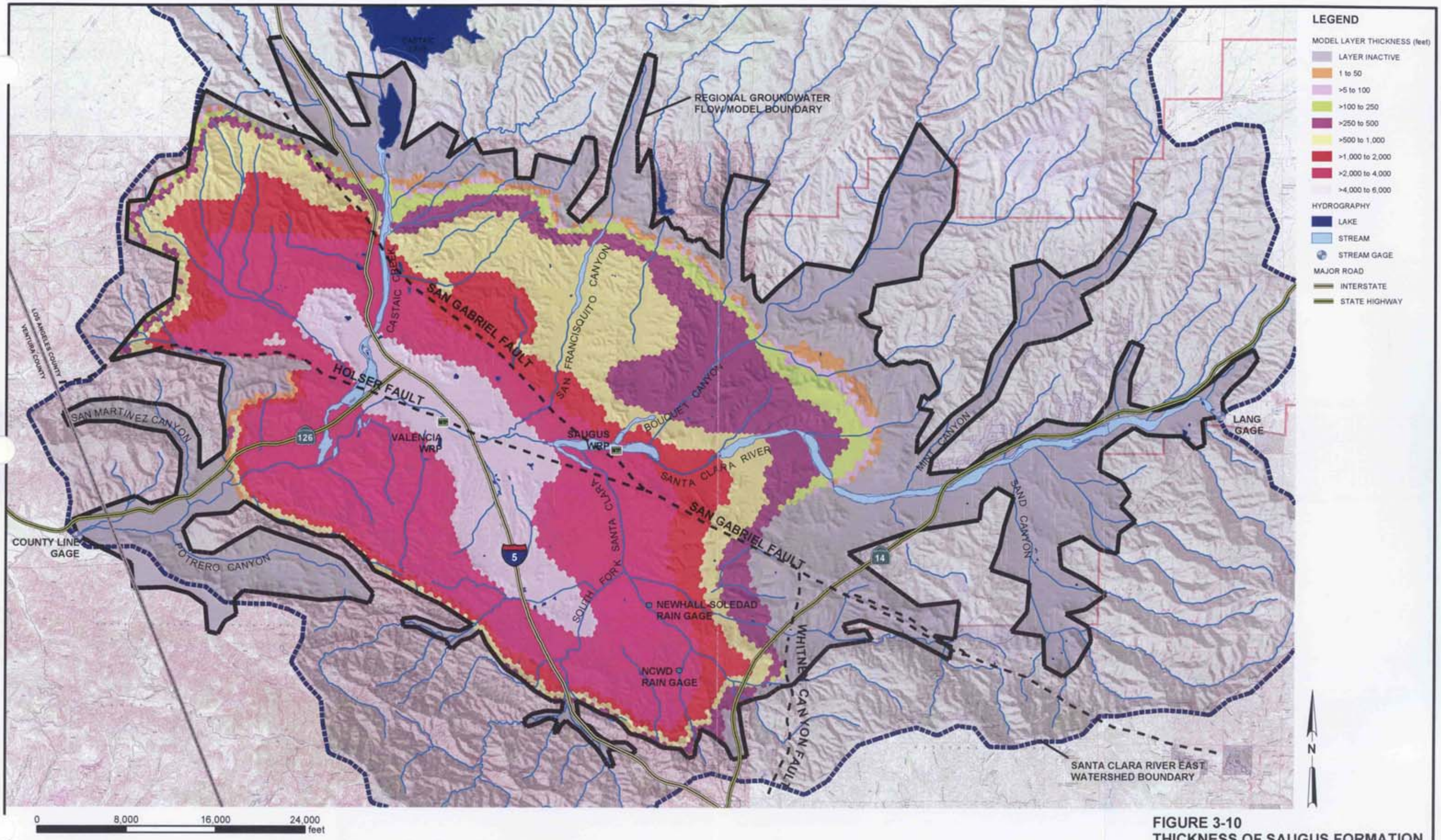

FIGURE 3-10
THICKNESS OF SAUGUS FORMATION (MODEL LAYERS 1 THROUGH 7)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG044.MXD FIG03-10.PDF 02/04/2004 14:19:00

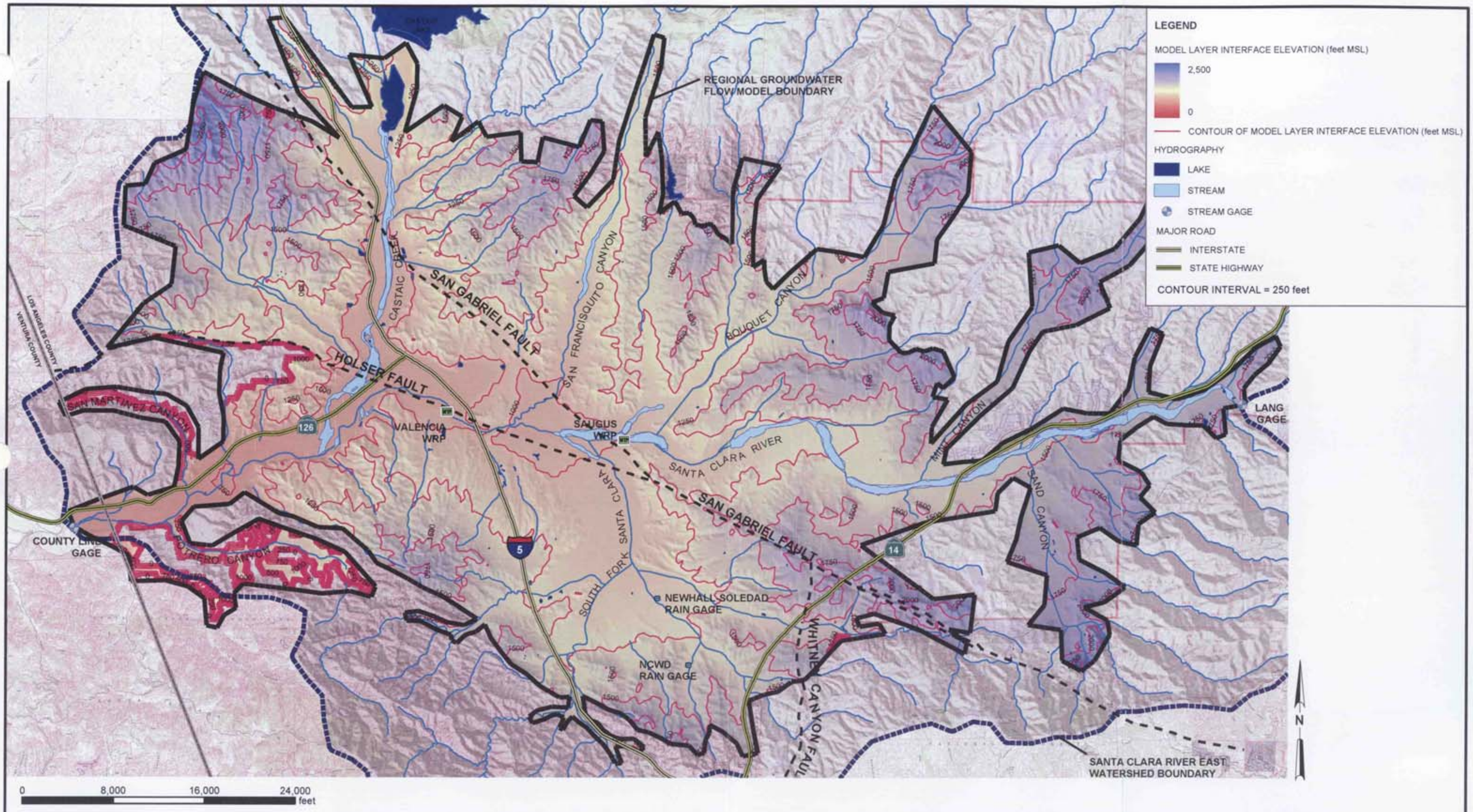

FIGURE 3-11
LAYER 1 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG027.MXD FIG03-11.PDF 02/04/2004 11:36:12

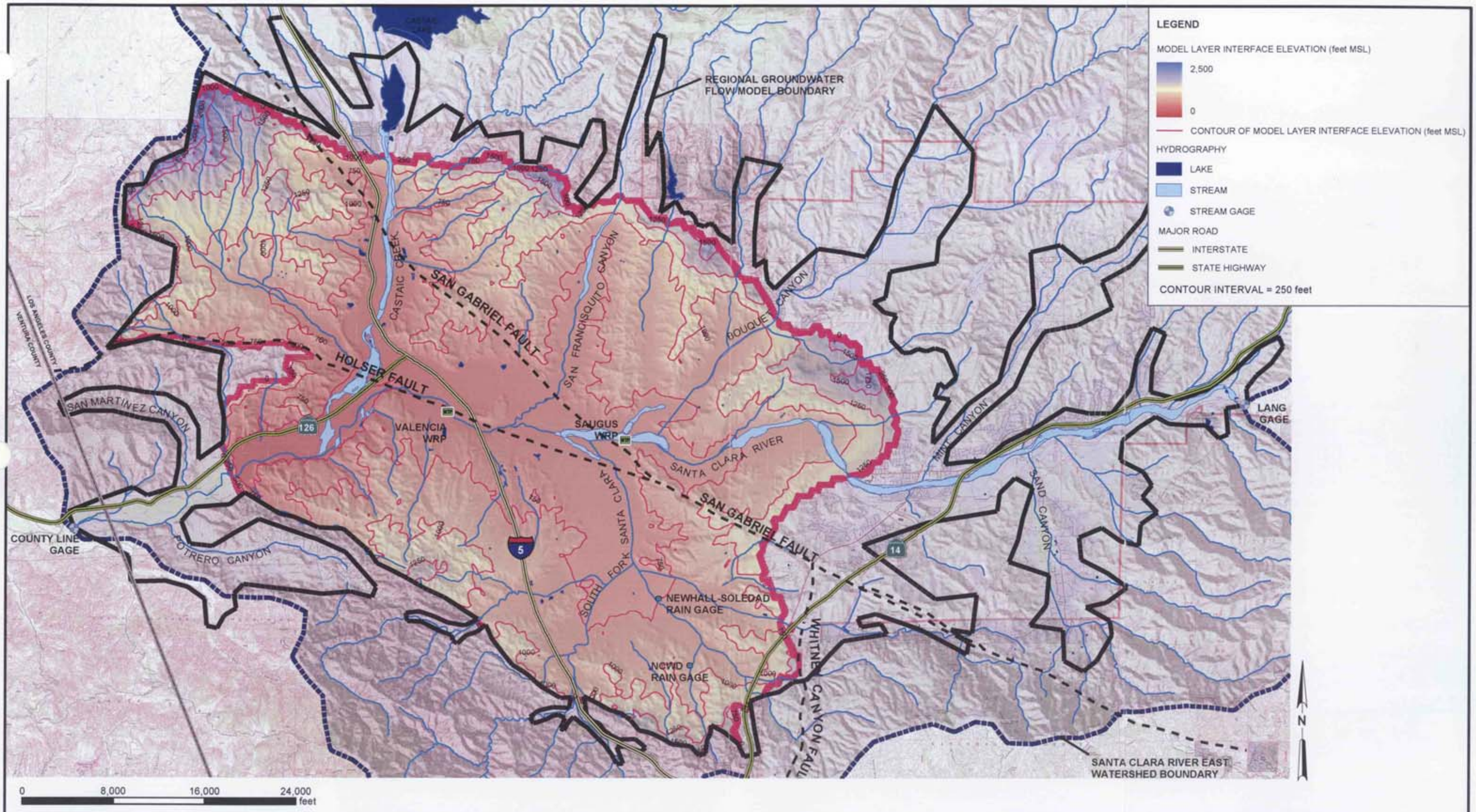

FIGURE 3-12

LAYER 2 BASE ELEVATION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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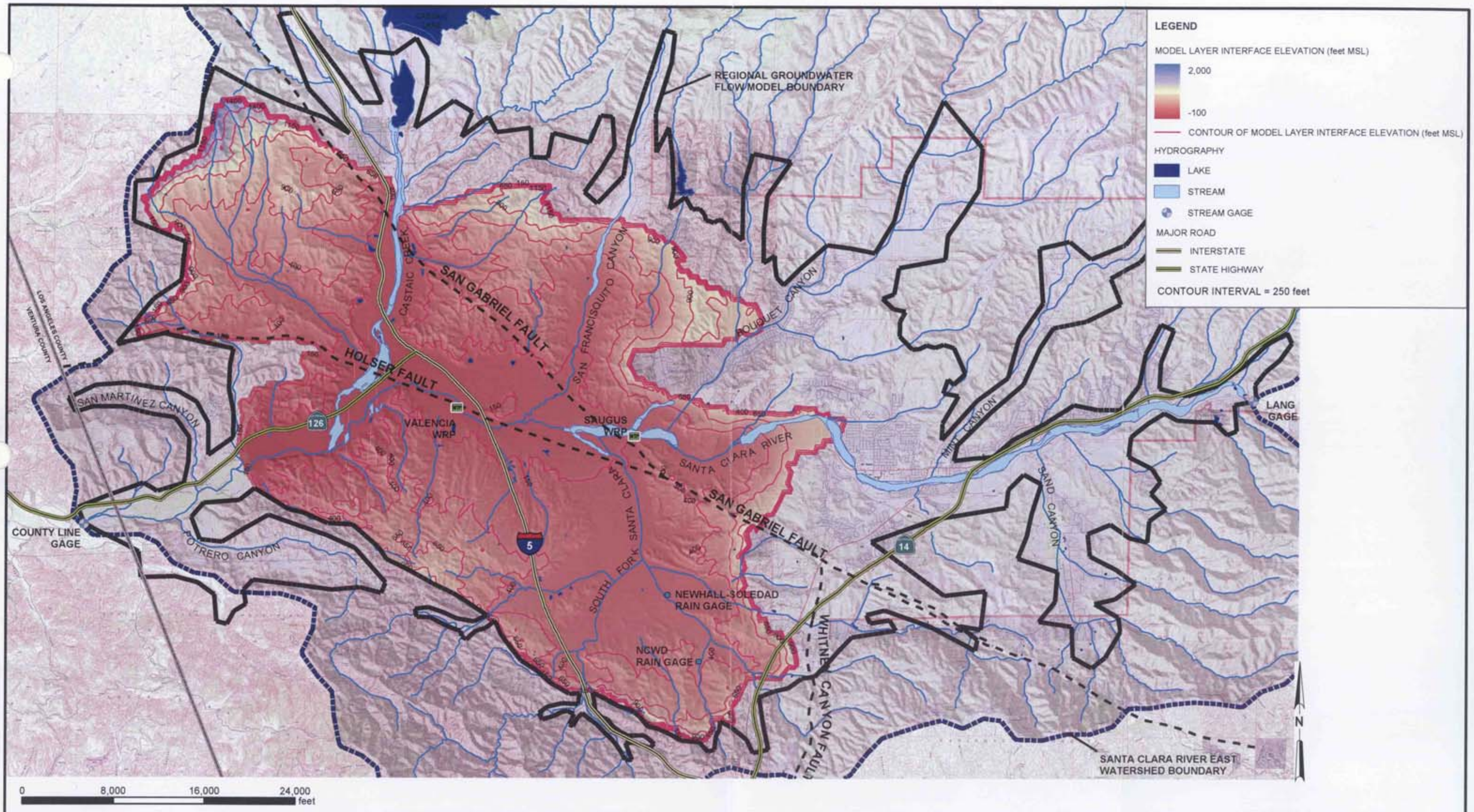

FIGURE 3-13
LAYER 3 BASE ELEVATION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG029.MXD FIG03-13.PDF 02/04/2004 11:42:48

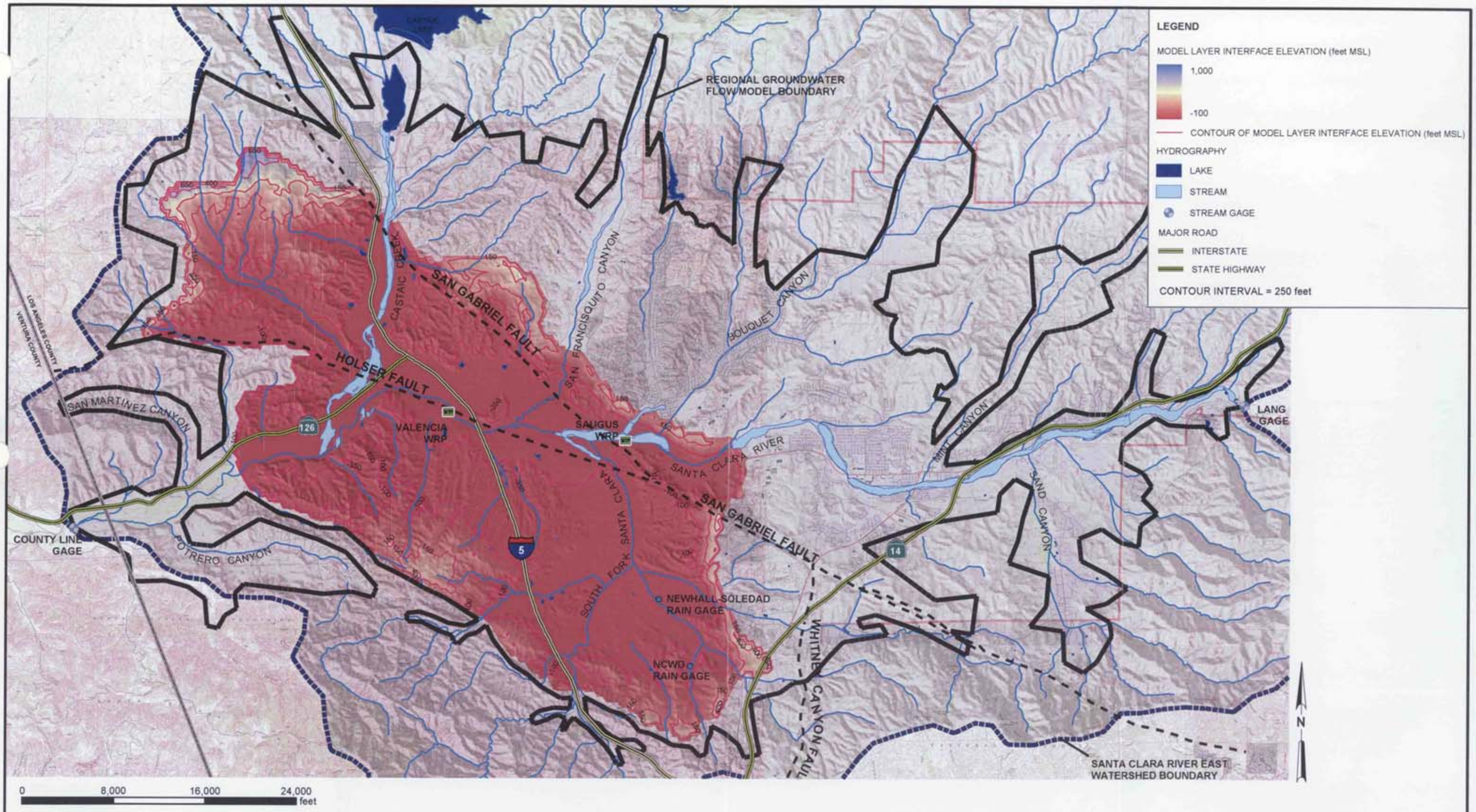


FIGURE 3-14
LAYER 4 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG030.MXD FIG03-14.PDF 02/04/2004 11:53:17

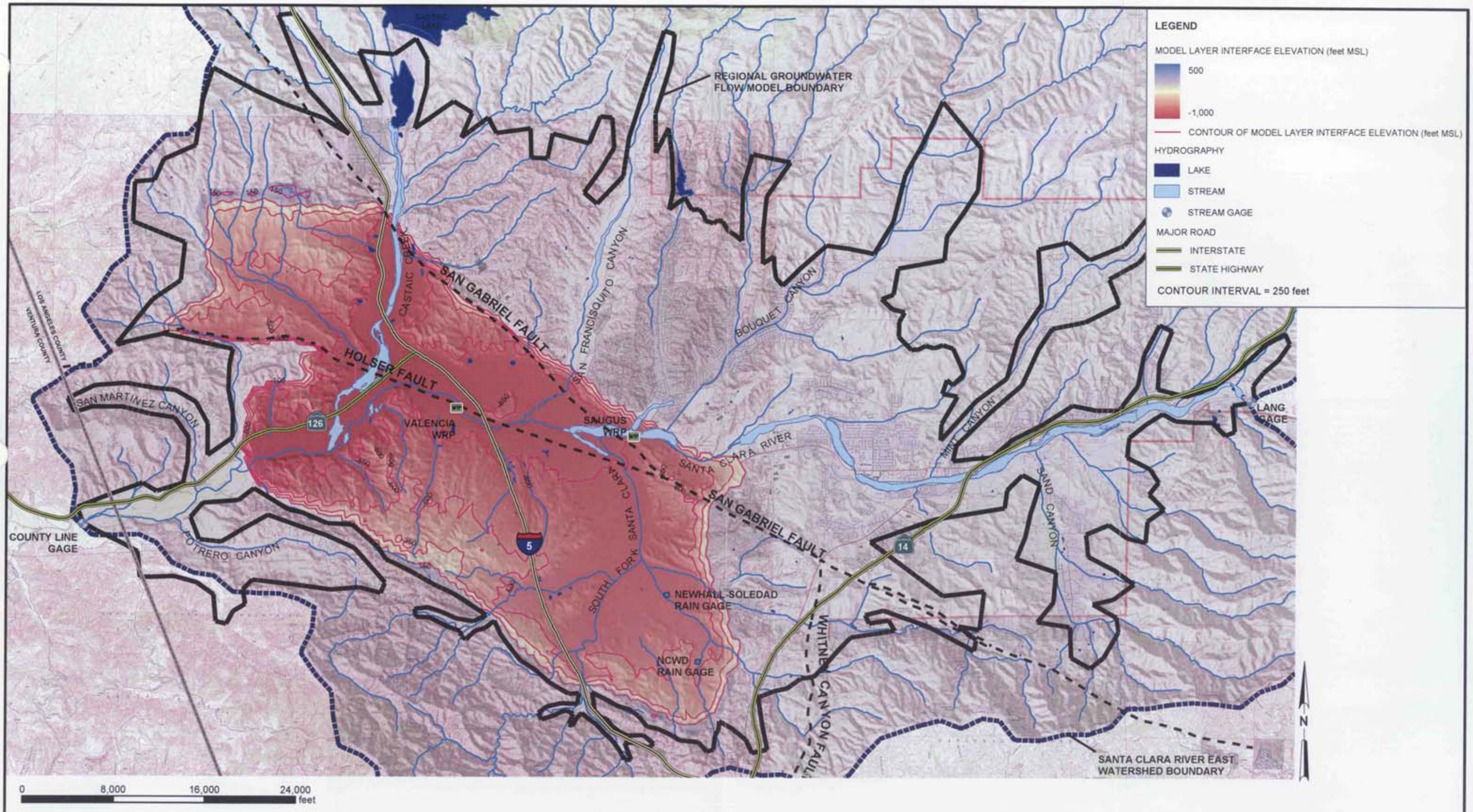


FIGURE 3-15
LAYER 5 BASE ELEVATION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG031.MXD FIG03-15.PDF 02/04/2004 12:53:31

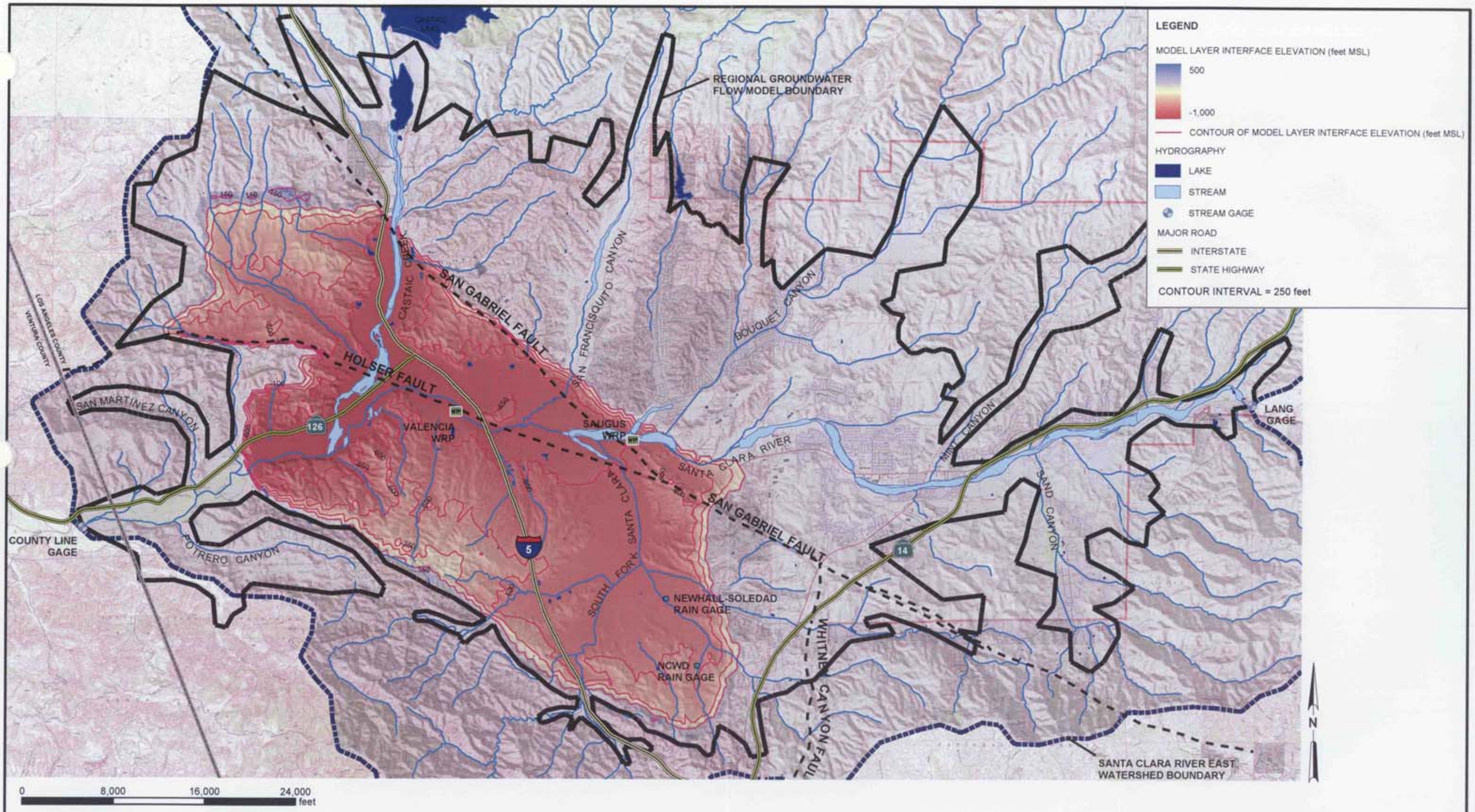


FIGURE 3-16
LAYER 6 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

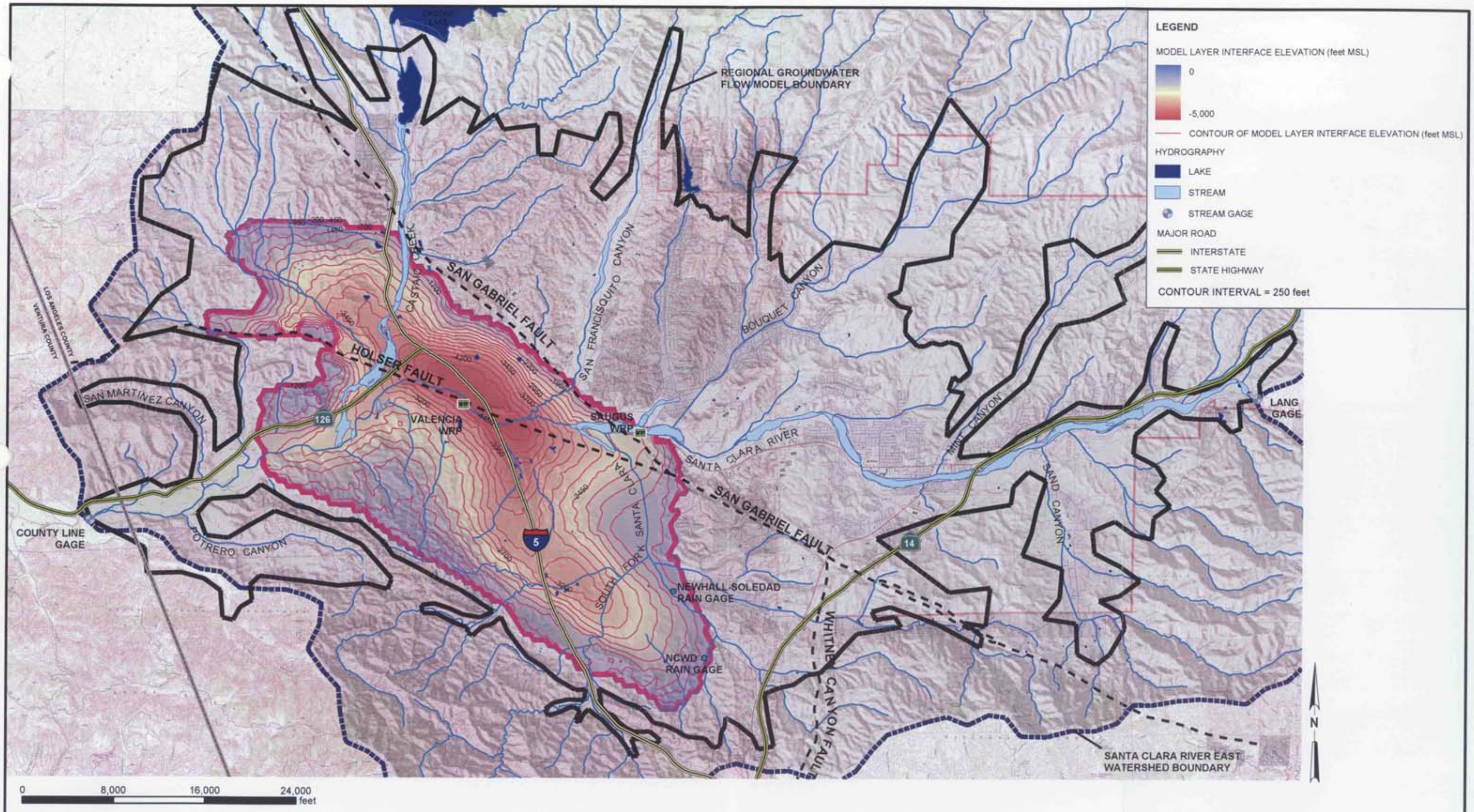
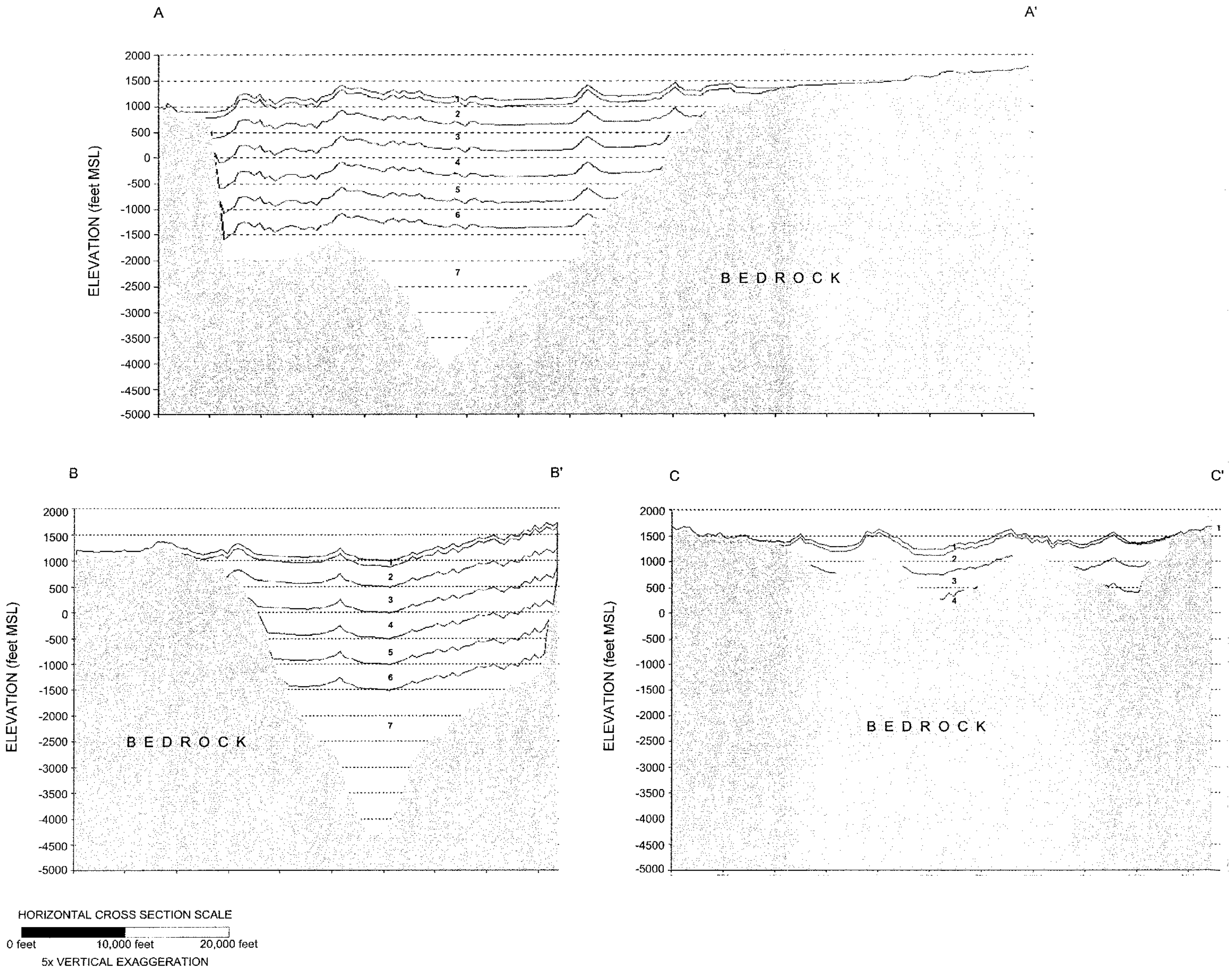
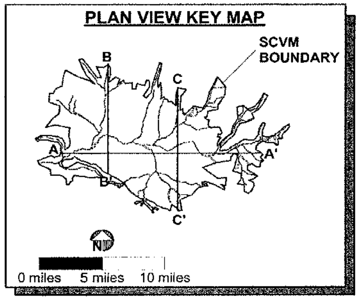


FIGURE 3-17
LAYER 7 BASE ELEVATION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL





LEGEND

1 = MODEL LAYER 1

2 = MODEL LAYER 2

3 = MODEL LAYER 3

4 = MODEL LAYER 4

5 = MODEL LAYER 5

6 = MODEL LAYER 6

7 = MODEL LAYER 7

FIGURE 3-18
SCHEMATIC CROSS SECTIONS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

SCHEMATICCROSSSECTIONS.SRF

SECTION 4

Model Calibration Process

This section describes the model calibration process. The Regional Model was calibrated according to the *Standard Guide for Calibrating a Ground-Water Flow Model Application,* published by the American Society for Testing and Materials (1996), which describes how to calibrate a model using historical data, including how to establish calibration target data, identify calibration parameters, and compare field data to model calibration results.

Following are discussions of the historical field conditions that were simulated during calibration; the goals of the calibration process; the model parameters (variables) that were adjusted during calibration; and the procedures and target data that were used to conduct the calibration process.

4.1 Calibration Conditions

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation.

4.1.1 Steady-State Calibration

The steady-state calibration was performed for calendar years 1980 through 1985. The purpose of the steady-state model was to simulate average regional flow patterns, regional hydraulic gradients, and groundwater budgets during the initial time period to be modeled as part of the transient calibration effort. The steady-state model also provided initial groundwater elevations for the beginning of the transient model.

During the 1980 through 1985 period:

a. The average precipitation (20.15 in/yr) was approximately 2.5 inches higher than the 1950 through 2000 mean (17.35 in/yr).

b. Alluvial Aquifer pumping decreased slightly (see Table 2-1).

c. Saugus pumping remained relatively constant, between 3,800 and 5,000 AF/yr (see Table 2-2).

d. Importation of SWP water increased steadily, from 1,125 acre-feet in 1980 to 11,823 acre-feet in 1985.

e. WRP discharges into the Santa Clara River increased from approximately 7,400 AF in 1980 to approximately 9,600 AF in 1985.

f. Groundwater elevations in the Alluvial Aquifer remained relatively stable, except for a slight decline in the eastern part of the valley during 1984 and 1985, due to below-normal rainfall during those years.

g. Groundwater elevations in the Saugus Formation remained relatively stable.

Hence, even though SWP imports and WRP discharges increased during this period, groundwater elevations did not rise, instead remaining fairly stable or decreasing slightly due to the relatively stable natural hydrologic conditions during this 6-year period and the below-normal rainfall in 1984 and 1985. Consequently, this time period was deemed suitable for the steady-state portion of the model calibration effort.

4.1.2 Transient Calibration

The transient calibration was performed for calendar years 1980 through 1999 to create a model capable of simulating seasonal and long-term variations in groundwater elevations, groundwater recharge, and groundwater discharge for a historical period characterized by variable rainfall and recharge and changing land use and water use patterns. This 20-year period was chosen for the following reasons:

a. The volume of data is greater during this period than in previous years. In particular, SCWC and VWC installed several production wells in the Saugus Formation during this time period. Also, regular monitoring of groundwater levels was performed at more wells during this period than before.

b. Annual pumping volumes are well known before and after the 1970s, but are not as well known during that decade. Hence, it would be more difficult to calibrate a model during the 1970s because of the uncertainties in pumping volumes during that time.

c. Significant urban growth occurred in the valley between 1980 and 1999. This growth resulted in changes in land use and increased importation of SWP water, from 1,125 acre-feet in 1980 to 27,302 acre-feet in 1999.

d. The local hydrology and the hydrology of the SWP system varied considerably during this period, and included single-year and multi-year droughts both locally and in the SWP system. (See Section 2.6.3.3.) Specifically, the groundwater elevations in the Alluvial Aquifer and the Saugus Formation showed multi-year periods of water level decline followed by multi-year periods of water level recovery. Consequently, calibrating to this period would allow a model to predict basin conditions during and between future drought periods.

4.2 Calibration Goals

The success of the model calibration was determined by its ability to satisfy specific calibration goals that were established by the CH2M HILL project team and the Purveyors. Separate calibration goals were defined for the steady-state model and the transient model. The specific goals are given below, along with a discussion of how calibration success was measured. Calibration goals are comprised of quantitative (statistical) and qualitative criteria.

4.2.1 Calibration Goals for the Steady-State Model

a. **Groundwater Flow Directions.** Correctly simulate groundwater flow directions in the Alluvial Aquifer and Saugus Formation, as defined by regional groundwater elevation contour maps prepared by RCS (1985, 1986, 2002) for various periods in both aquifer systems. (See Figures 2-7 and 2-8.)

b. **Groundwater Elevation Residuals.** At each target well, simulate groundwater elevations to within 10 feet in the Alluvial Aquifer and 25 feet in the Saugus Formation, compared with observed average groundwater elevations during this period. The value of the modeled groundwater elevation minus the observed average groundwater elevation is called the residual error (residual). A positive residual at a given target well indicates that the model simulates too high a groundwater elevation. Conversely, a negative residual indicates that the model simulates too low a groundwater elevation.

c. **Statistics of Groundwater Elevation Residuals.** Achieve the following statistics for the residuals on a modelwide scale (i.e., for the combined group of calibration target wells):

    1. A mean residual as close to zero as possible.
    2. A mean residual that is less than 5 percent of the range in groundwater elevations measured at the target wells.
    3. A root-mean-square (RMS) error of less than 10 feet for the residuals at Alluvial Aquifer target wells and less than 25 feet for the residuals at Saugus target wells.
    4. A normalized RMS error of 10 percent or less. The normalized RMS error equals the modelwide RMS error divided by the range in groundwater elevations across the entire model domain.
    5. A normalized residual standard deviation of less than 10 percent. The normalized residual standard deviation equals the standard deviation of the residuals divided by the range in groundwater elevations across the entire model domain.
    6. Minimize the degree of spatial bias in the distribution of the residuals. Specifically, avoid creating large areas where the residuals are predominantly positive or predominantly negative. A well-calibrated model shows a scattering of negative and positive residuals within any given localized area.

d. **Groundwater Gradients.** Simulate the direction and magnitude of groundwater gradients across the model domain, including a significant horizontal gradient in the Saugus Formation that exists across the San Gabriel Fault (as measured at four multi-port monitoring wells located on the Whittaker-Bermite property, east of wells SCWC-Saugus1 and SCWC-Saugus2).

e. **Groundwater Below Ground Surface.** At nodes where streams are not present, maintain groundwater elevations below ground surface. At stream nodes, groundwater elevations should also be below ground surface in most ephemeral reaches, though a limited number of nodes can have higher groundwater elevations in the downstream ephemeral reaches, where the exact location of the transition from ephemeral to perennial conditions is variable over time and is only approximately known.

f. **Groundwater Discharge to River.** Simulate a groundwater discharge to the Santa Clara River on the order of 29,000 AF/yr, which is the estimated average baseflow during the steady-state model period (see Section 2.6.2.5).

4.2.2 Calibration Goals for the Transient Model

a. **Water Level Trends/Hydrographs.** Match observed fluctuations in groundwater elevations.

b. **Groundwater Below Ground Surface.** Maintain groundwater elevations below ground surface in the same general areas as previously discussed for the steady-state model.

c. **Total River Flow at County Line Gage.** Match the observed Santa Clara River flows measured at the County Line gage.

d. **Groundwater Discharge to River.** Match the estimated groundwater discharge rates to the Santa Clara River.

Discussions of how these calibration goals are met by the Regional Model are contained in Section 4.4.

4.3 Calibration Variables

The following variables were the subject of model calibration and testing:

a. The horizontal hydraulic conductivity (Kh) and the vertical anisotropy (R), which is the ratio of horizontal to vertical hydraulic conductivity

b. The storage coefficients

c. The relationship between rainfall and stormwater runoff in the tributary watersheds lying upstream of the groundwater basin

d. The riverbed permeabilities in gaining and losing reaches of stream systems, particularly in the ephemeral reach of the Santa Clara River and in Castaic Creek

e. ET parameters (primarily rooting depth and the maximum potential ET rate)

4.3.1 Horizontal Hydraulic Conductivity and Vertical Anisotropy

Because the Regional Model consists of over 17,000 active nodes in each of the seven model layers, the calibration process relied on the definition of zones of uniform hydraulic conductivity (K), spanning multiple nodes in a given layer and, in some areas, spanning multiple layers. Specifically, in a given layer, a geographic area was defined as a zone, and the Kh and R values were assigned to all model cells in that zone.

The number of zones and their locations were assigned in the model by primarily considering the hydrostratigraphy and the locations of target wells in the various calibration models, then considering the spatial variations in saturated thickness as summarized by RCS (2002). During the course of the calibration process, adjustments were made to the locations of the zone boundaries and the number of zones. Figures 4-1 and 4-2 show the geographic area designations for the Alluvial Aquifer and Saugus Formation, respectively. In the final calibrated Regional Model, 48 zones were used in the Alluvial Aquifer and 8 zones were used in the Saugus Formation, including a zone along the San Gabriel fault.

The values of Kh for each zone in the Alluvial Aquifer were specified at the beginning of the calibration process from the analyses of specific capacity tests (Table 2-3). In the Saugus Formation, Kh and R values were initially defined from the ASR test analysis (CH2M HILL, 2001) and, in the case of Kh values, also from slug test results on the Whittaker-Bermite property (CH2M HILL, 2003). During calibration, attempts were made to keep these values as close to the initial assigned values as possible. However, adjustments were made if changes to other parameter values were unable to bring the model into calibration.

4.3.2 Storage Coefficients

Model layer 1 was assigned a specific yield of 0.10 to simulate this layer as unconfined. The specific yield was allowed to range between values as low as 0.075 and as high as 0.15. The final Regional Model used a value of 0.10 at each node in layer 1 for both the Alluvial Aquifer and the Saugus Formation (see Section 5).

In model layers 2 through 7, which simulate portions of the Saugus Formation lying below the uppermost model layer, the storage coefficients were allowed to range between 10^{-4} and 10^{-3}, based on analyses of the ASR test results (RCS, 2001) and pumping tests at other Saugus wells (RCS, 2002).

4.3.3 Stormwater Runoff in Upstream Watersheds

See Section 3.6 and Appendix C for discussions of the SWRM, which determined the amount of stormwater generated in upstream watersheds that is available to recharge the Alluvial Aquifer.

4.3.4 Riverbed Permeabilities

The establishment of streambed permeabilities for perennial (gaining) and ephemeral (losing) stream reaches are discussed separately below.

4.3.4.1 Perennial (Gaining) Streams

The streambed conductance terms in the MicroFEM® drain and wadi packages regulate the rate of water exchange between groundwater and surface water along selected stream reaches in the valley. As discussed in Section 3.5, the wadi package is used along the perennial reach of the Santa Clara River, and the drain package is used in the river's ephemeral reach and along Castaic Creek to drain groundwater during periods of high water table conditions. For the drain and wadi packages, the streambed conductance at each node where these packages are used is defined from the following relationship:

$$C = (a/LW) * ([0.5*b_{aq}/Kv_{aq}] + [b_{stream}/Kv_{stream}]) \quad (1)$$

where at each stream node:

a = wetted area of the streambed

L = one-half of the combined lengths of the two grid segments (lines) that connect the stream node to the adjoining upstream and downstream stream nodes

W = the width of the streambed

b_{aq} = the thickness of the Alluvial Aquifer beneath the stream node

Kv_{aq} = the vertical hydraulic conductivity of the Alluvial Aquifer beneath the stream node

b_{stream} = the thickness of the riverbed sediments

Kv_{stream} = the vertical hydraulic conductivity of the riverbed sediments

The calibrated Regional Model uses values of 2 feet for b_{aq} and 10 ft/day (3.5×10^{-3} centimeters per second [cm/sec]) for Kv_{aq}.

4.3.4.2 Ephemeral (Losing) Streams

During the transient calibration phase of model development, the SWRM adjusted the streambed conductance terms for Castaic Creek and for the ephemeral reach of the Santa Clara River. Adjustments in streambed conductance values were made for the following reasons:

a. To integrate this term into the transient model calibration process

b. To account for the variations in streambed conductance that arise from:

   1. Variations in riverbed permeability along the length of the streambed
   2. Variations in riverbed permeability that can occur at a given location due to sediment scouring and redeposition processes that occur during storm runoff periods
   3. Variations in streambed conductance that arise from variations in the width of the river (greatest during storm runoff periods, smallest during low-flow periods)

The adjustment of streambed conductance values during calibration of the transient model was performed for each month and was conducted in an iterative manner by running both the SWRM and the Regional Model repeatedly until the streambed conductance terms or groundwater elevations showed no significant changes (see Appendix C).

4.3.5 Evapotranspiration Parameters

The ET rooting depth was set at 10 feet to correspond to typical rooting depths for phreatophytes such as the willow and cottonwood trees that are present in the riparian corridor along the perennial reach of the Santa Clara River. The maximum potential ET rate was set at 6 feet per year (ft/yr) during model calibration. Ground surface elevation was specified by importing USGS Digital Elevation Model files.

4.4 Calibration Procedure and Target Calibration Data

The steady-state and transient models were calibrated by running the Regional Model and comparing results to the calibration goals described in Section 4.2. The comparison of model results with calibration goals relied on the use of target data that consisted of groundwater elevation data, groundwater discharge to the river, and total flow in the river. Following are discussions of the target calibration data.

4.4.1 Groundwater Elevation Target Data

Alluvial Aquifer target wells were selected for each of the Alluvial zones shown in Figure 4-1. In the Saugus Formation, most wells were used as targets (Figure 4-2). Generally, the selected target wells were those with the greatest number of groundwater elevation measurements during the periods 1980 through 1985 for the steady-state model and 1980 through 1999 for the transient model. Some wells were measured routinely through 1985 but not through 1999, and some wells were not measured until after 1985. Therefore, the list of wells used as targets is different for the steady-state and transient models.

Figure 4-1 shows the target wells for the Alluvial Aquifer, and Figure 4-2 shows the target wells for the Saugus Formation. Table 4-1 provides location and construction information for each target well. The target wells include (1) purveyor-owned production wells; (2) production wells located at the Wayside Honor Rancho (WHR) facility; and (3) a network of non-pumping or low-pumping monitoring wells where water levels have been measured routinely by the Los Angeles County Flood Control District (LACFCD) for many years.

For the production wells, the available water level measurements have been recorded as pumping elevations and static elevations. Static elevations are collected when the well is not pumping. Model-simulated groundwater elevations at a pumping well will be higher than those measured under pumping conditions for the following reasons:

a. In the model, pumping is assigned at these wells, but the pumping nodes have much larger areas than the diameter of the borehole in which each well is completed.

b. The field measurements of groundwater elevations under pumping conditions measure lower groundwater elevations than exist in the aquifer adjacent to the borehole, due to well losses across the borehole wall and the screen or slotted pipe.

Therefore, for model calibration purposes, the calibration goal at target wells that pump was to simulate groundwater elevations as close to the static elevations as possible, while also ensuring that simulated elevations were higher than the pumping elevations. More importantly, the transient calibration effort focused on the periods with the greatest groundwater elevation changes, and the analysis specifically focused on the slopes of the hydrographs, not just the absolute magnitudes of the groundwater elevations.

In the tributary canyons east of I-5, geologic logs were unavailable for many of the LACFCD wells. The total depths and open intervals for many of these wells suggested that they were completed in the geologic units underlying the alluvium, probably due to limited saturated thickness in the alluvium, particularly in the upper reaches of each canyon. For this reason, no targets were selected in Mint Canyon or upstream of the SCWC-Clark production well in Bouquet Canyon. In Sand Canyon, only the well farthest downstream, 7188A, was deemed suitable for use as an Alluvial Aquifer target well. Along the South Fork Santa Clara River, geologic logs and well construction data indicate that all target wells are constructed in the Saugus Formation, not the alluvium. The geologic data indicate that there is very limited saturated thickness in the alluvium in this area.

4.4.2 Santa Clara River Baseflow and Total Flow

Target river flow data to which the Regional Model results were compared were the total gaged flow at the County Line gage and estimates of how much of the gaged flow consisted of groundwater discharge to the river (baseflow).

The simulated total flow at the County Line gage equaled the sum of:

a. The simulated groundwater discharge to the river as calculated by the groundwater model from all wadi and drain nodes

b. The volume of water in the streams that the Visual Basic program (described in Section 3.6 and Appendix C) calculated as surplus stream flow that would not infiltrate to the underlying Alluvial Aquifer

This simulated total flow was compared directly with County Line gage results. The simulated groundwater discharge to the river was compared with the estimated values of river baseflow described previously in Section 2.6.2.5 of this report and listed in Table 2-6. For the steady-state model, the average baseflow during the period 1980 through 1985 was approximately 29,000 AF/yr.

4.4.3 Adjustments to Model Parameters

The steady-state and transient calibration process involved the adjustment of multiple parameters. Initially, the calibration effort focused on the steady-state model, where adjustments were made to Kh and Kv values and streambed coefficients, particularly in the gaining reaches of streams, to establish groundwater elevations, gradients, and flow directions. Attention was then devoted to the transient model, where the parameters receiving adjustment were the storativity, Sy, and the stormwater infiltration rates. Adjustments to Kh and Kv values that had been established during steady-state calibration were considered during transient calibration, but adjustments to these parameters were found to be unnecessary.

Initially, these efforts to calibrate the steady-state and transient models used a fixed, specified relationship between precipitation and stormwater to define the amount of water available for potential infiltration to groundwater. As Appendix C discusses, this relationship was in the form of an empirical power-function equation developed by Turner (1986). The empirical equation uses power-function coefficients that Turner (1986) developed from measurements of the yields from 68 different watersheds throughout California. Although the equation was used throughout the calibration process, including in the final model, the steady-state and transient calibration processes indicated that the empirical power-function coefficients reported by Turner (1986) generated too much stormwater and groundwater recharge to the Santa Clarita Valley during dry years and too little stormwater and groundwater recharge during wet years. This was determined by comparing hydrographs of measured and modeled groundwater elevations and river flows. After many attempts to achieve calibration by adjusting other model parameters, it was concluded that a different set of power coefficients would need to be developed for the Santa Clarita Valley. Consequently, during the final stages of calibration, adjustments to the model focused primarily on the values of these coefficients and on the values of the streambed vertical hydraulic conductivity. Calibration was considered complete once it was determined that the calibration goals were achieved or that no further improvements to the model were possible.

Tables

TABLE 4-1
Target Wells for Calibration of the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Well Name	Location	Model Zone	Well in Steady-State Model	Well in Transient Model	Year Drilled	Status 1986	Status 2001	Well Use	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Total Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval	Drilling Method	Sanitary Seal Depth (feet bgs)	Depth of Pump Intake (feet bgs)
Alluvial Aquifer West of I-5																		
NLF-B11	Santa Clara River	C1c	No	Yes	---	Active	Active	Agricultural supply	6362161	1971971	886							
NLF-B10	Santa Clara River	C1c	Yes	No	1956	Active	Active	Agricultural supply	6364235	1974541	901.4	142	30	130	Knife cut			
NLF-B7	Santa Clara River	C1c	No	Yes	1946	Active	Active	Agricultural supply	6364397	1973939	901.6	102	18	88	Knife cut			
NLF-C5	Santa Clara River	C1b	Yes	No	1939	Active	Active	Agricultural supply	6371746	1977874	960.1	139	31	133	Knife cut			
NLF-C6	Santa Clara River	C1b	No	Yes	1939	Active	Active	Agricultural supply	6371835	1978154	966	103	26	93	Knife cut			
NLF-E4	Santa Clara River	C1a	Yes	Yes	1940	Active	Active	Agricultural supply	6374844	1982371	992.5	142	50	136	Knife cut			
6995D	Santa Clara River	C1a	Yes	No	1970	Active	Active	Water levels	6379091	1983329	1018						0	
NLF-G45	Santa Clara River	B1b1	No	Yes	---	Active	Active	Agricultural supply	6381356	1982222	1030	140	40	140				
7076C	Santa Clara River	B1b1	Yes	No	---	Active	Destroyed?	Water levels	6385042	1980084	1059						0	
Alluvial Aquifer between I-5 and Soledad Canyon																		
VWC-I	Santa Clara River	B1b2	No	Yes	1945	Active	Inactive	Municipal supply	6388567	1981657	1090	171	30	165			55	120
NLF-S3	Santa Clara River	B1a	No	Yes	---	Active	Destroyed	Agricultural supply	6393334	1978292	1129	250	95	205				
VWC-N	Santa Clara River	B1a	No	Yes	1936	Active	Active	Municipal supply	6395527	1976081	1130	280	76	237	Knife cut		50	140
VWC-K2	Santa Clara River	B1a	Yes	No	1945	Active	Active	Municipal supply	6395788	1976021	1132	242	62	230	Knife cut		50	63
NLF-R	Santa Clara River	B1a	Yes	No	---	Active	Destroyed	Agricultural supply	6397463	1977860	1157	160	40	140				
7067D	Santa Clara River	B1a	No	Yes	1964	Active	Destroyed?	Water levels	6398546	1977483	1157.5						0	
VWC-Q2	Santa Clara River	B1a	No	Yes	1954	Active	Active	Municipal supply	6399032	1977459	1158	170	76	126				100
Alluvial Aquifer in Soledad Canyon																		
SCWC-Stadium	Santa Clara River	A1e1	Yes	Yes	1946	Active	Active	Municipal supply	6402385	1974713	1197	130	33	130	Knife cut	Unknown		130
VWC-T4	Santa Clara River	A1e1	Yes	No	1953	Active	Active	Municipal supply	6403350	1975164	1191	150	50	135	Knife cut		50	100
VWC-T2	Santa Clara River	A1e1	No	Yes	1952	Active	Active	Municipal supply	6403623	1975127	1201	150	50	138	Knife cut			100
LACFCD-7107C	Santa Clara River	A1d1	Yes	No	---	Active	Destroyed?	Water levels	6410792	1975622	1276						0	
SCWC-Honby	Santa Clara River	A1d1	No	Yes	1959	Active	Active	Municipal supply	6411408	1977202	1282	226	50	202	Factory	Rotary	30	130
7127D	Santa Clara River	A1d2	Yes	Yes	1974	Active	Active	Water levels	6417808	1977062	1333	157					0	
SCWC-N.Oaks West	Santa Clara River	A1d4	Yes	No	1940	Active	Active	Municipal supply	6421187	1972857	1392	136	80	118	Knife cut	Unknown		110
SCWC-N.Oaks East	Santa Clara River	A1d4	No	Yes	1940	Active	Active	Municipal supply	6421651	1972936	1398	132	81	150	Knife cut	Unknown		130
7148K	Santa Clara River	A1c1	No	Yes	---	Active	Active	Water levels	6423523	1973851	1435						0	
7158K	Santa Clara River	A1c2	Yes	No	1965 or earlier	Active	Active	Water levels	6427699	1973490	1460						0	
7168C	Santa Clara River	A1c2	Yes	Yes	---	Active	Active	Water levels	6430088	1974149	1488						0	
SCWC-Mitchell	Santa Clara River	A1c2	No	Yes	1976	Active	Active	Municipal supply	6430168	1974420	1489	262	76	246	125 Mesh	Rotary	76	162
SCWC-Sand Canyon	Santa Clara River	A1c3	Yes	No	1973	Active	Active	Municipal supply	6432953	1975589	1523	127	60	140	Factory	Rotary	60	112
7178D	Santa Clara River	A1c3	Yes	No	1950 or earlier	Active	Active	Water levels	6433648	1975837	1528						0	
SCWC-Lost Canyon 2	Santa Clara River	A1c3	No	Yes	1965	Active	Active	Municipal supply	6433582	1975573	1530	310	95	125	Factory	Rotary	30	295
7177B	Santa Clara River	A1b1	No	Yes	1949 or earlier	Active	Active	Water levels	6434745	1976476	1542						0	
7177P	Santa Clara River	A1b1	Yes	No	---	Active	Active	Water levels	6434036	1976556	1542						0	
7187C	Santa Clara River	A1b2	Yes	No	---	Active	Active	Water levels	6435847	1977582	1548						0	
7197	Santa Clara River	A1b2	Yes	Yes	1945 or earlier	Active	Destroyed?	Water levels	6437790	1977821	1579						0	
7197D	Santa Clara River	A1b2	No	Yes	---	Active	Active	Water levels	6438053	1977798	1582						0	
NCWD-Pinetree1	Santa Clara River	A1b2	No	Yes	1966	Active	Active	Municipal supply	6439881	1977964	1588	235	50	210			20	160
7197G	Santa Clara River	A1b2	Yes	No	1974 or earlier	Active	Active	Water levels	6440544	1978061	1600						0	
Alluvial Aquifer along Castaic Creek																		
VWC-D	Castaic Creek	C2b	No	Yes	1950	Active	Active	Municipal supply	6375668	1987267	1036	142	60	136	Knife cut		50	100
6993A	Castaic Creek	C2b	Yes	Yes	1958 or earlier	Active	Active	Water levels	6377865	1992457	1067						0	
6981D	Castaic Creek	C2a	Yes	Yes	1972 or earlier	Active	Active	Water levels	6376437	2000534	1127						0	
NCWD-Castaic3	Castaic Creek	C2a	No	Yes	1961	Active	Active	Municipal supply	6376475	2002309	1141	135	55	136				100
6980E	Castaic Creek	C2a	No	Yes	1962 or earlier	Active	Active	Water levels	6376282	2002242	1144						0	
6980G	Castaic Creek	C2a	Yes	No	1962 or earlier	Active	Destroyed?	Water levels	6376020	2002731	1151						0	

TABLE 4-1
Target Wells for Calibration of the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Well Name	Location	Model Zone	Well in Steady-State Model	Well in Transient Model	Year Drilled	Status 1986	Status 2001	Well Use	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Total Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval	Drilling Method	Sanitary Seal Depth (feet bgs)	Depth of Pump Intake (feet bgs)
Alluvial Aquifer in Other Tributary Canyons to the Santa Clara River																		
VWC-W6	San Francisquito Canyon	B4c	Yes	Yes	1952	Active	Active	Municipal supply	6393801	1985449	1159	158	90	153	Knife cut		50	100
7066D	Bouquet Canyon	B2c	Yes	Yes	---	Active	Active	Water levels	6400238	1979734	1182						0	
7086B	Bouquet Canyon	B2c	Yes	No	---	Active	Active	Water levels	6405151	1981611	1247						0	
SCWC-Clark	Bouquet Canyon	B2c	No	Yes	1946	Active	Active	Municipal supply	6405894	1983061	1257	160	20	120	Knife cut	Unknown		110
7095	Bouquet Canyon	B2b	Yes	No	1930 or earlier	Active	Active	Water levels	6409922	1986103	1323	146					0	
7188A	Sand Canyon	A3b	No	Yes	1952	Active	Active	Water levels	6434878	1972313	1588						0	
Saugus Formation																		
VWC-160	Santa Clara River	E	Yes	Yes	1964	Active	Active	Municipal supply	6388950	1976191	1101	2000	950	2000	Louvers	Rotary	65	260
7048C	Santa Clara River	E	Yes	Yes	1981	Active	Destroyed?	Water levels	6395222	1974491	1147						0	
VWC-157	S. Fork Santa Clara River	E	Yes	Yes	1962	Active	Active	Municipal supply	6395696	1974099	1151	2008	586	2008	Vertical slots	Rotary	15	340
VWC-201	S. Fork Santa Clara River	E	No	Yes	1989	Not Built	Active	Municipal supply	6394125	1973032	1152	1690	540	1670	Louvers	Mud rotary	460	360
SCWC-Saugus1	S. Fork Santa Clara River	E	No	Yes	1988	Not Built	Inactive	Municipal supply	6397847	1973452	1162	1640	490	1620	Wire wrap screen	Reverse	450	500
SCWC-Saugus2	S. Fork Santa Clara River	E	No	Yes	1988	Not Built	Inactive	Municipal supply	6398514	1972540	1158	1612	490	1591	Wire wrap screen	Reverse	460	500
NCWD-11	S. Fork Santa Clara River	F	Yes	Yes	1973	Active	Active	Municipal supply	6399004	1968019	1187	1136	200	1075	Louvers	Reverse rotary	150	340
NCWD-13	S. Fork Santa Clara River	F	No	Yes	1990	Not Built	Active	Municipal supply	6399098	1967327	1194	1300	420	750			50	445
NCWD-12	S. Fork Santa Clara River	F	Yes	Yes	1985	Inactive	Active	Municipal supply	6399282	1965920	1206	1340	485	1280	Louvers	Reverse rotary	420	400
NCWD-10	S. Fork Santa Clara River	F	Yes	Yes	1961	Active	Inactive	Municipal supply	6399388	1965803	1207	1555	780	1544	Louvers	Rotary	114	335
5851	S. Fork Santa Clara River	F	Yes	Yes	1968	Active	Active	Water levels	6396468	1962533	1233						0	
5851A	S. Fork Santa Clara River	F	Yes	No	1968	Active	Active	Water levels	6396432	1962504	1233						0	
5842F	S. Fork Santa Clara River	A	Yes	No	1974	Active	Active	Water levels	6395286	1960869	1248						0	
NCWD7	S. Fork Santa Clara River	F	Yes	Yes	1954	Active	Inactive	Municipal supply	6401264	1962732	1251	994	520	974	Knife cut	Cable tool		306
5841	S. Fork Santa Clara River	F	Yes	No	1973	Active	Active	Water levels	6393394	1963704	1256						0	
5871D	S. Fork Santa Clara River	F	Yes	No	1948 or earlier	Active	Active	Water levels	6402392	1962734	1262						0	
7053C	San Francisquito Canyon	D	Yes	No	---	Active	Destroyed?	Water levels	6397679	1992663	1291						0	
5882	S. Fork Santa Clara River	A	Yes	No	1931 or earlier	Active	Active	Water levels	6406409	1957586	1327						0	
5873E	S. Fork Santa Clara River	A	Yes	No	1957	Active	Active	Water levels	6403977	1957147	1353						0	
NCWD-9	S. Fork Santa Clara River	A	Yes	Yes	1958	Active	Inactive	Municipal supply	6404122	1956997	1354	675	311	674	Louvers	Rotary	75	230
5831	S. Fork Santa Clara River	A	Yes	No	1962	Active	Active	Water levels	6391103	1961398	1381						0	
7053D	San Francisquito Canyon	D	Yes	No	---	Active	Active	Water levels	6398984	1990433	1402						0	
5912A	S. Fork Santa Clara River	A	Yes	No	1948 or earlier	Active	Active	Water levels	6414810	1960110	1445						0	
7043C	San Francisquito Canyon	D	Yes	No	---	Active	Active	Water levels	6392762	1994816	1528						0	

[a] Coordinates are listed in California State Plane, NAD83 Datum, Zone V.

Notes:

Wells without owner designations belong to the Los Angeles County Flood Control District (LACFCD).

-- = No data available.

N. = nouth.

S. = south.

Figures

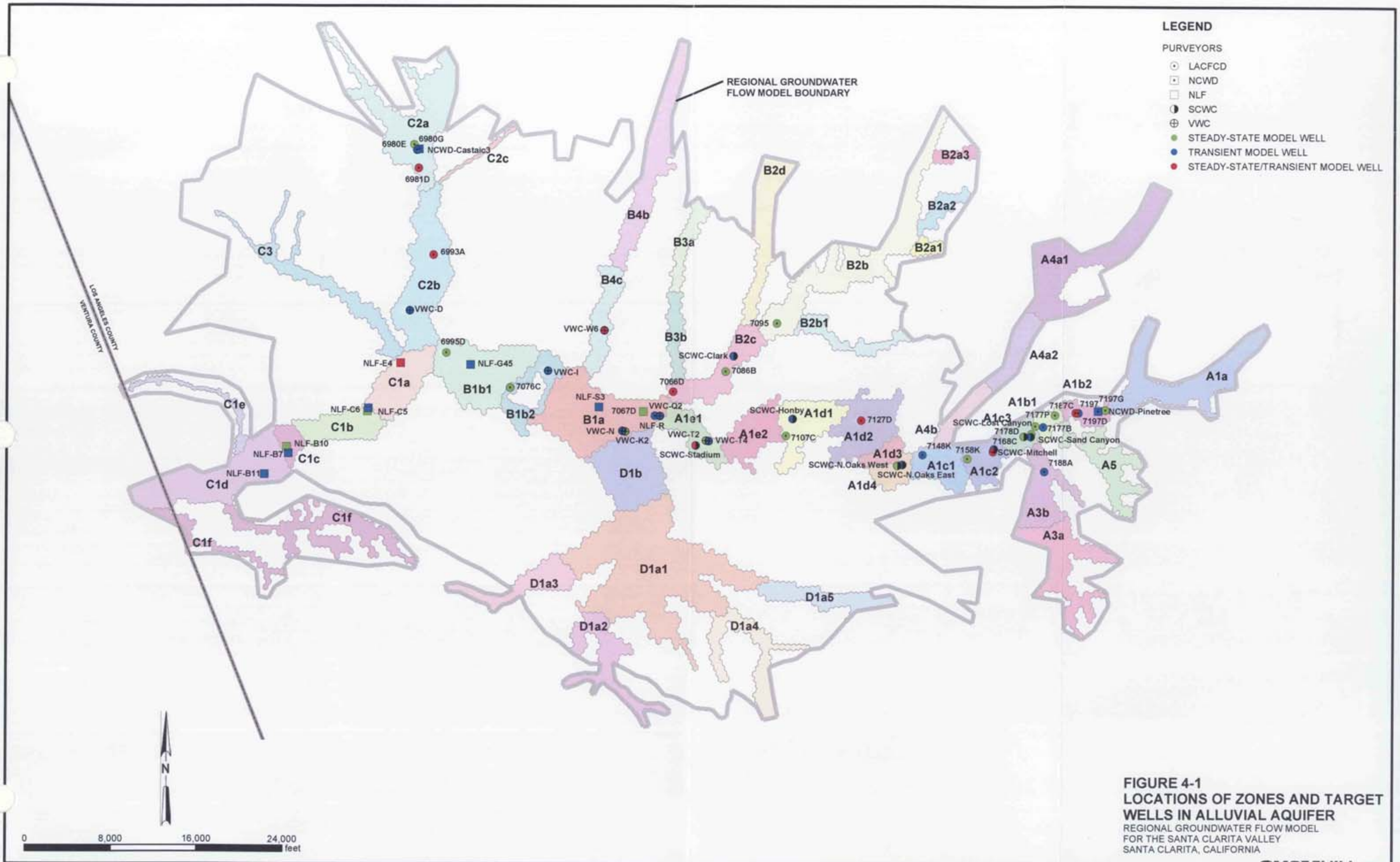


FIGURE 4-1
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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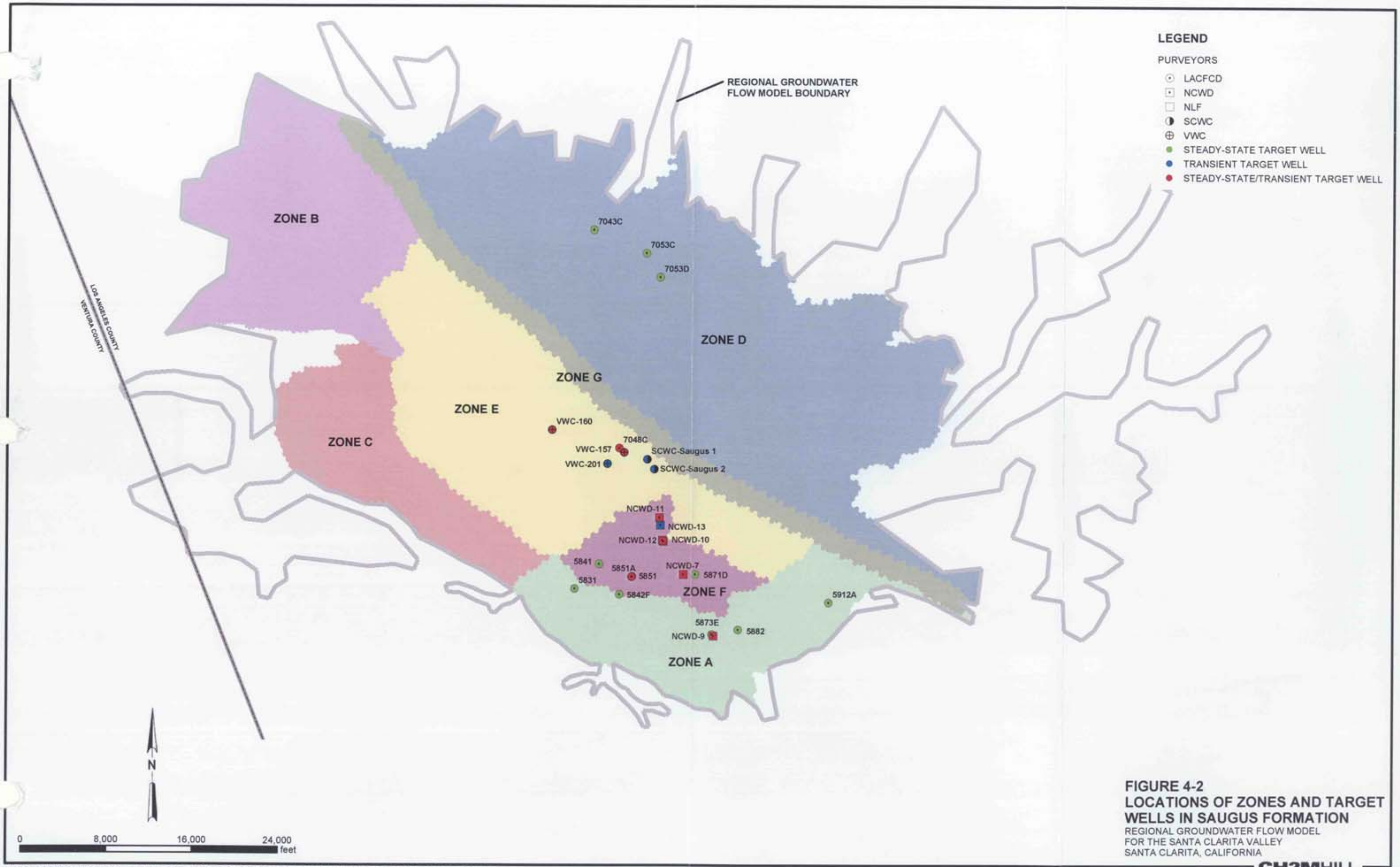

FIGURE 4-2
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG04-02.MXD FIG04-02.PDF 01/22/2004 15:06:57

SECTION 5

Calibration Results and Sensitivity Analysis

This section of the report presents the calibrated Regional Model and a sensitivity analysis of the Regional Model. Sections 5.1 and 5.2 discuss the calibration quality of the steady-state and transient models (respectively) with reference to the calibration goals discussed in Section 4.2. Section 5.3 discusses the groundwater budgets for both models. Section 5.4 describes a sensitivity analysis that further evaluated calibration quality by comparing the sensitivity of the model-predicted groundwater elevations and river flows to the values of key model parameters.

The distribution of Kh in the calibrated model is presented on Figures 5-1 through 5-7 for model layers 1 through 7, respectively. Table 5-1 summarizes the values of transmissivity, thickness, and hydraulic conductivity in the 48 alluvial zones. Table 5-2 summarizes values of the other calibrated hydraulic properties that are used in the model.

5.1 Calibration Results for the Steady-State Model

Following are discussions of how the calibrated model compares with the six calibration goals established for the 1980 through 1985 steady-state model.

5.1.1 Groundwater Flow Directions – Calibration Goal 1

Figure 5-8 shows simulated groundwater elevations and flow directions in the Alluvial Aquifer as computed by the steady-state model. The groundwater flow directions are from east to west along the Santa Clara River, which is in agreement with published contour maps for the Alluvial Aquifer (see Figure 2-7). The contours show a very flat hydraulic gradient in the lower reach of the valley containing the South Fork Santa Clara River, which also agrees with published interpretations.

Figures 5-9 through 5-14 show groundwater elevation contour maps for layers 2 through 7 of the Regional Model, which represent the Saugus Formation. Layer 3 (Figure 5-10) is situated from 500 feet bgs to 1,000 bgs and is partially or fully screened by several of the Saugus production wells that are situated in the valley containing the South Fork Santa Clara River. In this area, the model-simulated flow directions in layer 3 are in good general agreement with published interpretations (see Figure 2-8).

5.1.2 Groundwater Elevation Residuals – Calibration Goal 2

Figure 5-15 is a scatter plot comparing simulated and observed average groundwater elevations for target wells in both the Alluvial Aquifer and the Saugus Formation. For a perfect simulation, each point shown on the figure would lie on the diagonal line. The figure shows that the Alluvial Aquifer target wells lie very close to the diagonal line, indicating a very good calibration to the observed average groundwater elevations from 1980 through 1985. For the Saugus Formation, there is greater variability. Some Saugus wells plot very close to the diagonal line, while one well (5882) lies 80 feet above the line and another well

(5831) lies 80 feet below the line. These two particular wells are near the southern model boundary, where the available water level data indicate that the groundwater gradients in the Saugus are very steep compared to areas closer to the Saugus production wells. Nonetheless, the Saugus wells are generally close to the diagonal line and do not plot consistently above or consistently below the line, indicating that the Saugus Formation is closely calibrated in the steady-state model.

Table 5-3 lists the residuals for Alluvial and Saugus wells. The residuals are also plotted on Figures 5-16 through 5-19. Positive residuals indicate that the Regional Model over-predicts the groundwater elevation, and negative residuals indicate that it under-predicts the groundwater elevation. Observations regarding the residuals are as follows:

a. Figure 5-16 shows the magnitudes of the groundwater elevation residuals for the 21 target wells in the Alluvial Aquifer that lie along the Santa Clara River. The plot shows the target wells in order from the downstream end of the valley (left side) to the upstream limit of the valley (right side). The plot shows that 13 of the 21 wells have residuals in the range of –5 to +5 feet, and that only one well (7158K) does not meet the 10-foot residual criterion for Goal 2. The plot also shows little, if any, spatial bias in the direction of the residuals; specifically, long reaches of the river do not show consistently positive or consistently negative residuals. Consequently, the groundwater elevations are very well calibrated along the Santa Clara River.

b. Figure 5-17 shows an equivalent plot for Alluvial Aquifer wells located in three of the tributary canyons. In these areas, where gradients are steep, the modeled groundwater elevations are generally within 10 to 11 feet of the average measured elevations. The plot indicates a tendency to slightly under-predict groundwater elevations, particularly in the upper-most reach of Bouquet Canyon, but the residuals generally meet the criterion for Goal 2.

c. Figures 5-18 and 5-19 show similar residual plots for production wells and for LACFCD monitoring wells, respectively, in the Saugus Formation. Three of the seven production wells meet the 25-foot residual criterion for Goal 2, and three of the monitoring wells meet this criterion. Both plots indicate a tendency to under-predict static groundwater elevations, particularly in four wells that are near the outer limits of the Saugus Formation (wells NCWD-9, 5831, 7043C, and 7053D). However, the water levels in these four wells appear to be anomalously high, compared with the water levels in surrounding wells. Consequently, the water level data indicate that these wells (particularly the three LACFCD wells) are constructed in perched Saugus zones lying above the regional Saugus aquifer system, and the negative residuals at these wells correspond to the anomalously high groundwater elevations. Excluding these four wells, three of the six production wells and five of the ten LACFCD monitoring wells meet the Goal 2 criterion, indicating that the steady-state calibration of the Saugus Formation is adequate, particularly because the focus of the model calibration effort is transient calibration, which is discussed in Section 5.2.

5.1.3 Statistics of Groundwater Elevation Residuals – Calibration Goal 3

Table 5-4 lists the residual statistics for target wells in both aquifer systems. The table shows statistics for the same wells listed in Table 5-3 and shown on Figures 5-16 through 5-19, except for Saugus wells 5831, 7043C, and 7053D. Table 5-4 shows that the residual statistics for the Alluvial Aquifer generally meet the criteria specified in Goal 3. For the Saugus Formation, the statistics meet the mean residual criterion, but the statistics for the square of the residuals are slightly above the criteria of (1) less than 25 feet for RMS error or (2) 10 percent or less for normalized RMS error. The Regional Model as a whole, however, with the Alluvial Aquifer and Saugus Formation combined, meets all Goal 3 criteria.

5.1.4 Groundwater Gradients – Calibration Goal 4

In the Alluvial Aquifer, the results for the first three calibration goals indicate that the steady-state model simulates groundwater gradients quite well, and therefore meets Goal 4.

For the Saugus Formation, the residuals for the NCWD wellfield in the South Fork Santa Clara River are consistently negative. However, the residual at the upgradient end of the wellfield at NCWD-7[5] is similar in magnitude to the average residual at the downgradient end of the wellfield at NCWD-10 and NCWD-11. Consequently, the gradients in this area are simulated reasonably well. Simulated gradients from the NCWD wellfield to the downgradient well VWC-160 are slightly low, as suggested by the more negative residuals in the NCWD wellfield and the less negative residual at VWC-160.

Additionally, recent water level data from the Whittaker-Bermite property indicate that the gradients are well simulated within the Saugus Formation in that area, which lies east and northeast of NCWD's wellfield. Table 5-5 shows the calculations of the model-simulated and measured groundwater gradients between wells MP-1 and MP-2, which are both on the downthrown side of the San Gabriel fault, and between MP-2 and MP-3, which are located on the downthrown side and upthrown side of the fault, respectively. These calculations are based on three rounds of manual water level measurements that were taken from January through October in 2003. Between wells MP-1 and MP-2, the gradients are almost perfectly matched. However, across the San Gabriel fault, the modeled gradient is approximately half as large as the measured gradient because the simulated groundwater elevation is low at MP-3.

Several attempts were made during model calibration to reduce the Saugus permeability to very low levels across the fault, but no further increases in MP-3 water levels could be obtained. The calibrated Regional Model uses a permeability along the fault that is between 100 and 1,000 times lower than the permeability of adjoining Saugus areas. Although the Regional Model was unable to simulate as high a groundwater elevation as has been measured recently at MP-3, it does simulate a substantial drop in groundwater elevations across the San Gabriel fault, which is consistent with the understanding of the limited hydraulic connection across the fault (see Section 2.4.2 and Figure 2-9). Therefore, the Regional Model is well calibrated across the fault because it simulates the permeability differences that exist on each side of the fault and also simulates the very limited movement of groundwater across the fault that is indicated by the significant difference in groundwater elevations that has been measured in the multi-port wells on each side of the fault.

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[5] Well NCWD-9 is located farther upgradient, but has been used only sparingly since 1987.

5.1.5 Groundwater Below Ground Surface – Calibration Goal 5

Groundwater elevations simulated by the steady-state model are below ground surface at all non-stream nodes and in each tributary stream. Along the Santa Clara River, a small number of nodes showed groundwater elevations above the streambed in the western portion of Soledad Canyon, and also at and immediately upstream of Round Mountain, a Saugus outcrop that likely lies at shallow depths beneath the river itself. The reach of the river west of I-5 was calculated to be predominantly gaining (groundwater above ground surface). However, the Regional Model predicts that the river is losing over a reach extending between approximately 0.75 mile upstream to 0.5 mile downstream of the location where the river crosses over the western limit of the Saugus Formation. In this area, the riverbed has a gentler slope than in adjoining areas, and the riverbed does not lie beneath the water table in this particular reach.

5.1.6 Groundwater Discharge to River – Calibration Goal 6

The model-simulated groundwater discharge to the river was 28,600 AF/yr, which closely agrees with the 29,000 AF/yr value estimated from the hydrograph separation process described in Section 2.6.2.5.

5.2 Calibration Results for the Transient Model

Following are discussions of how the calibrated Regional Model compares with the four calibration goals established for the 1980 through 1999 transient model.

5.2.1 Groundwater Elevation Trends/Hydrographs – Calibration Goal 1

Trends in groundwater elevations are discussed for the following areas:

a. The Alluvial Aquifer along the Santa Clara River, west of I-5, as shown on Figure 5-20

b. The Alluvial Aquifer along the Santa Clara River, between I-5 and Soledad Canyon, as shown on Figure 5-21

c. The Alluvial Aquifer along the Santa Clara River in Soledad Canyon, as shown on Figure 5-22

d. The Alluvial Aquifer along Castaic Creek, as shown on Figure 5-23

e. The Alluvial Aquifer in other tributary canyons to the Santa Clara River, as shown on Figure 5-24

f. The Saugus Formation, where targets are located along the South Fork Santa Clara River, as shown on Figure 5-25

As discussed in Section 4.4.1, the calibration goal at target production wells was to simulate groundwater elevations that were higher than the pumping elevations and as close as possible to the static elevations. Therefore, the hydrographs show the model-simulated groundwater elevations, the measured static groundwater elevations, and, for production wells, the measured pumping groundwater elevations.

5.2.1.1 Alluvial Aquifer West of I-5

Modeled and measured groundwater elevations both show long-term stability, with no significant increases or decreases during the 1980 through 1999 transient calibration period. The Regional Model simulates somewhat greater seasonal variation in groundwater elevations than is suggested by the field measurements. However, the field measurements were collected infrequently. In general, the Regional Model is well calibrated in this area because of the close match between simulated and measured groundwater elevations and because it simulates the long-term stability of groundwater elevations in this area.

5.2.1.2 Alluvial Aquifer Between I-5 and Soledad Canyon

North of the Santa Clara River, near the mouth of San Francisquito Canyon, the Regional Model simulates the observed trends in static groundwater elevations at wells NLF-S3 and VWC-I during the period that data are available. The groundwater elevation trends are particularly well simulated at VWC-I starting in mid-1996, when the water level measurement frequency increased at this well.

Just upstream and along the south side of the river, the Regional Model simulates the trends in static water levels at well VWC-N very closely throughout the 20-year simulation period. The Regional Model also simulates the trends in static water levels quite well at well VWC-Q2, near the mouth of Soledad Canyon. In this same area, monitoring well 7067D simulates groundwater elevations that are somewhat lower than measured elevations, and the 40-foot fluctuation in simulated water levels at this well is of a generally similar magnitude as the observed fluctuation of 50 feet.

5.2.1.3 Alluvial Aquifer In Soledad Canyon

At wells throughout Soledad Canyon, the Regional Model closely simulates the regional decline in groundwater elevations during the late 1980s and early 1990s. The simulated and measured declines are especially close for wells in the eastern portion of this area, such as SCWC-North Oaks, SCWC-Mitchell, SCWC-Lost Canyon 2, and NCWD-Pinetree1.

Although the sharp increases in groundwater elevations in 1992 and 1993 are modeled well, these same wells (in the eastern half of Soledad Canyon) are unable to maintain high enough groundwater elevations during short dry periods that occur intermittently from 1993 through 1999. During this period, wells further to the west, such as SCWC-Stadium, VWC-T2, SCWC-Honby, and 7127D show better matches between modeled and measured groundwater elevations. Many model runs were performed to try to maintain higher water levels in eastern Soledad Canyon, but no substantial improvements could be made, suggesting that the lack of stream gage data at the Lang gage during this period may be responsible for the discrepancies.

A visual inspection of the former Lang gage station was conducted on July 17, 2003 during the model calibration process. The equipment that records the depth of water in the river was observed to be approximately 3 to 4 feet above the bed of the river at the time of the inspection. Although high river flows are known to have occurred since the time the gage was abandoned, it is unlikely that the bed elevation would have been lowered 3 or 4 feet by the net sediment scouring and redeposition processes that occur during high river flows. This observation means there likely was more flow occurring in the river prior to October

1989 than was recorded by this gage. This in turn means that measured and estimated flows during the period 1980 through 1999 are likely too low in the Regional Model, which would explain the model's simulation of too rapid a decline in water levels after high river flows recharge the aquifer. In summary, the design of the gage and the absence of data after October 1989 are the likely reasons that the Regional Model has difficulty maintaining sufficiently high groundwater elevations during dry periods in the eastern portion of the Alluvial Aquifer.

5.2.1.4 Alluvial Aquifer Along Castaic Creek

In the upper reaches of the Castaic Creek valley, the Regional Model simulates the measured groundwater elevation trends very well during the drought at wells NCWD-Castaic3, 6980E, and 6980G, though this evaluation is somewhat uncertain during the early 1980s due to infrequent data collection. However, these same wells show too much recovery during the initial post-drought recovery period in 1992, and they also show a small rise in groundwater elevations from 1993 through 1999 that is not indicated by the field measurements.

Farther downstream, the Regional Model closely matches the measured groundwater elevation trends at well 6993A well until the last few years of the drought, when groundwater elevations do not drop sufficiently. Well VWC-D (farther downstream) is modeled even better, but also shows a bit too much fluctuation during the mid- and late 1990s.

5.2.1.5 Alluvial Aquifer in Other Tributary Canyons to the Santa Clara River

At production well VWC-W6 in the lower reaches of San Francisquito Canyon, the Regional Model appears to simulate the measured groundwater elevations well, except for a possibly insufficient decline in early 1992 at the conclusion of the regional drought.

In Bouquet Canyon, the Regional Model closely simulates the measured groundwater elevation changes at the SCWC-Clark production well, although the groundwater elevations are a bit high throughout the simulation. The groundwater elevation trends are also well simulated farther downstream at monitoring well 7066D, though the groundwater elevations are somewhat under-predicted throughout the simulation.

In Sand Canyon, the simulation at monitoring well 7188A is good, although there is some uncertainty at the end of the drought due to the lack of data collection during 1990 and 1991.

5.2.1.6 Saugus Formation

In general, the Regional Model simulates the trends in groundwater elevations quite well at each Saugus production and monitoring well. Simulated and measured static groundwater elevations agree particularly well in the NCWD wellfield at the observation well (5851) and each NCWD production well.

Farther downgradient, the model tends to slightly over-predict groundwater elevations in the VWC and SCWC production wells (VWC-157, VWC-201, SCWC-Saugus1, and SCWC-Saugus2) and slightly under-predict groundwater elevations in the lone monitoring well (7048-C). However, the Regional Model closely simulates the groundwater elevation trends at each of these locations, which is the primary consideration for evaluating the quality of the transient calibration process in the Saugus Formation.

5.2.2 Groundwater Below Ground Surface – Calibration Goal 2

This goal was met at each target in the transient model. Of the 44 transient model target wells, 11 had simulated groundwater elevations within 5 feet of ground surface during the wettest periods of the model simulation. Three of these wells were located in the Castaic Valley (6980E, 6981D, and NCWD-Castaic3), one was in lower Sand Canyon (7188A), one was in Bouquet Canyon (SCWC-Clark), and six were in Soledad Canyon (VWC-T2, 7127D, SCWC-Mitchell, SCWC-Lost Canyon 2, 7177B, and NCWD-Pinetree1).

5.2.3 Total River Flow at County Line Gage – Calibration Goal 3

Figure 5-26 compares the modeled and measured total flows of the Santa Clara River at the County Line gage. The figure contains both a linear plot and a semi-logarithmic plot to better illustrate how the modeled and measured flows compare during low flow periods in the river.

Figure 5-26 also shows that the Regional Model adequately replicates seasonal cycles of low and high river flows. Prior to 1992, peak flows during the wettest months tend to be somewhat underestimated, probably because of under-predicted flow in the streams rather than insufficient groundwater discharge to the river. From 1992 through 1997, peak flows match well, but they are again underestimated in 1998 and 1999.

Seasonal low flows, during the summer months, are slightly over-predicted. In years such as 1990, the model over-estimates river flows by approximately 100 to 200 acre-feet per month. In other years, the Regional Model over-estimates the river flows by as much as 1,000 acre-feet per month. To evaluate this further, the estimated and model-simulated groundwater discharges to the river were compared, as discussed below.

5.2.4 Groundwater Discharge to River – Calibration Goal 4

Figure 5-27 compares the model-simulated groundwater discharges to the river with the discharges that have been estimated from hydrograph separation techniques (see Section 2.6.2.5). Because of uncertainty in the amount of treated water that infiltrates the streambed, Figure 5-27 displays a range for the estimated values, varying according to how much of the Saugus WRP treated water is estimated to infiltrate to groundwater as it travels down the Santa Clara River. For the purposes of this comparison, it was estimated that the infiltration could be negligible (blue line) and would be unlikely to exceed 75 percent of the Saugus WRP discharge (green line).

Figure 5-27 shows that the Regional Model simulates the patterns of groundwater discharges well. The Regional Model predicts lower groundwater discharge rates during high flow/high water table periods than were estimated from the hydrograph separation technique, but model uncertainty may not be the cause of this difference. It is equally, if not more, likely that the difference is due to the significant uncertainties associated with the hydrograph separation process during periods of high river flows. Specifically, as discussed in Section 2.6.2.5, it is difficult to determine how much of the receding flow after peak flow events is due to groundwater discharges versus continued stormwater drainage from within the basin or from upstream watersheds.

Figure 5-27 also shows that the Regional Model tends to predict higher rates of groundwater discharge during dry periods than estimated from the County Line gage. This is consistent with the Regional Model's over-prediction of total river flows, but anecdotal observations at the former gaging station site during low flow periods indicate that the river sometimes carved small channels that diverted a portion of the flow away from the gage, where it could not be measured. Consequently, the differences between modeled and measured total river flows and measured versus estimated groundwater discharges result from uncertainties in both the Regional Model and the gage data.

5.3 Groundwater Budget

Table 5-6 summarizes the groundwater budget for the 1980 through 1985 steady-state model. The values in the table are the average groundwater recharge and discharge rates in AF/yr during this period. As shown in the table, the majority of the recharge occurs from direct rainfall and stormwater flows, with irrigation and Castaic Lake underflow each comprising a very small portion of the total basin recharge. Groundwater discharge during this time period was approximately one-third pumping and one-third discharge to the Santa Clara River, with the rest consisting of subsurface outflow and ET. The table shows that ET is an important part of the groundwater budget, 15 percent of the total groundwater discharge in the basin.

Table 5-7 summarizes the groundwater budget for each year of the 20-year transient model simulation period (1980 through 1999). Figures 5-28 and 5-29 show the annual groundwater recharge and groundwater discharge rates, respectively. Figure 5-30 shows the change in groundwater storage each year, and Figure 5-31 shows the cumulative change in groundwater storage during the simulation period.

As is evident from Figure 5-28, recharge from precipitation and streamflows varies considerably from year to year, ranging from less than 15,000 AF/yr in the driest years to over 100,000 AF/yr in wetter years. In fact, for the five wettest years during this period, the model estimates that groundwater recharge ranged between 175,000 AF/yr and 270,000 AF/yr. In contrast, total groundwater discharges have been less variable (Figure 5-29), ranging from approximately 61,000 AF/yr at the end of the drought in the late 1980s through early 1990s to 116,000 acre-feet during 1998. Table 5-7 and Figure 5-29 together show that this variability in groundwater discharge does not follow the year-to-year pumping patterns, but instead is caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlate well with groundwater recharge patterns. For example, groundwater discharge rates increase during or immediately after significant rainfall years in 1983, 1992 through 1993, 1995, and 1998, and subsequently decrease in response to below-normal precipitation in the ensuing 1 to 2 years. This indicates that the predominant factors influencing changes in storage and groundwater discharge are the local rainfall recharge and stream recharge patterns from year to year, with anthropogenic influences (pumping and irrigation) having a smaller effect on the groundwater system. This is reinforced by Figures 5-30 and 5-31, which show that changes in groundwater storage volumes reflect year-to-year variations in regional rainfall.

5.4 Sensitivity Analysis

Sensitivity analyses were performed on the calibrated Regional Model to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the model. The sensitivity analyses focused on the transient model. Following is a description of the design of the analyses and the findings.

5.4.1 Method of Sensitivity Analysis

Analysis focused on identifying the sensitivity of the transient model to Kh and Kv for both aquifer systems, the permeability of the bed of the Santa Clara River, and, to a lesser degree, the ET parameters.

To perform the analysis, one model variable, or group of variables, was varied upward or downward, and the model was run again. The amount by which each model variable was adjusted upward or downward was based on the range of values that was considered to be plausible for the variable, according to the data analysis that was conducted in support of development of the hydrogeologic conceptual model for the valley, which is described in Section 2 of this report. The following pairs of sensitivity runs were performed:

a. Adjusting the Kh. This parameter was multiplied and divided by a factor of 1.5 in all model layers. The R (Kh:Kv) was left unchanged for these runs, but the change in Kh caused a change in Kv values.

b. Adjusting the R upward or downward by a factor of 4.0. This caused changes to Kv, but not to Kh.

c. Adjusting the storage parameters. In model layer 1, the Sy was adjusted from the calibrated model value of 0.10 to 0.075 and 0.15. In model layers 2 through 7, the storativity was adjusted from the calibrated model value of 5×10^{-4} to values of 1×10^{-4} and 1×10^{-3}. The reductions to Sy and storativity were run simultaneously in a single model run, and the increases in Sy and storativity were run simultaneously in a single model run.

d. Adjusting the riverbed leakage terms at drain and wadi nodes in the Santa Clara River and Castaic Creek. These terms were multiplied and divided by a factor of 10.

e. Adjusting the ET parameters in a way that produced less ET. In one run, the maximum evaporation depth was changed from 10 feet to 5 feet. In another run, the maximum evaporation rate was changed from 6 ft/yr to 3 ft/yr.

5.4.2 Sensitivity Analysis Results

The results of the focused sensitivity analysis are presented as time-series plots of water levels and groundwater discharges to the river. Results are first presented for the aquifer hydraulic parameters (Kh, R, Sy, and storativity), then for the riverbed permeability and ET terms.

5.4.2.1 Sensitivity of Groundwater Elevation Trends to Aquifer Parameters

Figures 5-32 through 5-38 show the sensitivity of Alluvial Aquifer groundwater elevations in the transient model to variations in Kh, R, and Sy. Figures 5-39 through 5-43 show the same information for three Saugus production wells and two Saugus monitoring wells. The results and the conclusions that can be drawn from them are:

a. Alluvial wells in the western part of the basin (NLF-B7 and NLF-G45) show slight sensitivity to the choice of Kh, and little sensitivity to R and Sy. Lower Kh values would degrade the calibration quality of the Regional Model, whereas the tested ranges of the other parameters would have little effect on calibration quality.

b. Further east, VWC-N shows greater sensitivity to each parameter, though it is relatively insensitive to lower Kh values. Lower Kh values or changes to R values would not degrade calibration quality, whereas other parameter changes could potentially degrade the calibration.

c. Results are similar in Soledad Canyon at SCWC-Stadium, SCWC-North Oaks East, and NCWD-Pinetree1. Higher Kh values substantially degrade the calibration quality of the transient model at each of these wells.

d. The transient model was slightly to moderately sensitive to the choice of Alluvial Aquifer Kh in Castaic Creek at well VWC-D. In this area, it showed little sensitivity to R or Sy in the Alluvial Aquifer. The results suggest that higher K values could slightly improve the calibration.

e. Water levels at Saugus production wells along the lower reaches of the South Fork Santa Clara River (VWC-201 and SCWC-Saugus2) are sensitive to the choice of R, moderately sensitive to the choice of Kh, and comparatively insensitive to storativity. The transient model is more sensitive to Kh and storativity at nearby monitoring well 7048C than at the pumping wells. The plots generally indicate the model is well calibrated, although small decreases in Kh might slightly improve the calibration quality.

f. Similar results are seen for production well NCWD-11 and monitoring well 5851 farther upstream in the South Fork Santa Clara River valley. At NCWD-11, the R appears to be particularly well calibrated, as lower values cause groundwater elevations to fluctuate insufficiently, and higher values cause too much fluctuation, and in some cases, model-simulated water levels that are below pumping levels. Changes to Kh would not improve the model, and could in fact degrade it at the monitoring well.

5.4.2.2 Sensitivity of Groundwater Elevation Trends to River and Evapotranspiration Parameters

Figures 5-44 through 5-50 show the sensitivity of Alluvial Aquifer groundwater elevations in the transient model to variations in the riverbed K for drain and wadi nodes and to decreases in the two ET parameters, extinction depth and maximum potential ET rate. Figures 5-51 through 5-55 show the same information for the three Saugus production wells and two Saugus monitoring wells discussed in Section 5.4.2.1. The results and the conclusions that can be drawn from them are:

a. Alluvial wells in the western and central parts of the basin (NLF-B7, NLF-G45, and VWC-N) and along Castaic Creek (VWC-D) are sensitive to the choice of the riverbed K for the drain and wadi nodes. Reduced conductivity values notably increase the groundwater elevations at some wells, while higher values somewhat decrease groundwater elevations. The plots suggest that changes to this term would not improve calibration quality and could substantially degrade the calibration at some of these wells. Further east, in Soledad Canyon, the Regional Model is relatively insensitive to riverbed K in the gaining reaches of the Santa Clara River.

b. Reductions in drain and wadi riverbed K increase groundwater elevations by raising groundwater elevations in the Alluvial Aquifer, to which the Saugus discharges. Decreased riverbed permeability backs up water in the Alluvial Aquifer, and hence in the Saugus Formation. Changes to riverbed permeability do not improve Saugus calibration.

c. Groundwater levels in both the Alluvial Aquifer and the Saugus Formation are insensitive to the choice of ET parameters.

5.4.2.3 Sensitivity of Groundwater Discharge to the River to Changes in Aquifer Parameters

Figures 5-56 shows the sensitivity of discharges of Alluvial Aquifer groundwater to the river to changes in K, R, and Sy. The plots show that the model-calculated discharge to the river is sensitive to Kh, but not to R or Sy. A reduction in Alluvial Aquifer Kh would improve the calibration quality during seasonal or longer dry periods, but at the expense of degrading the calibration during the rainfall season for all but the wettest years. Increasing the Kh would slightly increase the predicted discharges during seasonal or longer dry periods.

5.4.2.4 Sensitivity of Groundwater Discharge to the River to Changes in River and Evapotranspiration Parameters

Figure 5-56 also shows the sensitivity of discharges of Alluvial Aquifer groundwater to the river to changes in riverbed K for drain and wadi nodes and to decreases in the two ET parameters, extinction depth and maximum potential ET rate. Figure 5-56 shows that a lower riverbed permeability would improve calibration during seasonal and longer dry periods, but notably degrade calibration during all rainfall periods. Figure 5-56 shows that reducing the ET extinction depth from 10 feet to 5 feet has little effect on model-calculated discharge to the river, while reducing the maximum ET rate slightly increases the model-calculated discharge.

5.5 Conclusion

The process of calibrating the Regional Model to a 20-year period of groundwater elevation and streamflow data has resulted in a model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary attributes of the model's calibration that makes this tool appropriate for its intended uses are:

a. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased SWP water imports (from outside the valley), and associated changes in land use and water use.

b. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property).

c. Its use of an integrated model of the watershed (the SWRM) to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system.

The calibration process has resulted in a Regional Model that closely simulates, on a monthly basis, total flows in the river and estimated volumes of groundwater discharging to the river. The calibration process has also resulted in a Regional Model that closely simulates the short-term and long-term time-varying trends in groundwater elevations throughout the valley, which is necessary for evaluating groundwater management strategies. The close calibration of the groundwater elevation trends and absolute groundwater elevations in both the Alluvial Aquifer and the Saugus Formation near the Whittaker-Bermite property also renders the Regional Model suitable for particle-tracking analyses, to support the design of a long-term pumping and groundwater treatment plan that will restore impaired water supplies while also preventing contamination in unimpacted portions of the aquifer.

Tables

TABLE 5-1
Alluvial Aquifer Parameters in Calibrated Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Zone	Location	T (ft^2/day)	Kh (ft/day)	Average Alluvium Thickness (feet)
A1a	Santa Clara River below Lang gage	9,000 to 25,500	300	30 to 85
A1b2	Santa Clara River below A1a	31,500	350	90
A1b1	Santa Clara River below A1b2	31,500	350	90
A1c3	Santa Clara River below A1b1	36,000	400	90
A1c2	Santa Clara River below A1c3	49,500	550	90
A1c1	Santa Clara River below A1c2	49,500	550	90
A1d4	Santa Clara River below A1c1	49,500	550	90
A1d3	Santa Clara River below A1d4	16,500	550	30
A1d2	Santa Clara River below A1d3	60,500	550	110
A1d1	Santa Clara River below A1d2	49,500	550	90
A1e2	Santa Clara River below A1d1	63,250	550	115
A1e1	Santa Clara River below A1e2	63,250	550	115
B1a	Santa Clara River at South Fork mouth	54,375 to 79,750	375 to 550	145
B1b2	Santa Clara River below B1a	22,500	375	60
B1b1	Santa Clara River below Bb2	63,250	550	115
C1a	Santa Clara River below B1b1	71,500	550	130
C1b	Santa Clara River below C1a	60,500	550	110
C1c	Santa Clara River below C1b	60,500	550	110
C1d	Santa Clara River below C1c	60,500	550	110
D1b	Lower South Fork Santa Clara River	12,600	105	120
D1a1	Upper South Fork Santa Clara River	5,775	105	55
D1a2	Gavin Canyon	15	0.75	20
D1a3	Pico Canyon	15	0.75	20
D1a4	Newhall Canyon	15	0.75	20
D1a5	Placerita Canyon	200	10	20
A3a	Upper Sand Canyon	1,750	175	10
A3b	Lower Sand Canyon	5,250	105	50
A4a1	Upper Mint Canyon	2,800	140	20
A4a2	Central Mint Canyon	2,100	105	20
A4b	Lower Mint Canyon	13,125	175	75
A5	Oak Spring Canyon	8,750	175	50
B2a1	Unnamed tributary canyon	10,500	105	100
B2a2	Vasquer Canyon	10,500	105	100
B2a3	Texas Canyon	10,500	105	100

TABLE 5-1
Alluvial Aquifer Parameters in Calibrated Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Zone	Location	T (ft^2/day)	Kh (ft/day)	Average Alluvium Thickness (feet)
B2b1	Plum Canyon	10,500	105	100
B2b	Upper Bouquet Canyon	2,625 to 12,600	25 to 90	105
B2c	Lower Bouquet Canyon	22,050	245	90
B2d	Haskell Canyon	6,825	105	65
B3a	Lower Dry Canyon	6,300	105	60
B3b	Upper Dry Canyon	6,300	105	60
B4b	Upper San Francisquito Canyon	6,300	105	60
B4c	Lower San Francisquito Canyon	10,500	105	100
C1e	San Martinez Canyon	5,250	105	50
C1f	Potrero and Salt Canyons	5,250	105	50
C2a	Upper Castaic Creek valley	25,200	315	80
C2b	Lower Castaic Creek valley	35,000	350	100
C2c	Charlie Canyon	10,500 to 17,500	175	60 to 100
C3	Hasley Canyon	3,150	30	105

Notes:

The zones are based on alluvial storage units defined by RCS (1986, 2002).
However, they have been further subdivided in certain areas to facilitate model calibration.

See Figure 4-1 for the locations of the alluvial storage units.

TABLE 5-2
Aquifer Hydraulic Parameters Used in the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Parameter	Aquifer	Value	Comment
Kh	Alluvium	Variable	See Figure 5-1 and Table 5-1.
	Saugus	Variable	See Figures 5-2 through 5-7.
R (Kh:Kv)	Alluvium	10:1	Derived during model calibration process.
	Saugus	50:1 to 100:1	
Sy	Alluvium and Saugus outcrops	0.10	Derived during model calibration process.
Storativity	Saugus below model layer 1	5×10^{-4}	Derived during model calibration process.
Santa Clara River and Castaic Creek streambed thicknesses	Alluvium	2 feet	Assumed thickness of streambed sediments in gaining river reaches.
Santa Clara River and Castaic Creek streambed Kv	Alluvium	10 ft/day (3.5×10^{-3} cm/sec)	Derived during model calibration process.
ET extinction depth	Alluvium and Saugus	10 feet	Corresponds to typical rooting depth for phreatophytes along Santa Clara River.
Potential ET rate	Alluvium and Saugus	6 ft/yr	Estimated maximum water use by phreatophytes along Santa Clara River.

Notes:
cm/sec = centimeters per second
ET = evapotranspiration

TABLE 5-3

Residual Errors for 1980 through 1985 Steady-State Calibration Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Aquifer	Owner	Well Name	Number of Measurements	Measured Groundwater Elevation (feet msl)	Modeled Groundwater Elevation (feet msl)	Residual (Modeled - Measured) (feet)	Residual^2 (ft^2)
Alluvium	NLF	B10	5	890.70	889.51	-1.19	1.42E+00
	NLF	C5	14	940.61	945.04	4.44	1.97E+01
	NLF	E4	4	977.18	977.84	0.67	4.45E-01
	LACFCD	6995D	17	1003.04	998.75	-4.29	1.84E+01
	LACFCD	7076C	5	1037.16	1027.58	-9.58	9.18E+01
	VWC	K2	2	1113.00	1114.36	1.36	1.84E+00
	NLF	R	4	1137.50	1129.94	-7.56	5.72E+01
	VWC	T4	14	1180.20	1187.69	7.49	5.61E+01
	SCWC	Stadium	15	1186.27	1184.41	-1.86	3.44E+00
	LACFCD	7107C	51	1258.45	1256.45	-2.00	4.00E+00
	LACFCD	7127D	66	1315.83	1320.11	4.28	1.83E+01
	SCWC	N.Oaks West	45	1378.61	1373.49	-5.12	2.62E+01
	LACFCD	7158K	13	1427.48	1444.48	17.00	2.89E+02
	LACFCD	7168C	13	1464.85	1465.79	0.94	8.85E-01
	LACFCD	7178B	12	1495.78	1493.56	-2.21	4.90E+00
	SCWC	Sand Canyon	60	1504.32	1503.73	-0.59	3.47E-01
	LACFCD	7178D	12	1499.21	1509.63	10.42	1.09E+02
	LACFCD	7177P	11	1523.64	1514.99	-8.65	7.47E+01
	LACFCD	7187C	16	1526.06	1534.57	8.51	7.24E+01
	LACFCD	7197	13	1560.34	1556.41	-3.93	1.55E+01
	LACFCD	7197G	3	1577.00	1584.72	7.72	5.96E+01
	LACFCD	6993A	12	1042.95	1032.18	-10.77	1.16E+02
	LACFCD	6981D	3	1092.00	1092.24	0.24	5.66E-02
	LACFCD	6980G	10	1110.77	1107.87	-2.90	8.43E+00
	VWC	W6	5	1146.80	1139.03	-7.77	6.04E+01
	LACFCD	7066D	13	1154.92	1158.65	3.72	1.39E+01
	LACFCD	7086B	9	1227.33	1216.15	-11.19	1.25E+02
	LACFCD	7095	11	1297.96	1277.59	-20.38	4.15E+02
Saugus	LACFCD	5841	14	1114.98	1104.27	-10.71	1.15E+02
	LACFCD	5842F	13	1154.65	1111.16	-43.49	1.89E+03
	LACFCD	5851	45	1137.58	1109.08	-28.50	8.12E+02
	LACFCD	5851A	42	1140.77	1109.09	-31.68	1.00E+03
	LACFCD	5871D	13	1138.03	1117.18	-20.85	4.35E+02
	LACFCD	5873E	3	1286.67	1243.22	-43.44	1.89E+03
	LACFCD	5882	11	1251.99	1318.26	66.26	4.39E+03
	LACFCD	5912A	10	1424.13	1441.47	17.34	3.01E+02
	LACFCD	7048C	47	1110.32	1099.48	-10.84	1.17E+02
	LACFCD	7053C	9	1266.52	1267.60	1.08	1.16E+00

TABLE 5-4

Statistics of Residual Errors for 1980 through 1985 Steady-State Calibration Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Statistic	Alluvial Aquifer	Saugus Formation	Combined System	Criterion for Goal 3
Target Groundwater Elevations				
Number of Target Wells	28	10	38	---
Maximum Groundwater Elevation	1,577	1,424	1,577	---
Minimum Groundwater Elevation	891	1,110	891	---
Range in Groundwater Elevations	686	314	686	---
Statistics for Residuals				
Mean Residual	-1.19	-10.48	-3.63	As close to zero as possible
Mean Residual / Range in Groundwater Elevations	-0.2%	-3.3%	-0.5%	5%
Standard Deviation of Residuals	7.62	31.39	17.86	---
Standard Deviation of Residuals / Range in Groundwater Elevations	1.1%	10.0%	2.6%	10%
Statistics for Residual^2 Values				
Sum of Residual^2 Values	1,664	10,954	12,617	---
Average of Residual^2 Values	59	1,095	332	---
Root-Mean-Square Error (RMS)	8	33	18	10 feet for Alluvial, 25 feet for Saugus
RMS / Range in GW Elevations	1.1%	10.5%	2.7%	10%

Note:

An entry of --- means no criterion was established.

TABLE 5-5

Comparison of Modeled and Measured Horizontal Hydraulic Gradients for Multi-Port Monitoring Wells
Near the San Gabriel Fault
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	MP-3	MP-2	MP-1	MP-2
Modeled Groundwater Elevation (feet)	1,225.52	1,092.02	1,084.78	1,092.02
Measured Groundwater Elevation (feet)	1,304.46	1,074.28	1,066.99	1,074.28
Residual Error (feet)	-78.94	17.74	17.79	17.74
Easting (feet)	6,406,801	6,405,215	6,399,944	6,405,215
Northing (feet)	1,971,284	1,968,850	1,970,850	1,968,850
Distance Between Wells		2,905.13		5,637.68
Difference in Modeled Groundwater Elevations		133.50		-7.24
Difference in Measured Groundwater Elevations		230.18		-7.29
Modeled Horizontal Gradient		-4.60E-02		1.28E-03
Measured Horizontal Gradient		-7.92E-02		1.29E-03
Modeled Gradient / Measured Gradient		0.58		0.99

Notes:

Wells MP-1 and MP-2 are located on the west (downthrown) side of the fault.

Well MP-3 is located on the east (upthrown) side of the fault.

Measured groundwater elevations are the average of measurements from January through July of 2003.
Wells MP-1 and MP-2 are in model layer 4; well MP-3 is in model layer 2.

TABLE 5-6

Groundwater Budget for 1980 through 1985 Steady-State Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Total Recharge	**AF/yr**	**Percent**
Rainfall	35,000	44.8
Streams	38,200	48.8
Irrigation	3,300	4.2
Subsurface Inflow (Castaic)	1,700	2.2
Total	**78,200**	**100.0**

Total Discharge	**AF/yr**	**Percent**
Discharge to Santa Clara River	28,600	36.6
Evapotranspiration	12,000	15.3
Subsurface Outflow	6,600	8.4
Pumping	31,000	39.6
Total	**78,200**	**100.0**

TABLE 5-7

Annual Water Budgets Calculated by the Calibrated Regional Model for 1980 through 1999

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Castaic Dam Underflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
1980 to 1981	41,003	3,375	43,226	1,705	89,310	35,542	30,507	15,387	6,691	88,128	1,181	1,181
1981 to 1982	12,102	3,871	13,148	1,700	30,821	35,209	22,304	9,214	6,641	73,368	-42,547	-41,365
1982 to 1983	52,415	3,022	35,134	1,700	92,270	24,918	25,583	11,157	6,695	68,353	23,917	-17,448
1983 to 1984	183,342	2,657	79,681	1,700	267,380	23,169	51,128	26,020	7,017	107,333	160,047	142,598
1984 to 1985	1,316	3,606	10,714	1,705	17,341	30,645	32,258	19,609	6,647	89,158	-71,817	70,781
1985 to 1986	2	3,279	9,082	1,700	14,063	28,963	25,369	10,629	6,572	71,533	-57,470	13,311
1986 to 1987	43,258	3,211	26,471	1,700	74,641	28,658	27,557	12,354	6,668	75,236	-595	12,716
1987 to 1988	11,915	2,991	9,694	1,700	26,299	27,085	24,434	8,601	6,566	66,686	-40,386	-27,670
1988 to 1989	27,949	3,075	17,106	1,705	49,835	27,571	23,518	8,752	6,613	66,454	-16,619	-44,289
1989 to 1990	0	3,393	7,899	1,700	12,993	30,415	21,004	6,676	6,520	64,614	-51,621	-95,911
1990 to 1991	0	3,787	9,092	1,700	14,579	31,652	18,151	4,711	6,530	61,043	-46,464	-142,375
1991 to 1992	51,315	3,397	28,933	1,700	85,345	41,067	19,924	6,963	6,647	74,600	10,745	-131,630
1992 to 1993	131,293	3,850	60,449	1,705	197,296	37,567	27,043	14,114	6,906	85,629	111,666	-19,964
1993 to 1994	113,547	3,773	64,341	1,700	183,361	39,741	34,976	22,598	6,875	104,191	79,170	59,207
1994 to 1995	813	4,415	13,436	1,700	20,365	44,120	21,612	12,839	6,586	85,157	-64,793	-5,586
1995 to 1996	114,663	4,517	60,647	1,700	181,527	42,009	32,426	21,314	6,887	102,637	78,890	73,305
1996 to 1997	46,312	5,205	30,512	1,705	83,734	45,574	25,888	17,092	6,762	95,317	-11,583	61,721
1997 to 1998	17,485	5,267	16,277	1,700	40,729	47,051	21,488	12,791	6,667	87,997	-47,268	14,453
1998 to 1999	138,991	4,758	90,634	1,700	236,084	42,043	41,283	26,213	6,959	116,498	119,585	134,039
1999 to 2000	26	5,343	13,714	1,700	20,783	46,867	24,335	15,943	6,607	93,752	-72,969	61,070
Minimum	0	2,657	7,899	1,700	12,993	23,169	18,151	4,711	6,520	61,043	-72,969	-142,375
Maximum	183,342	5,343	90,634	1,705	267,380	47,051	51,128	26,213	7,017	116,498	160,047	142,598
Average	49,387	3,840	32,010	1,701	86,938	35,493	27,539	14,149	6,703	83,884	3,053	5,907
Median	34,476	3,689	21,789	1,700	62,238	35,376	25,476	12,815	6,657	85,393	-14,101	6,949

Note:

All flow volumes are listed in AF/yr.

Figures

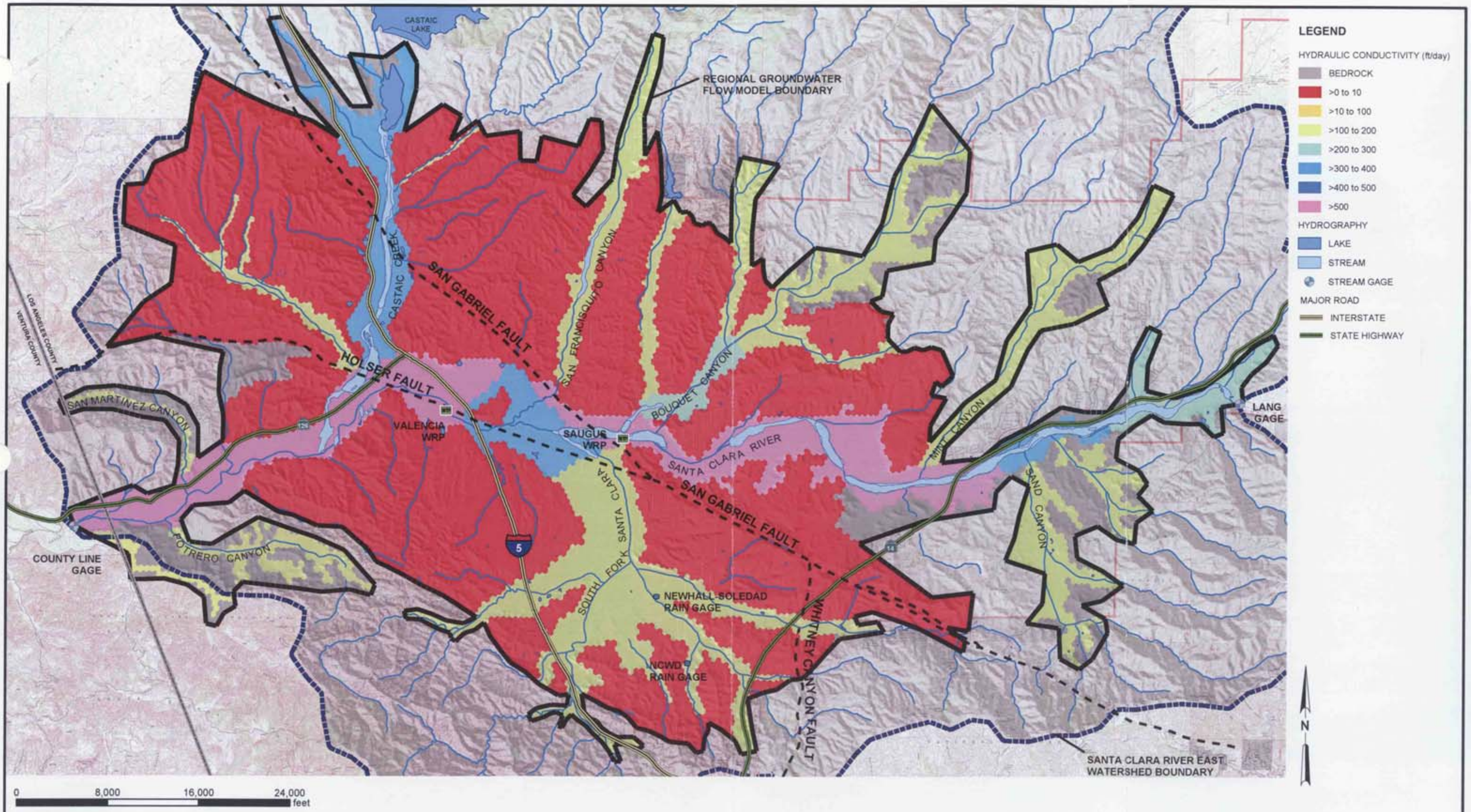

FIGURE 5-1
HYDRAULIC CONDUCTIVITY LAYER 1
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG036.MXD FIG05-01.PDF 01/28/2004 19:28:25

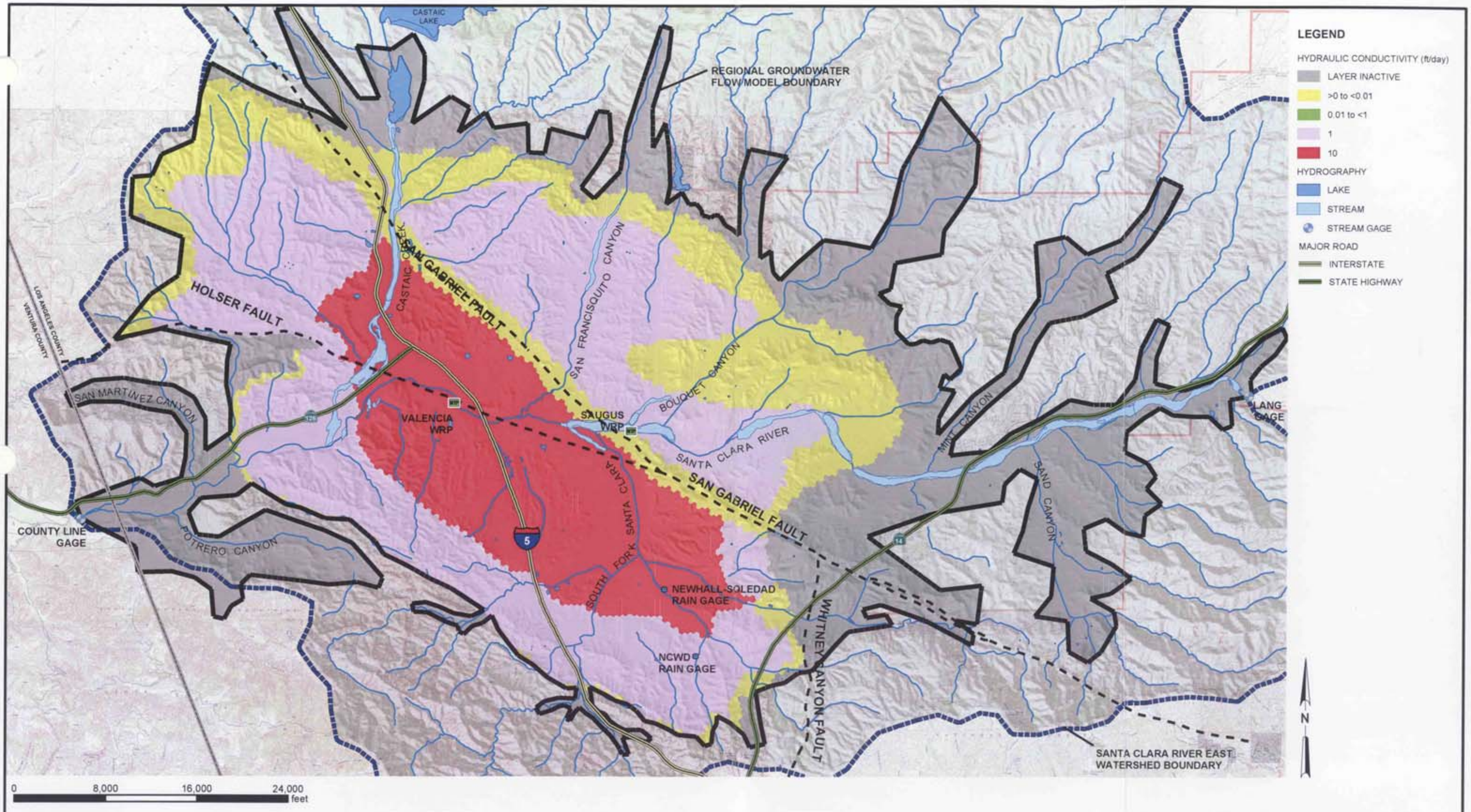

FIGURE 5-2
HYDRAULIC CONDUCTIVITY LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG037.MXD FIG05-02.PDF 01/22/2004 17:55:45

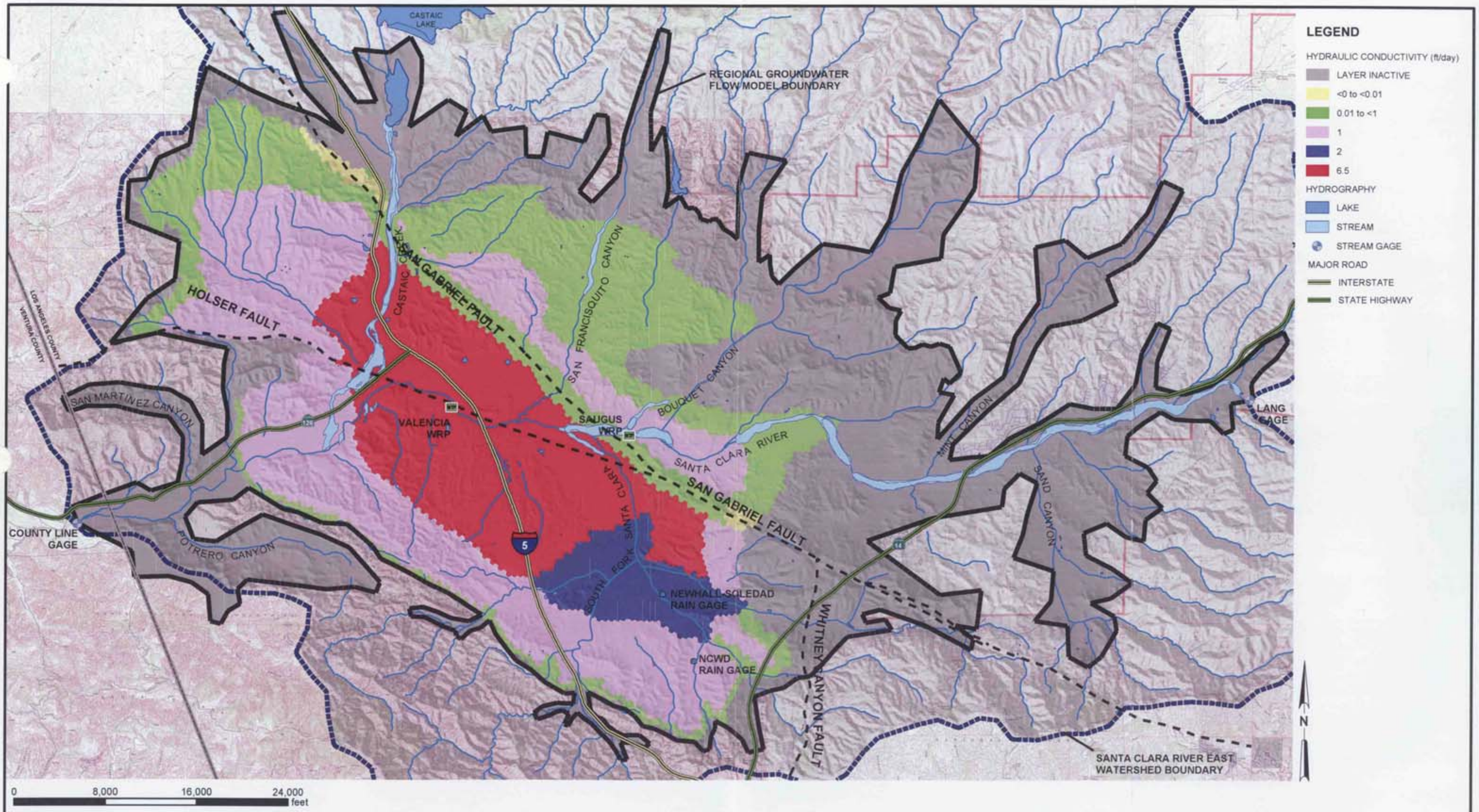

FIGURE 5-3
HYDRAULIC CONDUCTIVITY LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG039.MXD FIG05-03.PDF 01/22/2004 18:08:34

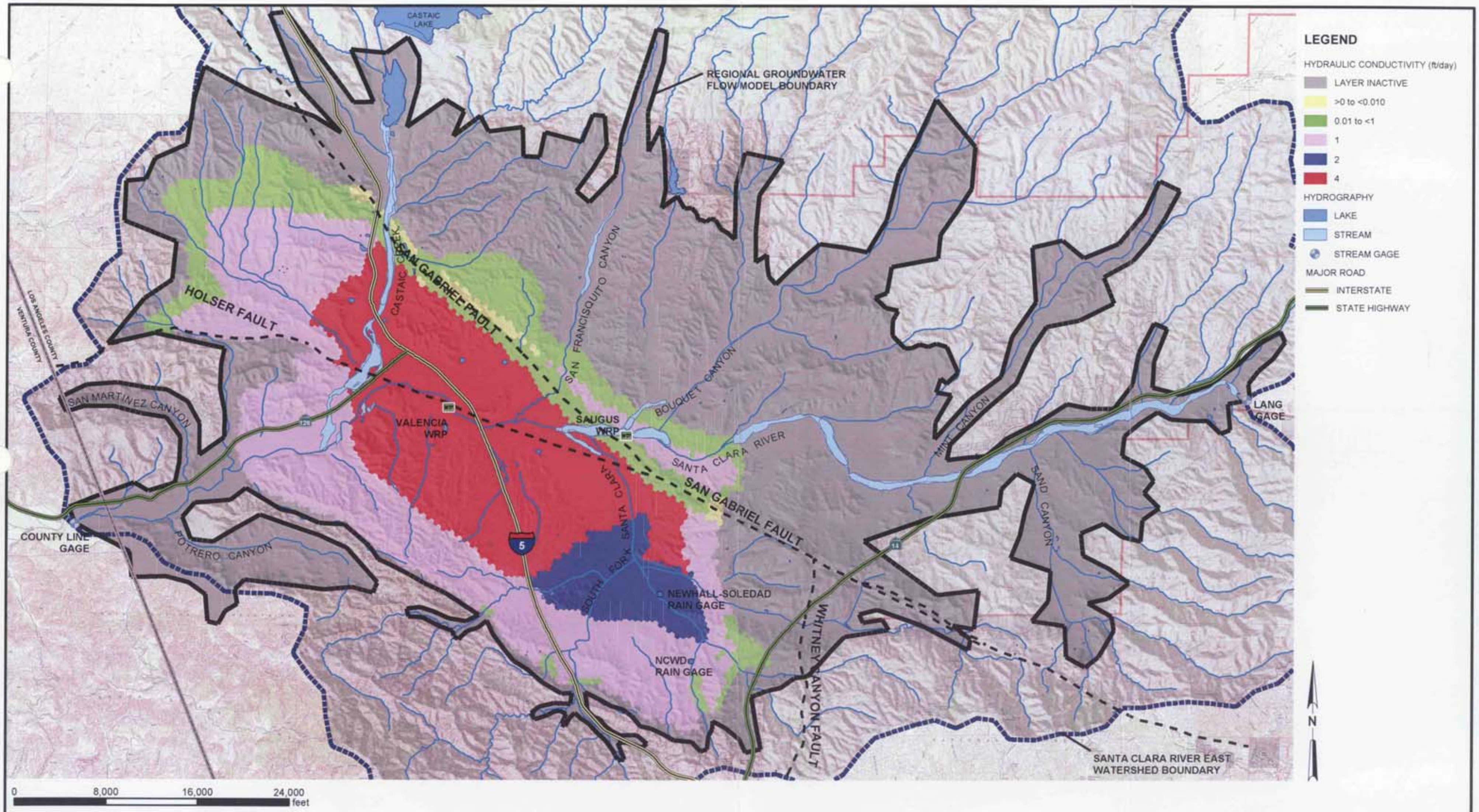

FIGURE 5-4
HYDRAULIC CONDUCTIVITY LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

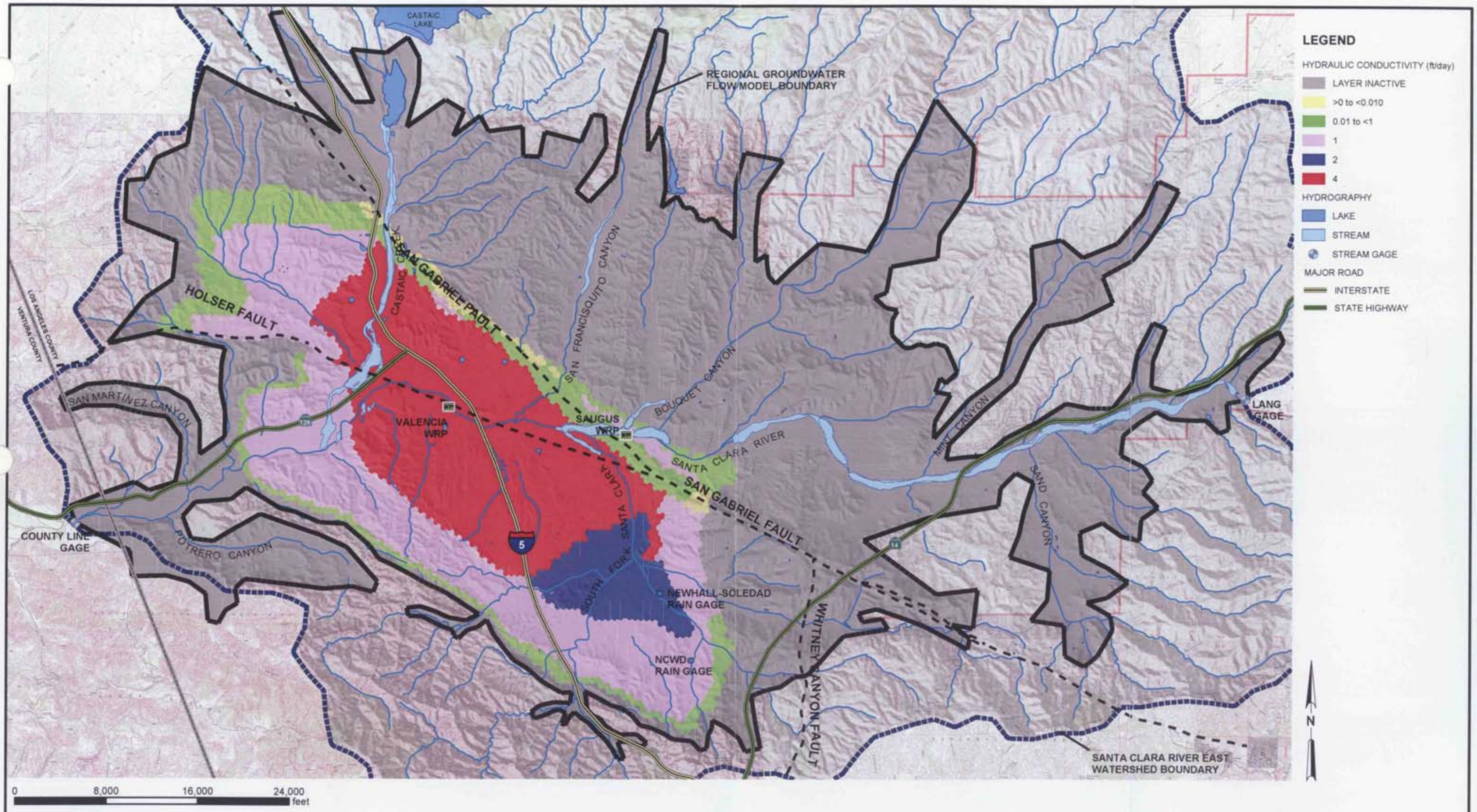

FIGURE 5-5
HYDRAULIC CONDUCTIVITY LAYER 5

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

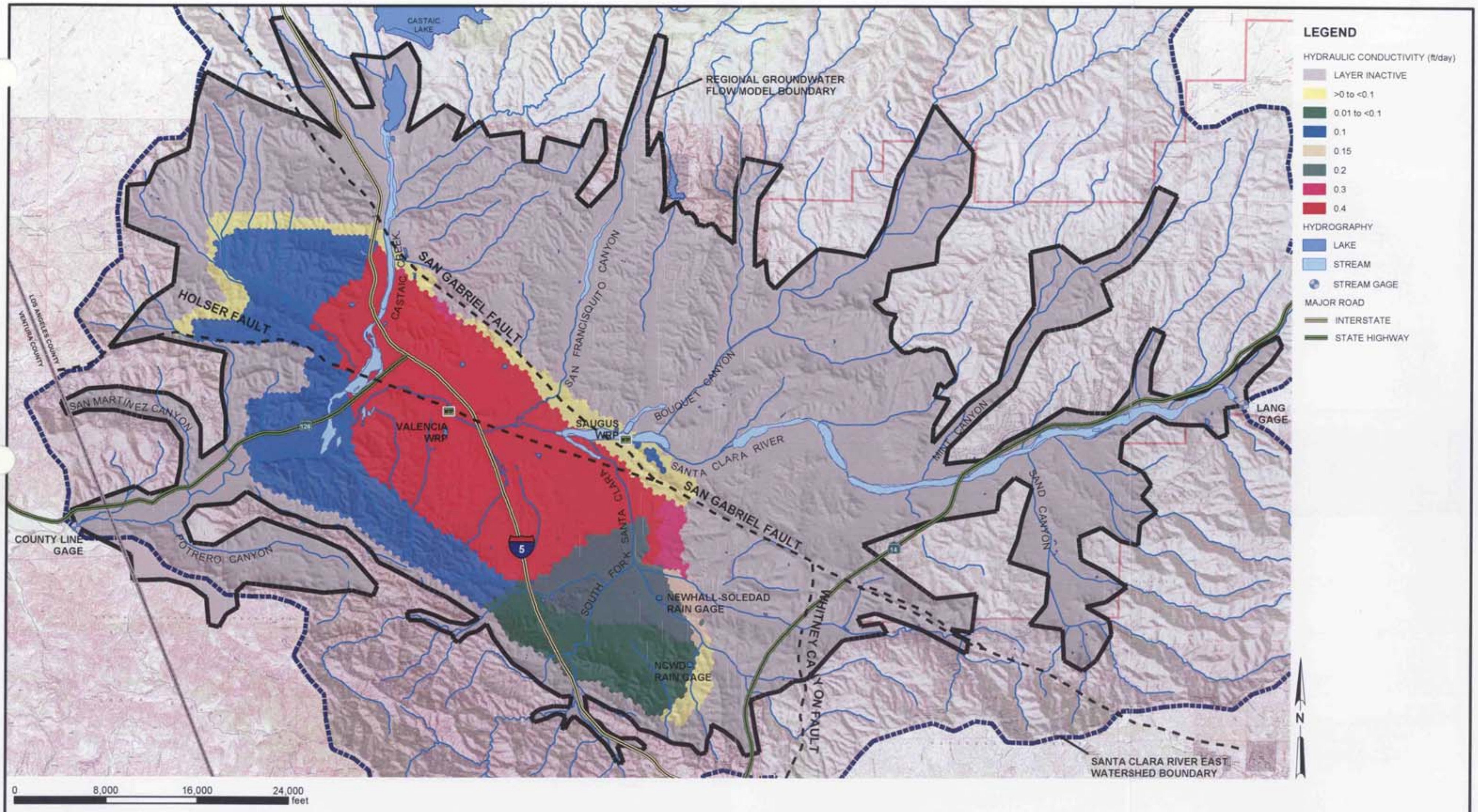

FIGURE 5-6
HYDRAULIC CONDUCTIVITY LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

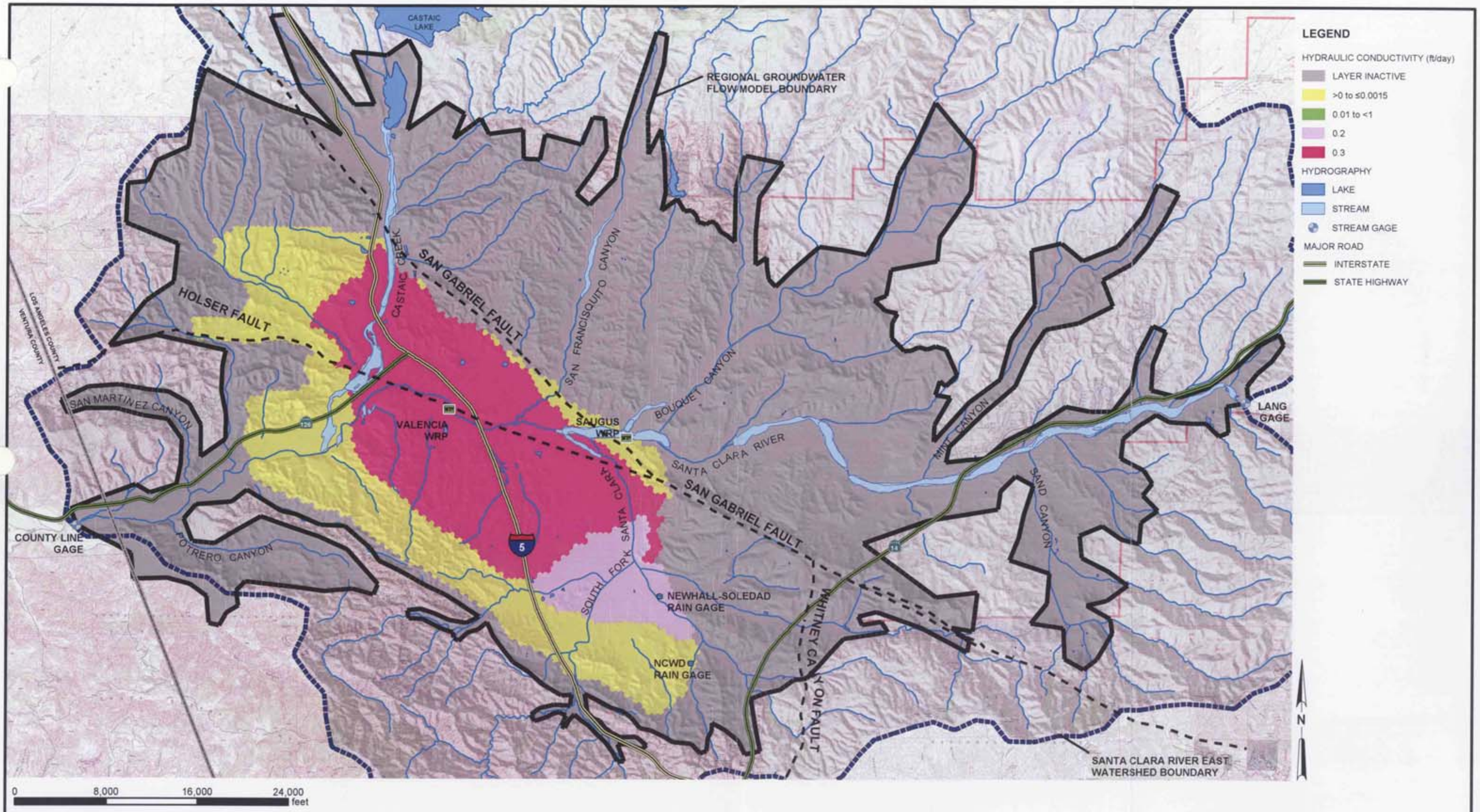

FIGURE 5-7
HYDRAULIC CONDUCTIVITY LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG042.MXD FIG05-07.PDF 01/22/2004 18:22:27

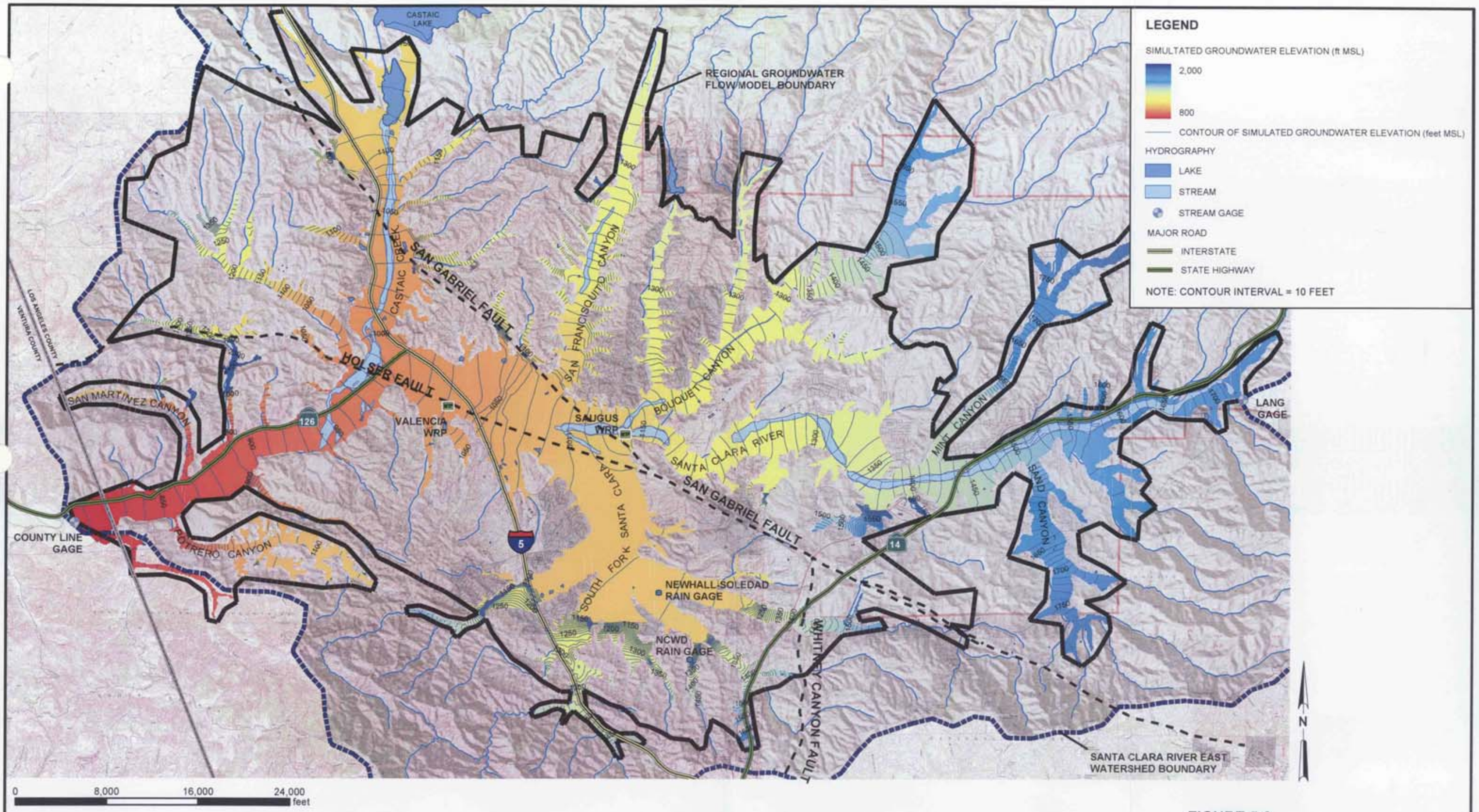

FIGURE 5-8
STEADY-STATE 1980-1985
GROUNDWATER ELEVATION
CONTOURS FOR ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

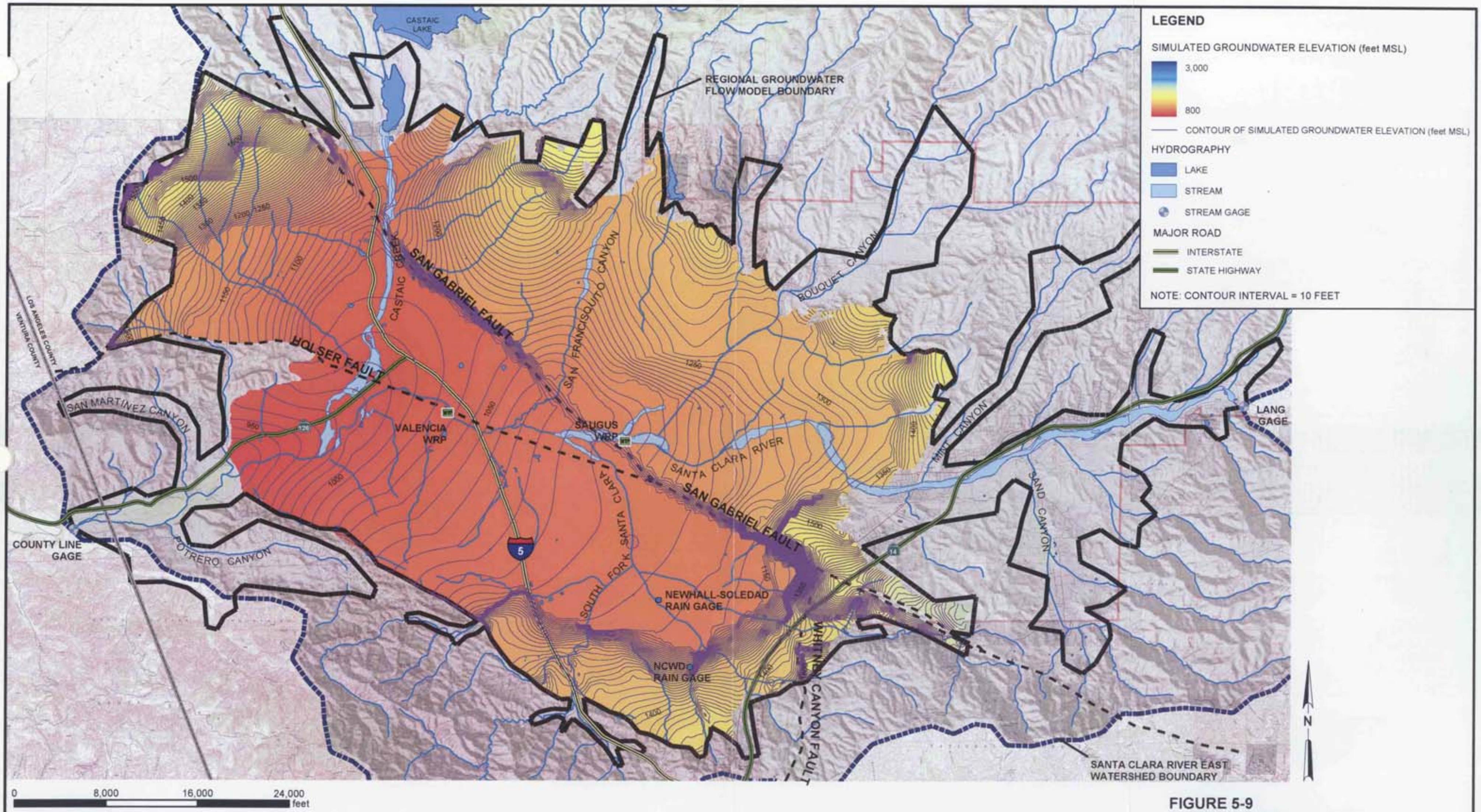

FIGURE 5-9
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 2

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG046.MXD FIG05-9.PDF 02/02/2004 10:58:01

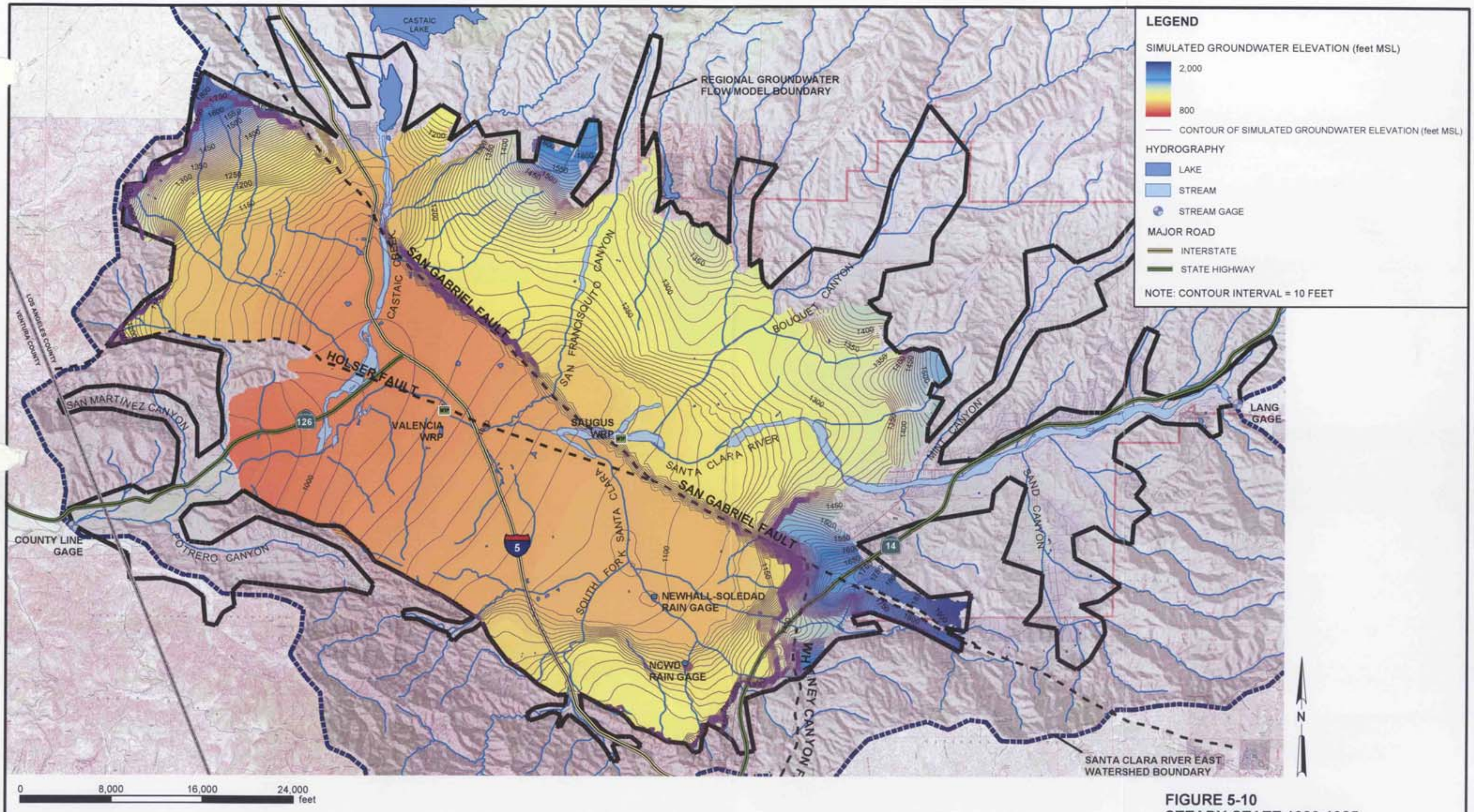

FIGURE 5-10
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 3

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

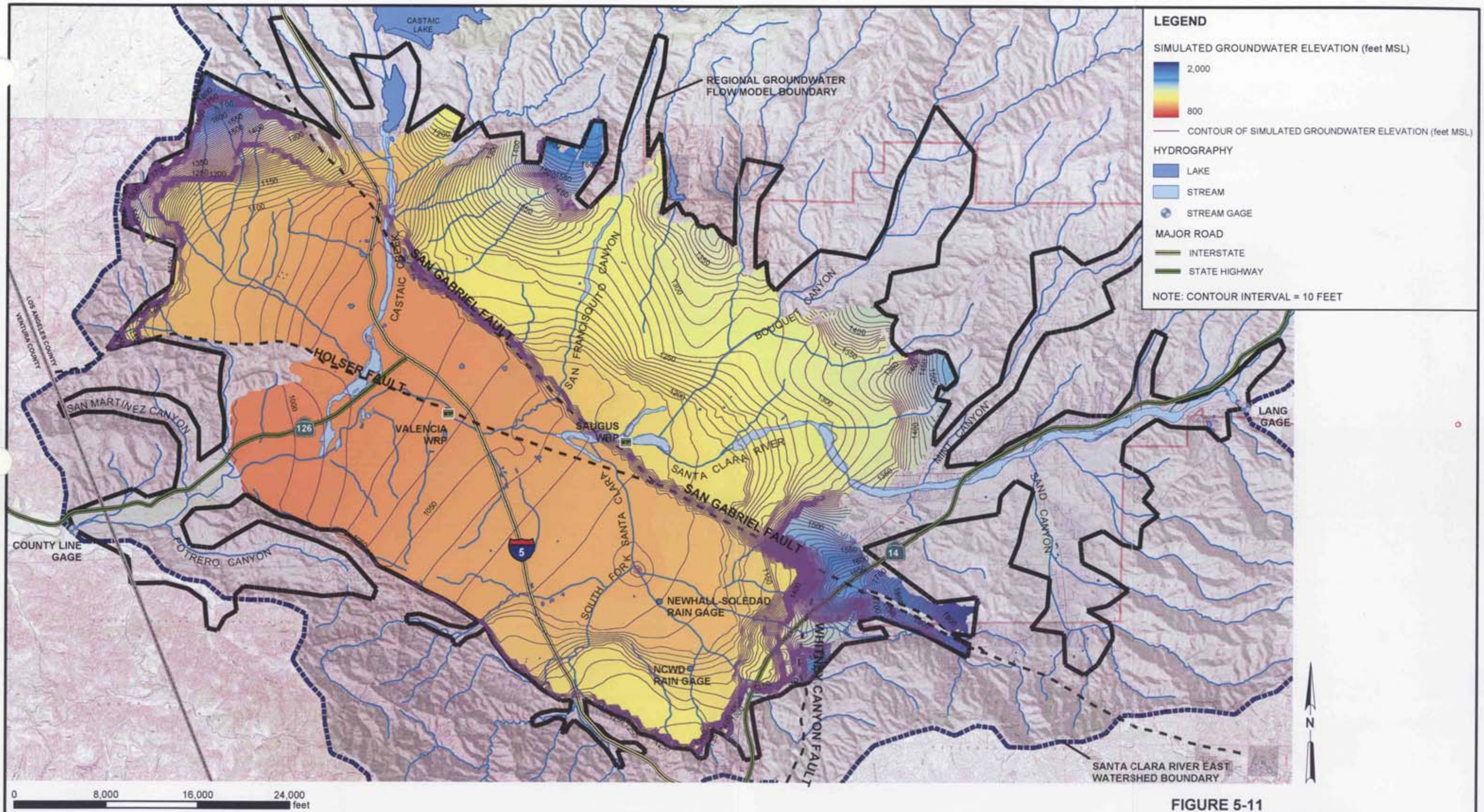

FIGURE 5-11
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 4

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

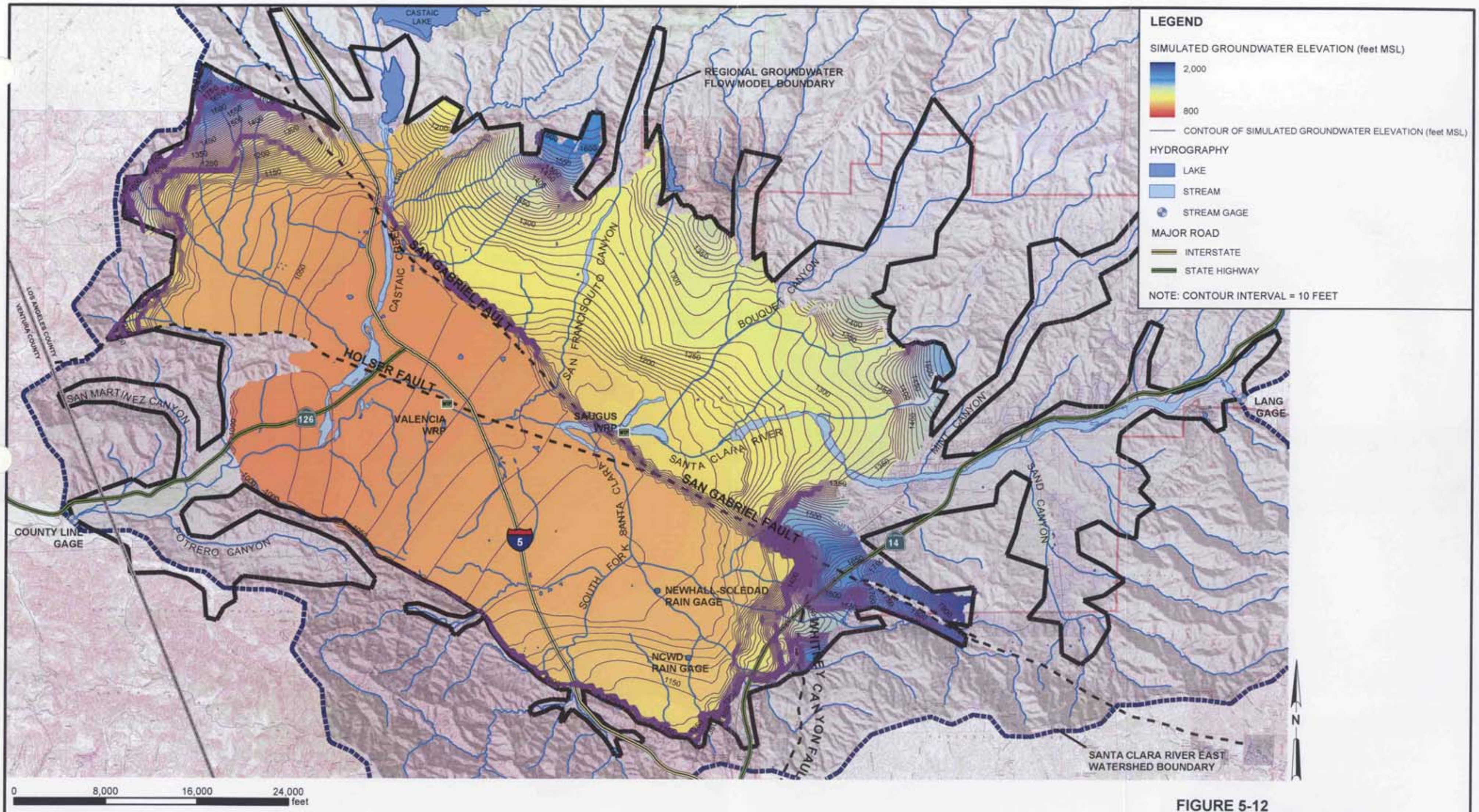

FIGURE 5-12
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 5

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

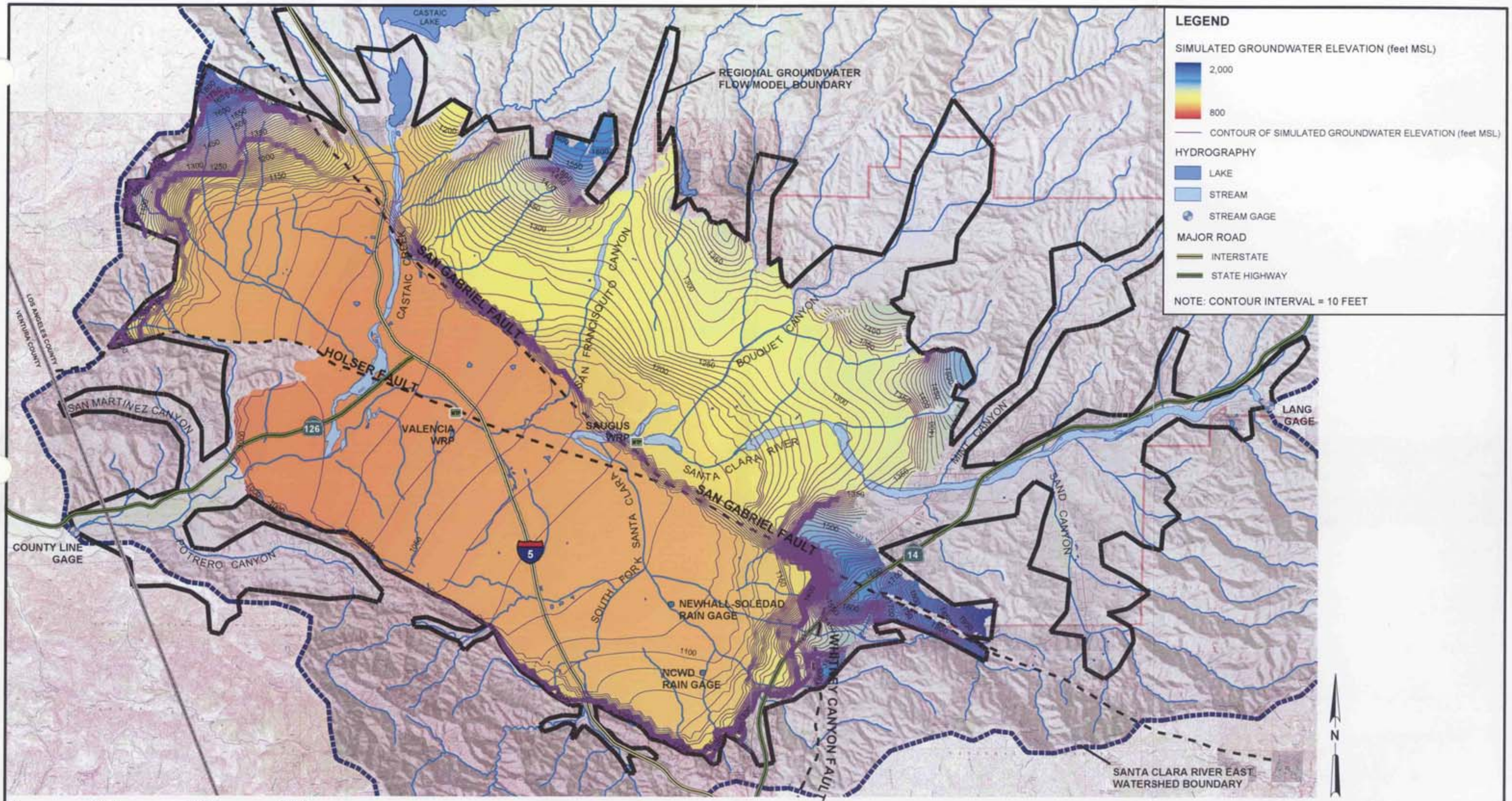

FIGURE 5-13
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 6

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG051.MXD FIG05-13.PDF 02/02/2004 11:11:08

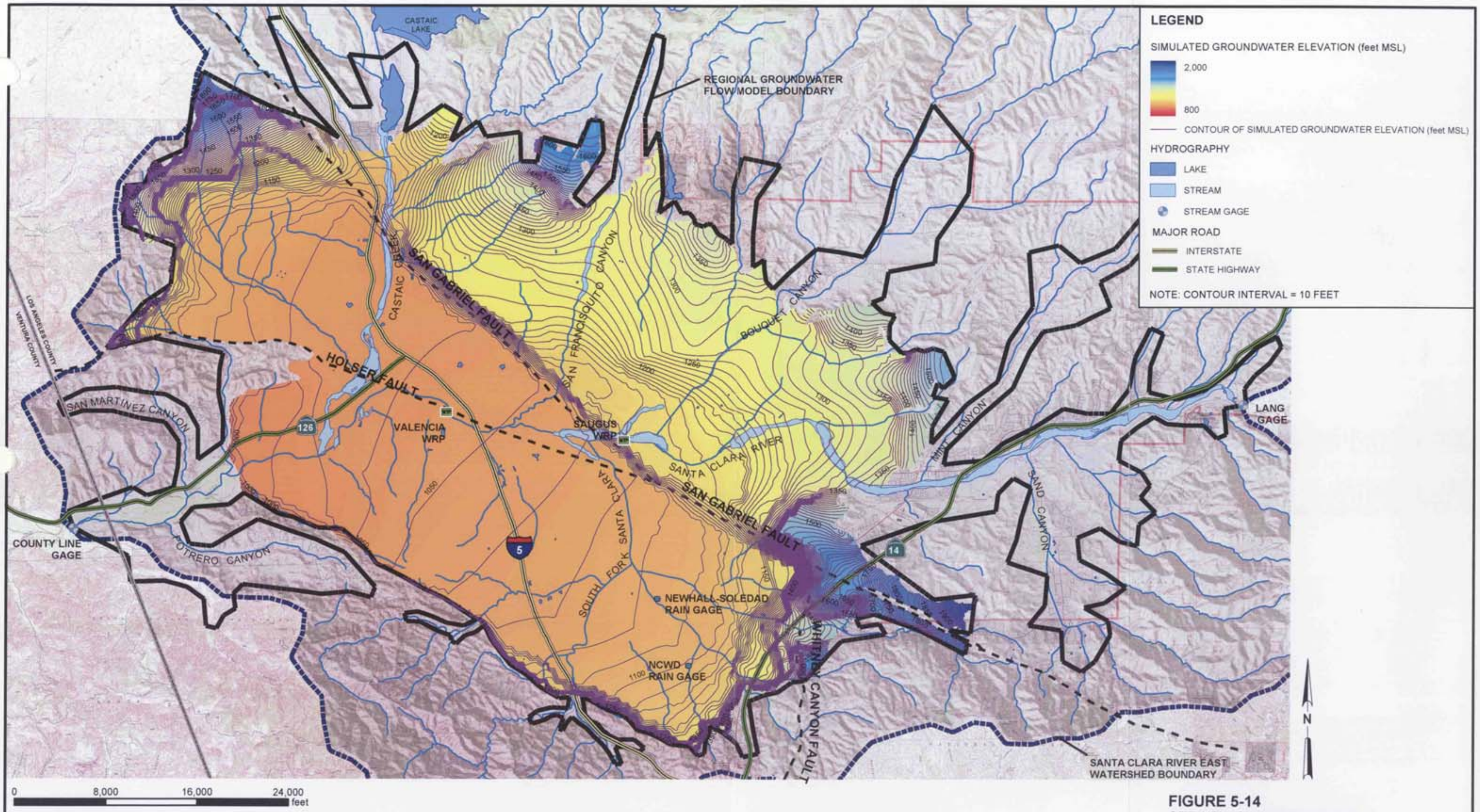

FIGURE 5-14
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 7

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG050.MXD FIG05-14.PDF 02/02/2004 11:18:17

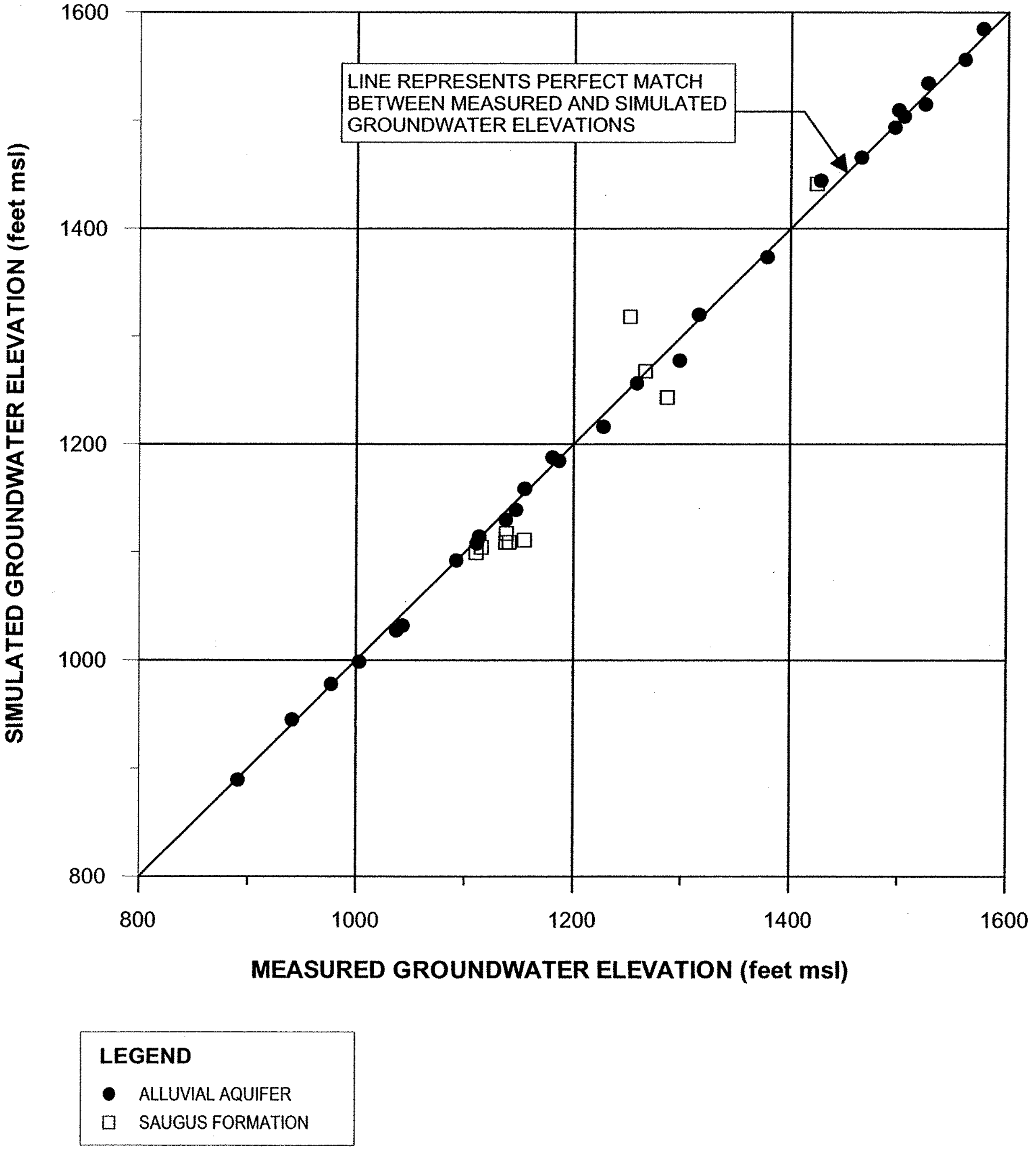

FIGURE 5-15
SIMULATED VERSUS MEASURED GROUNDWATER ELEVATIONS FOR THE STEADY-STATE MODEL

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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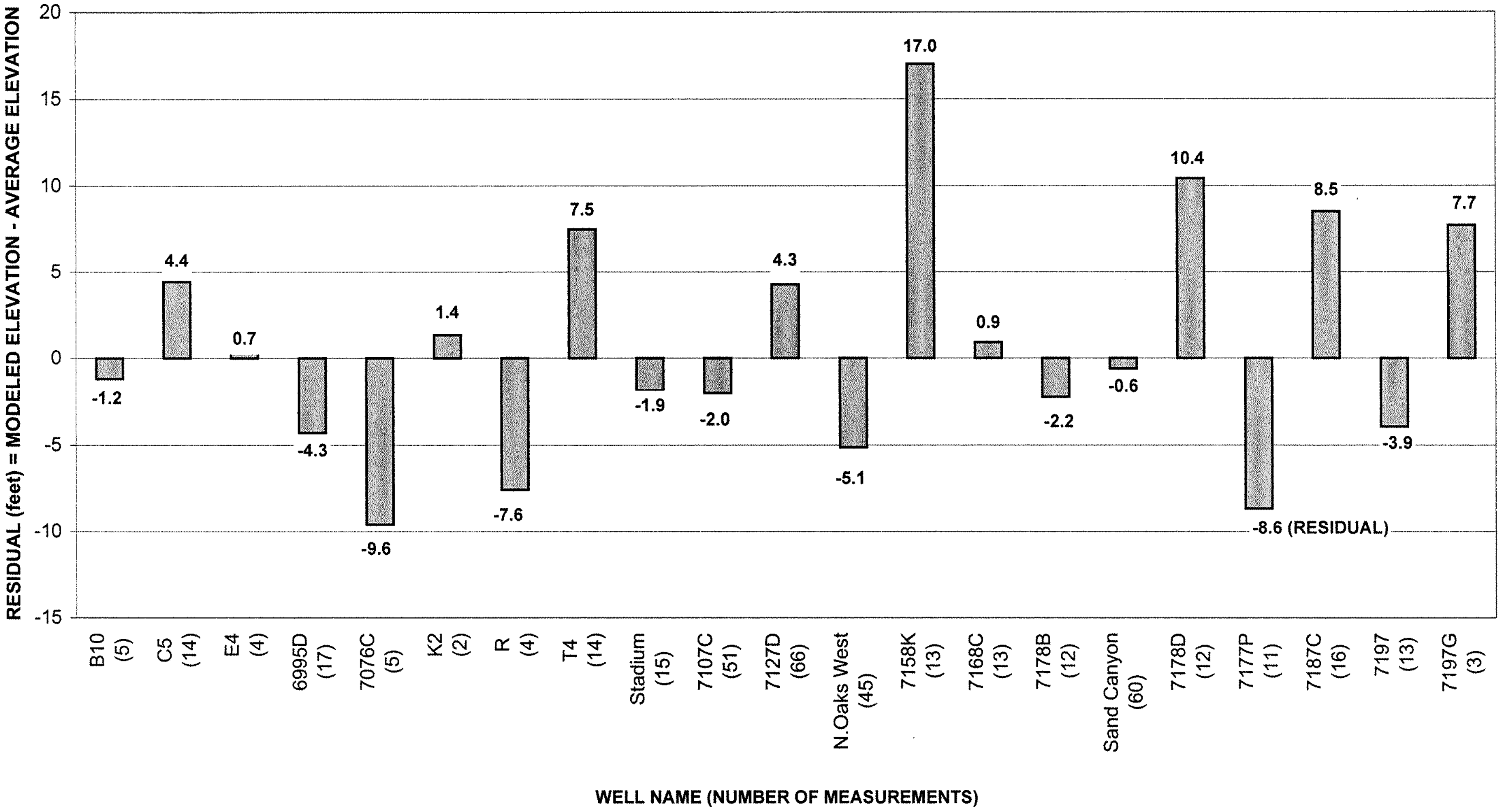


FIGURE 5-16

STEADY-STATE MODEL ERROR FOR ALLUVIAL AQUIFER TARGET WELLS ALONG THE SANTA CLARA RIVER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

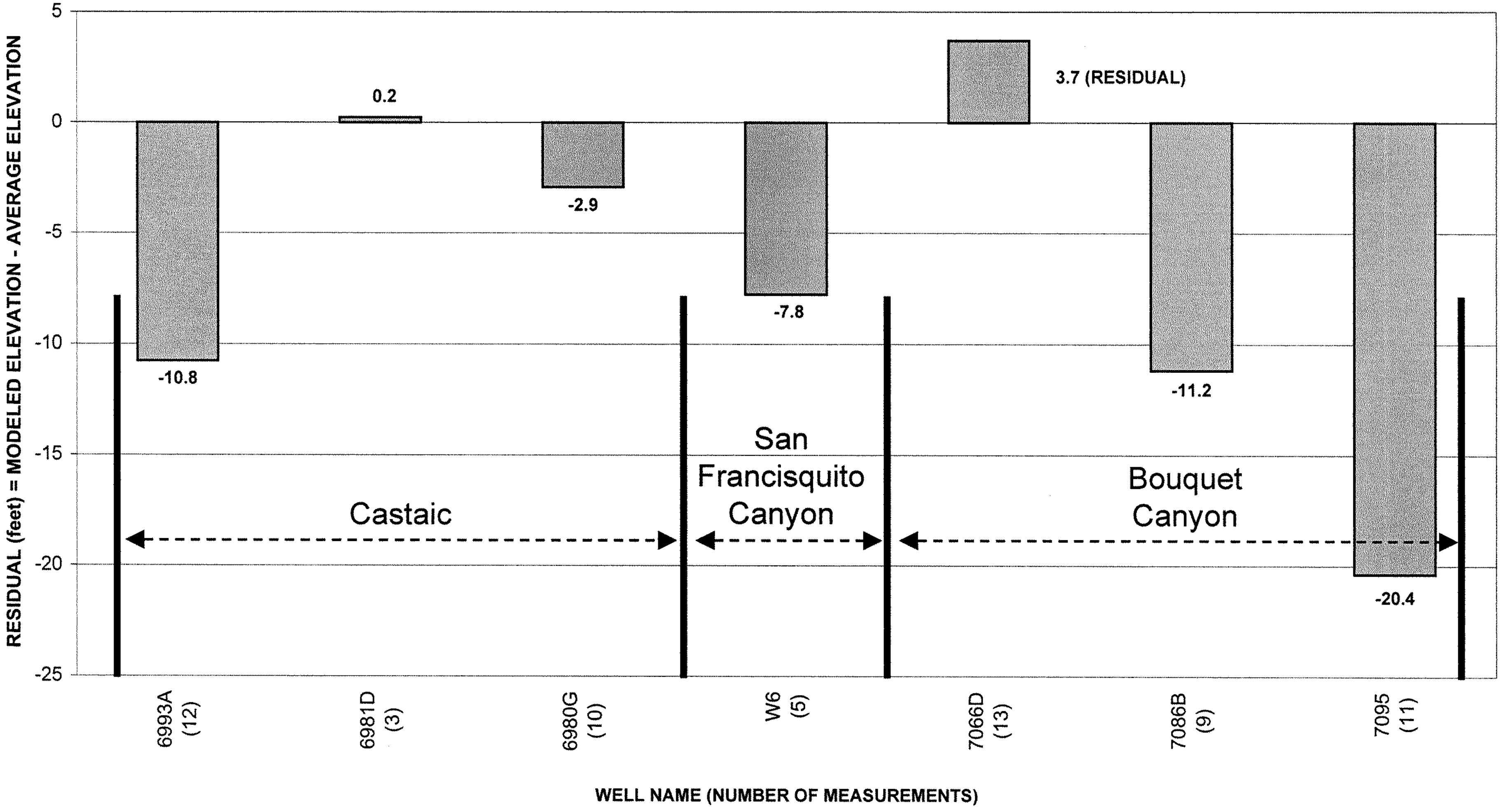
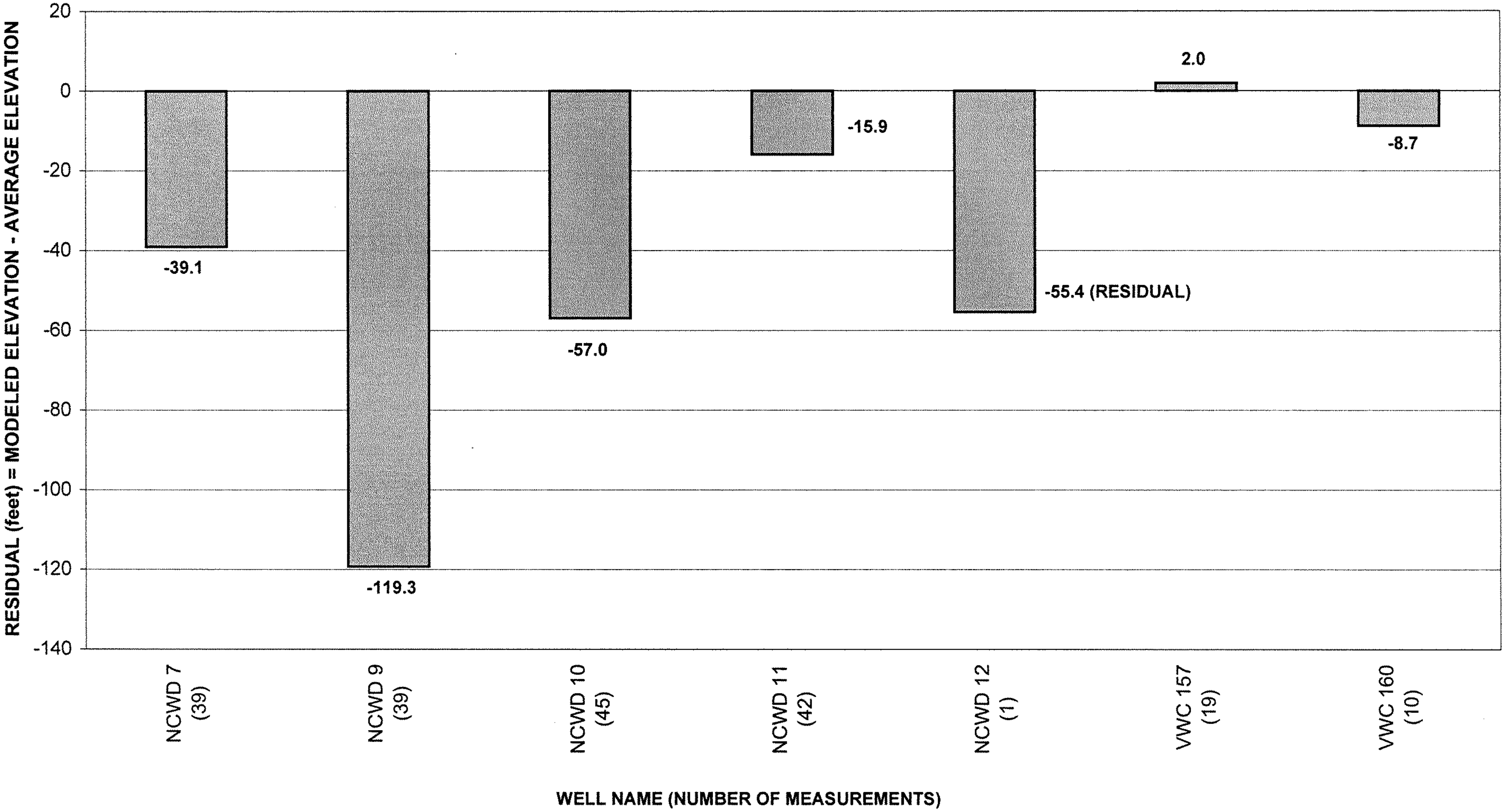


FIGURE 5-17
STEADY-STATE MODEL ERROR FOR ALLUVIAL AQUIFER TARGET WELLS AWAY FROM THE SANTA CLARA RIVER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



NOTE:
ALL WELLS SHOWN ON THIS PLOT ARE LOCATED IN THE SOUTH FORK SANTA CLARA RIVER VALLEY

FIGURE 5-18
STEADY-STATE MODEL ERROR FOR SAUGUS FORMATION PRODUCTION WELLS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

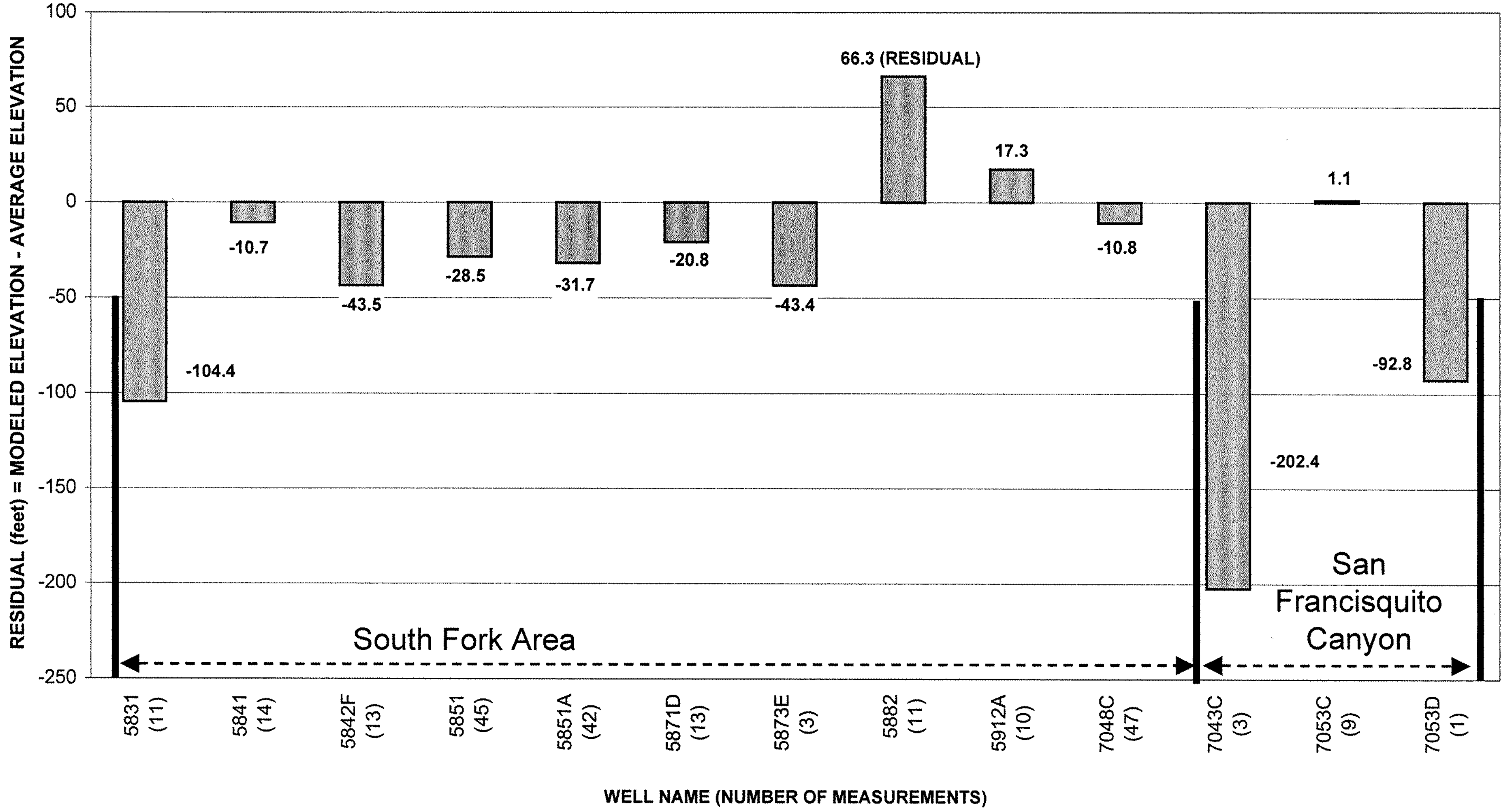
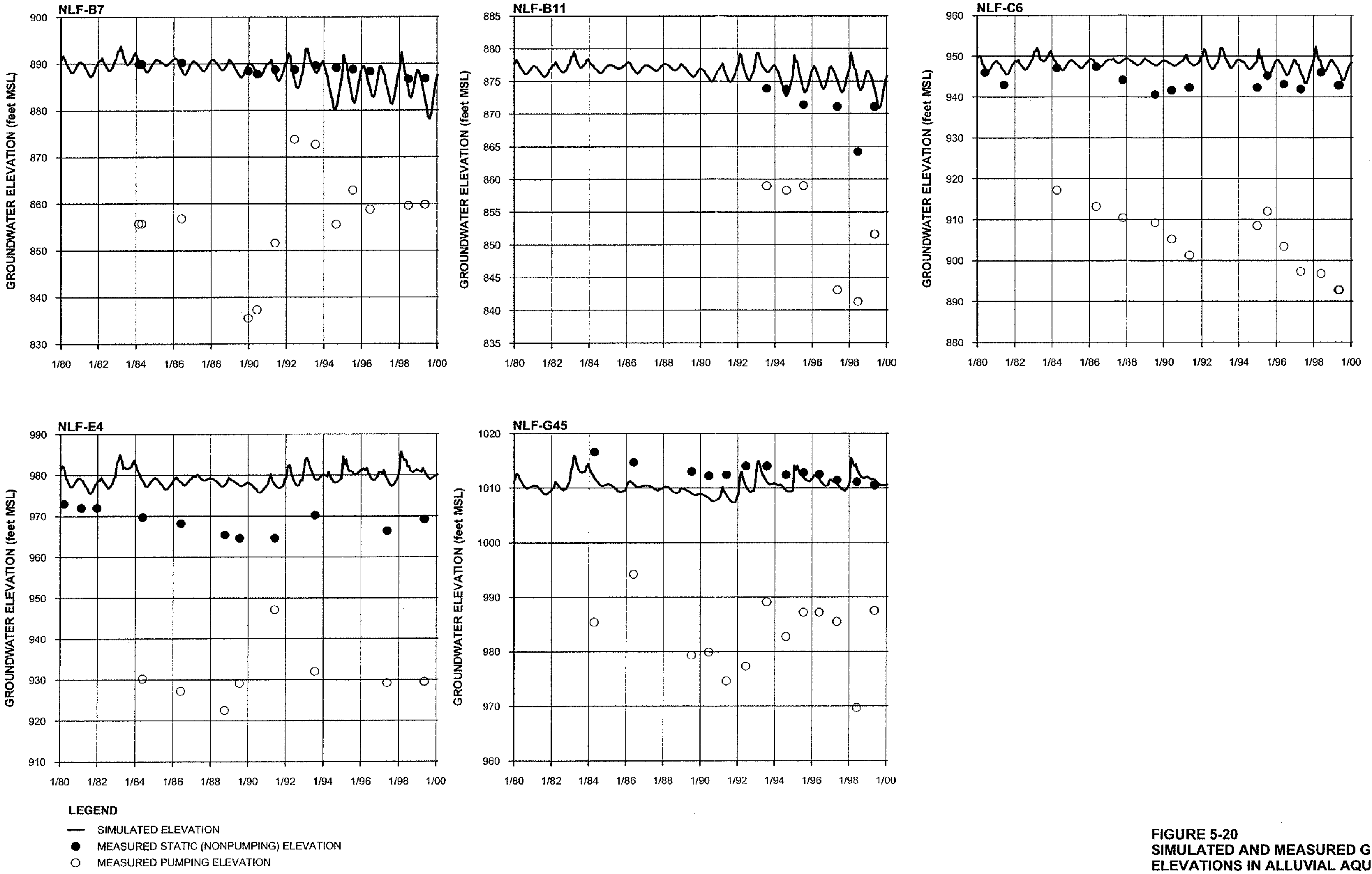


FIGURE 5-19
STEADY-STATE MODEL ERROR FOR SAUGUS FORMATION OBSERVATION WELLS

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-20
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS WEST OF INTERSTATE 5

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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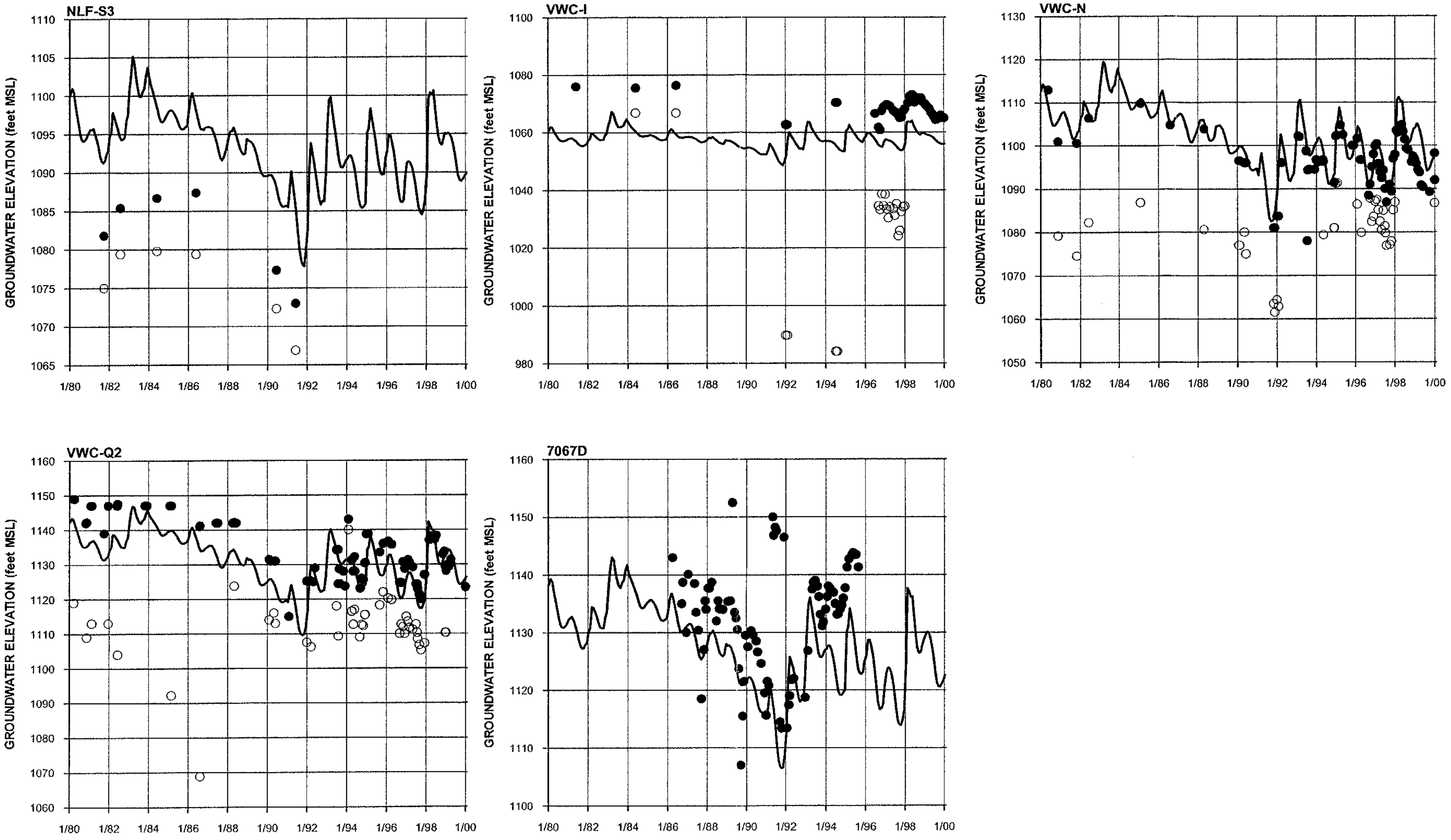


LEGEND

— SIMULATED ELEVATION

● MEASURED STATIC (NONPUMPING) ELEVATION

○ MEASURED PUMPING ELEVATION

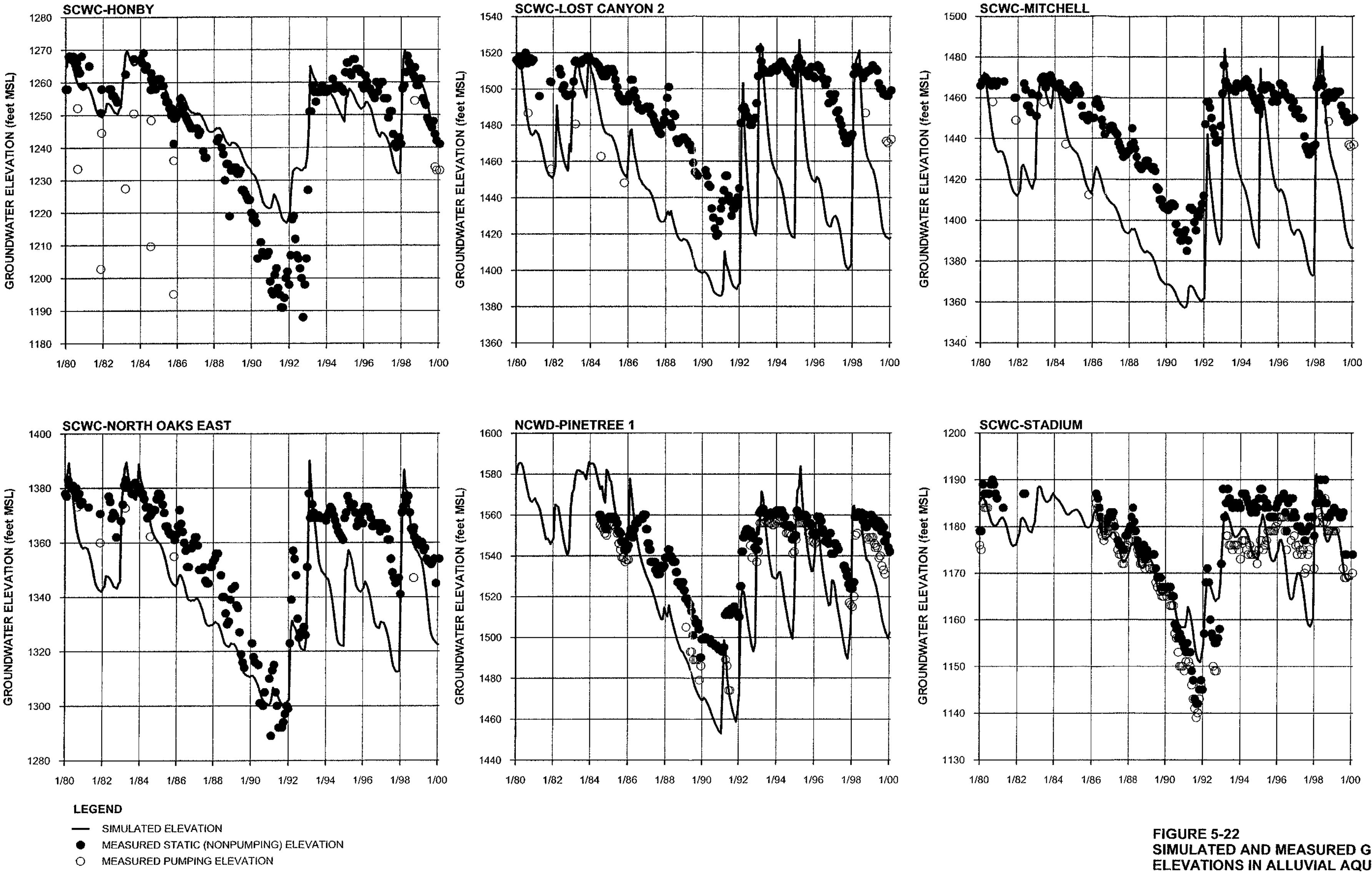
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-21
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS BETWEEN INTERSTATE 5 AND SOLEDAD CANYON

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

175570-312.GRF

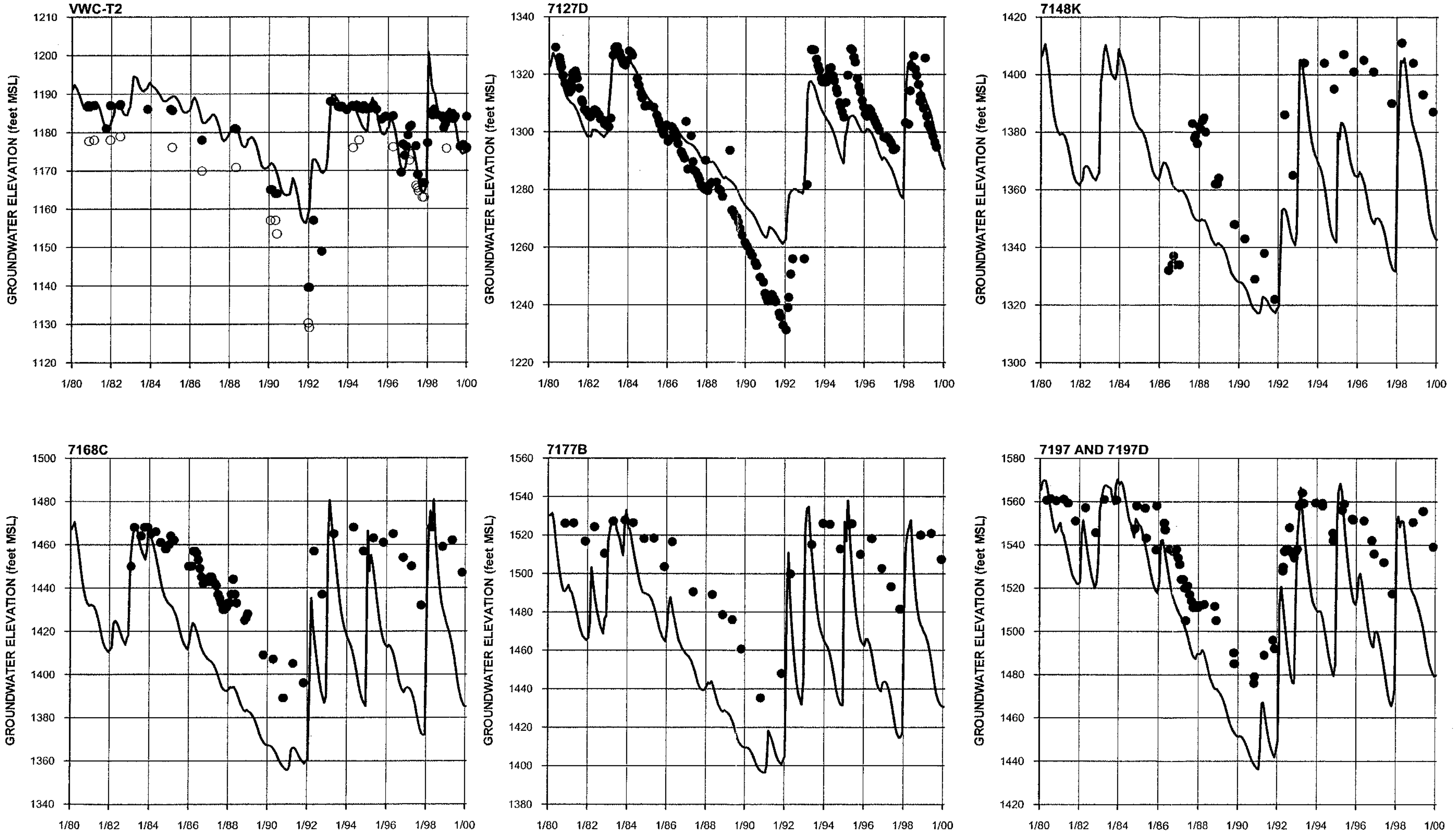


NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-22
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 1 OF 2)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



LEGEND

— SIMULATED ELEVATION

● MEASURED STATIC (NONPUMPING) ELEVATION

○ MEASURED PUMPING ELEVATION

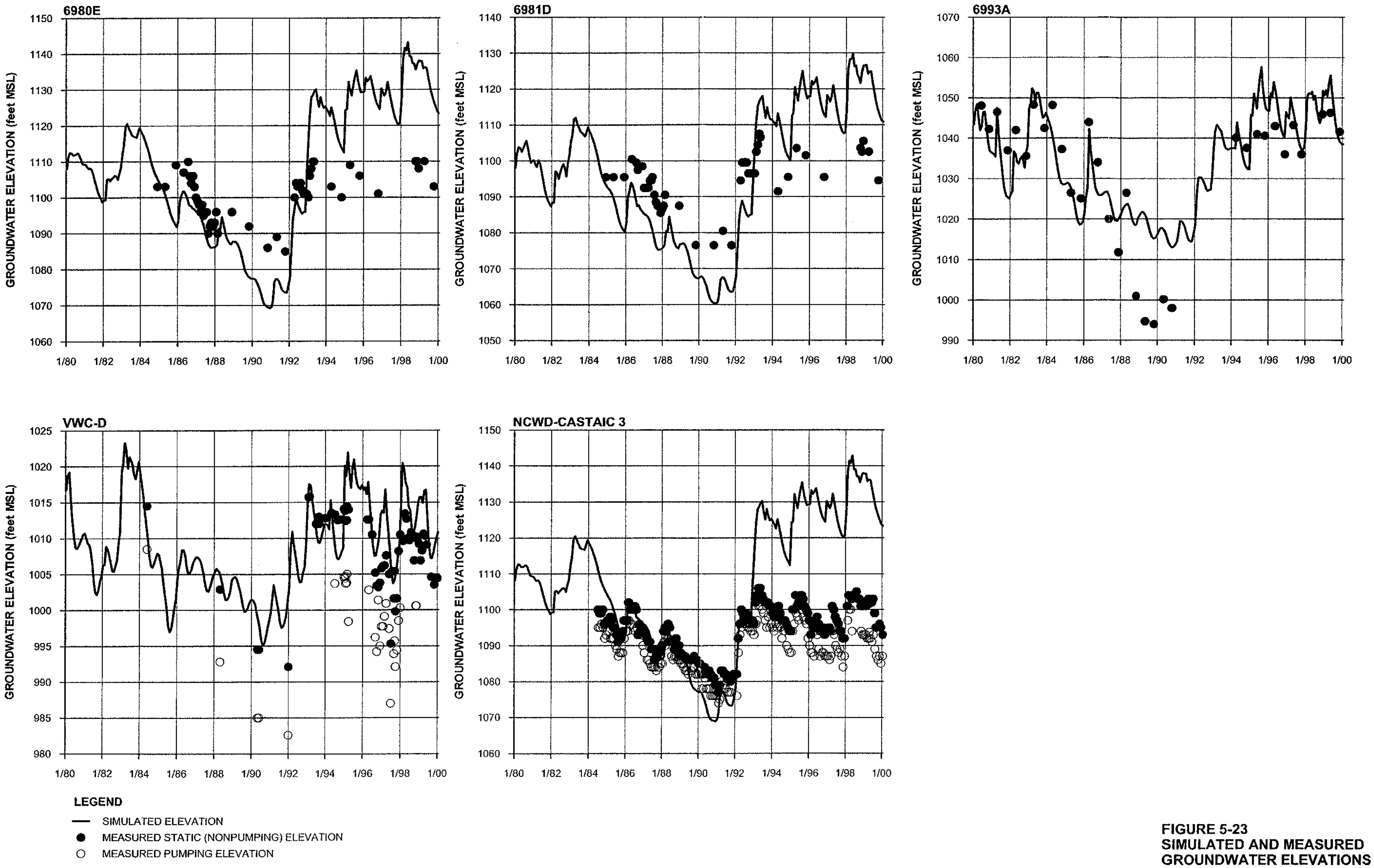
NOTE: SEE FIGURE 2-3 FOR LOCATION OF WELLS.

FIGURE 5-22
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 2 OF 2)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-314.GRF

CH2MHILL



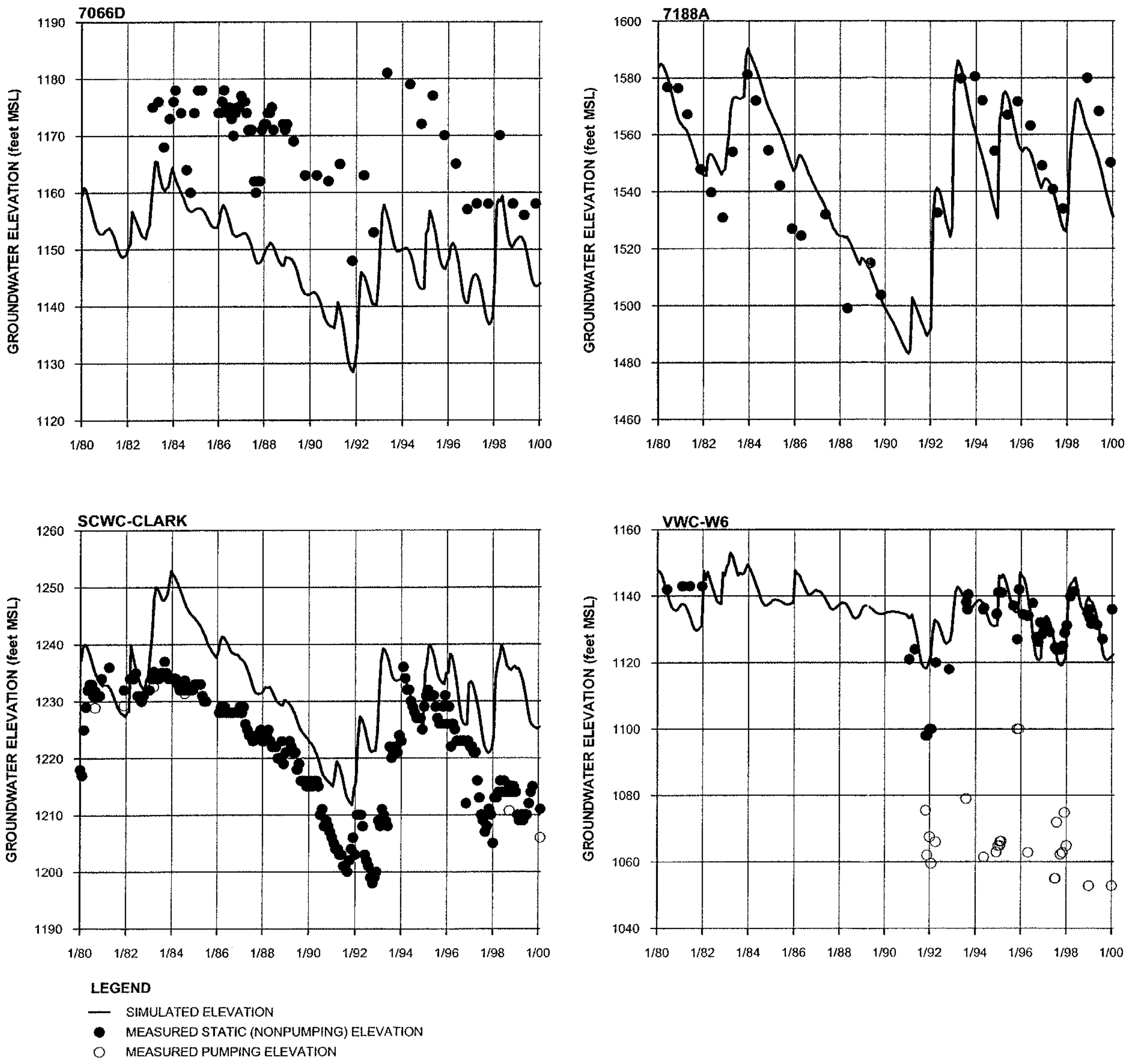
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-315.GRF

FIGURE 5-23
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS ALONG CASTAIC CREEK

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



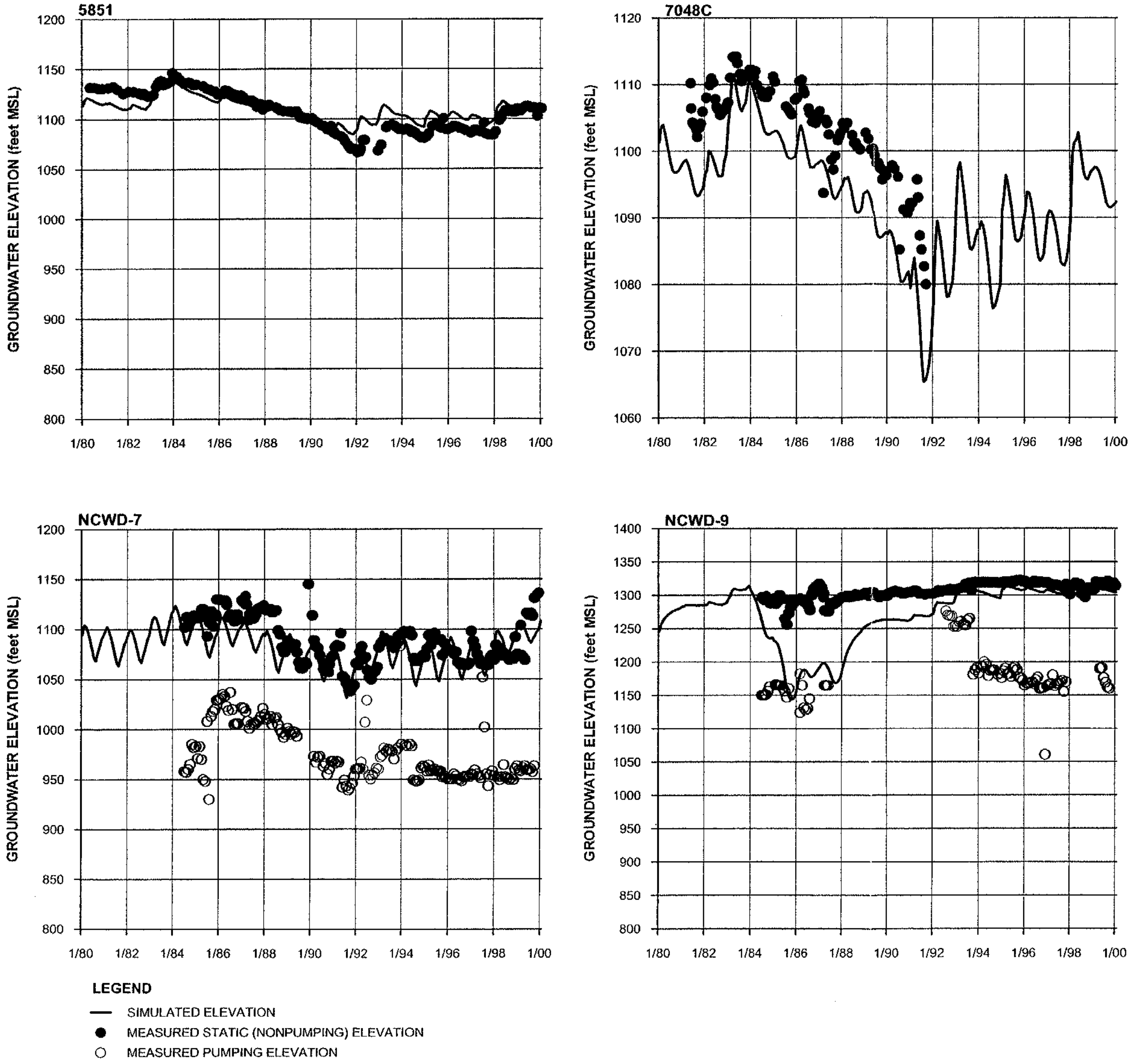
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-316.GRF

FIGURE 5-24
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN OTHER TRIBUTARY CANYONS TO THE SANTA CLARA RIVER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



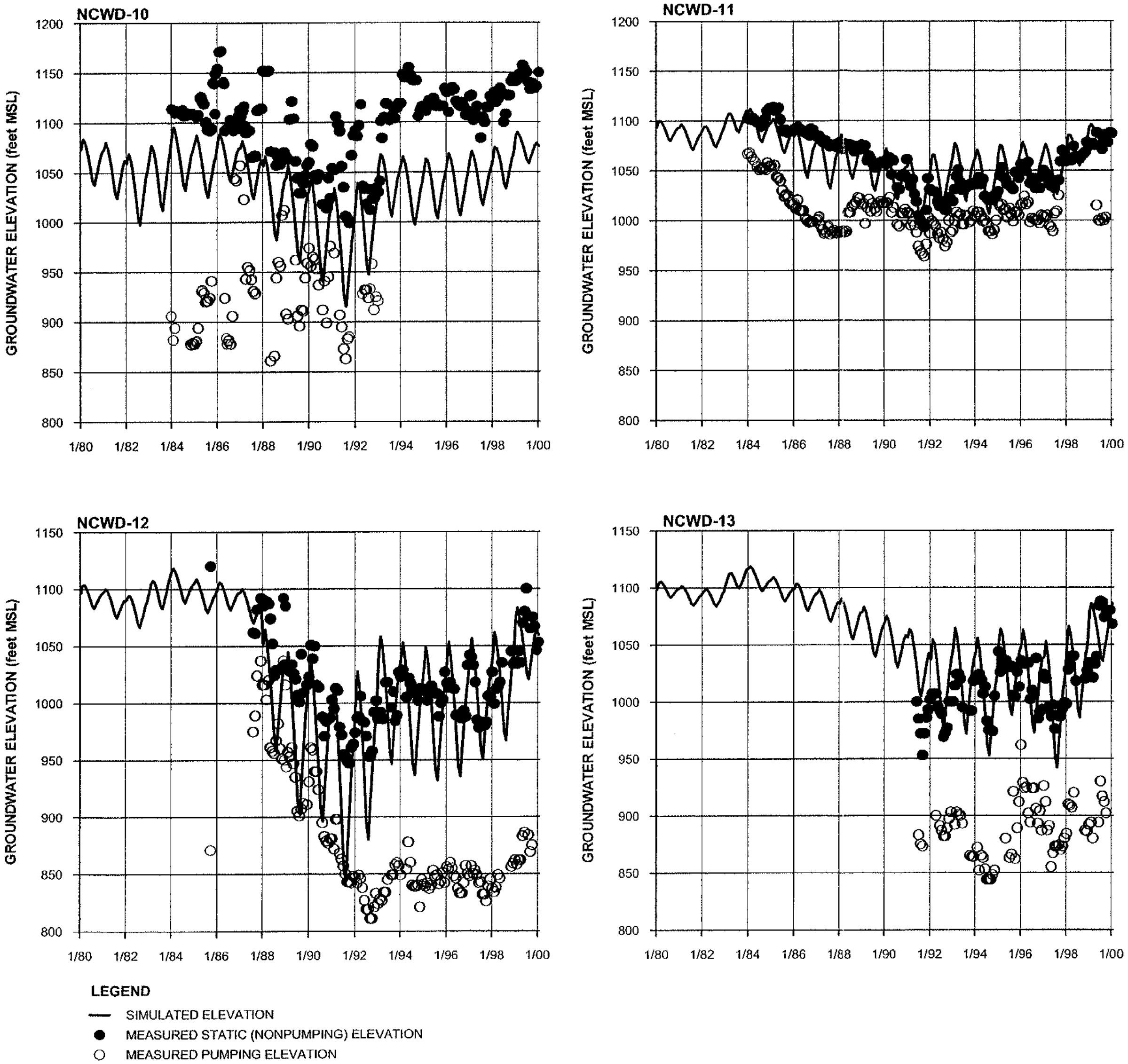
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-319.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 1 0F 3)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

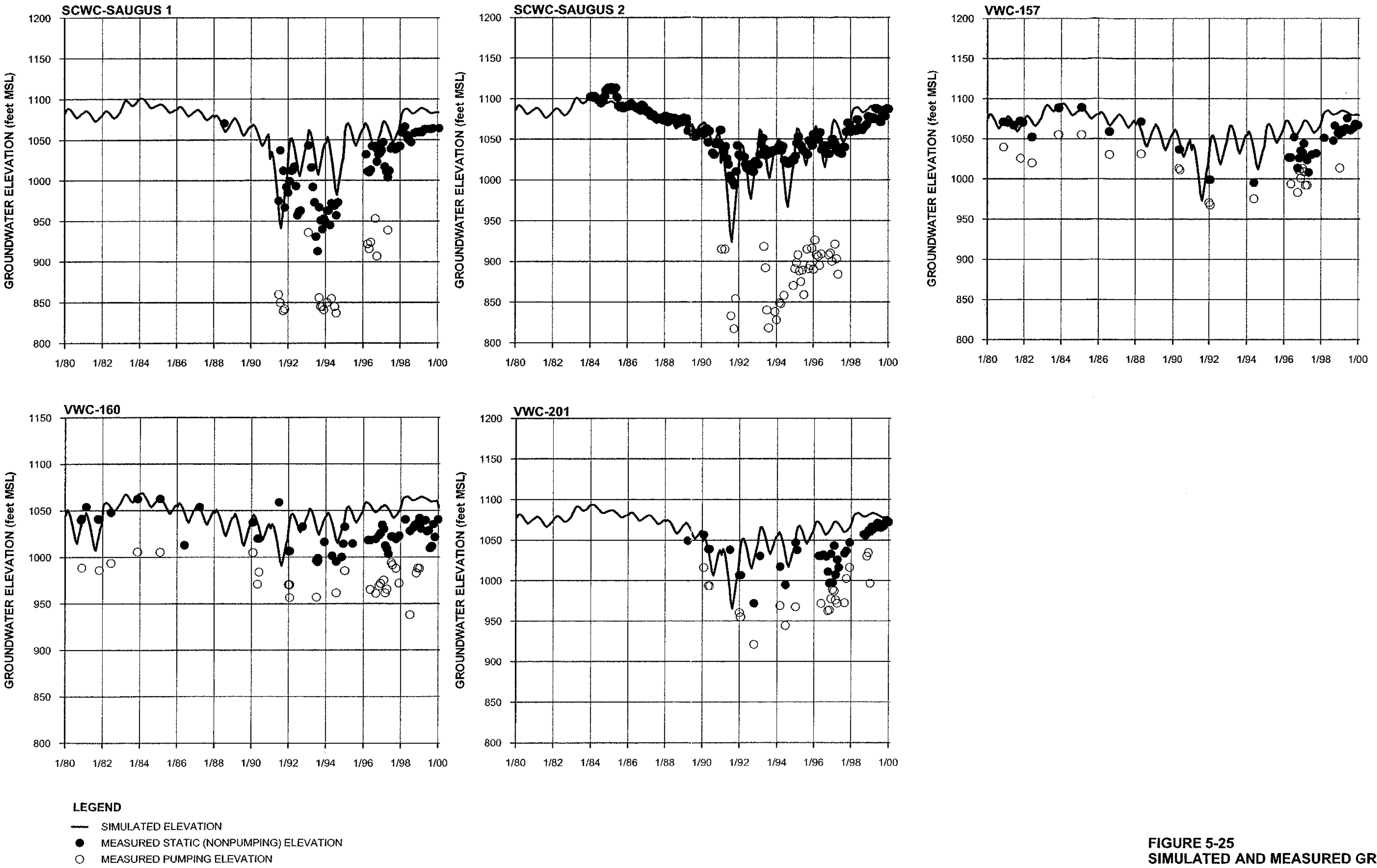


NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-317.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS
(PAGE 2 0F 3)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-318.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 3 0F 3)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

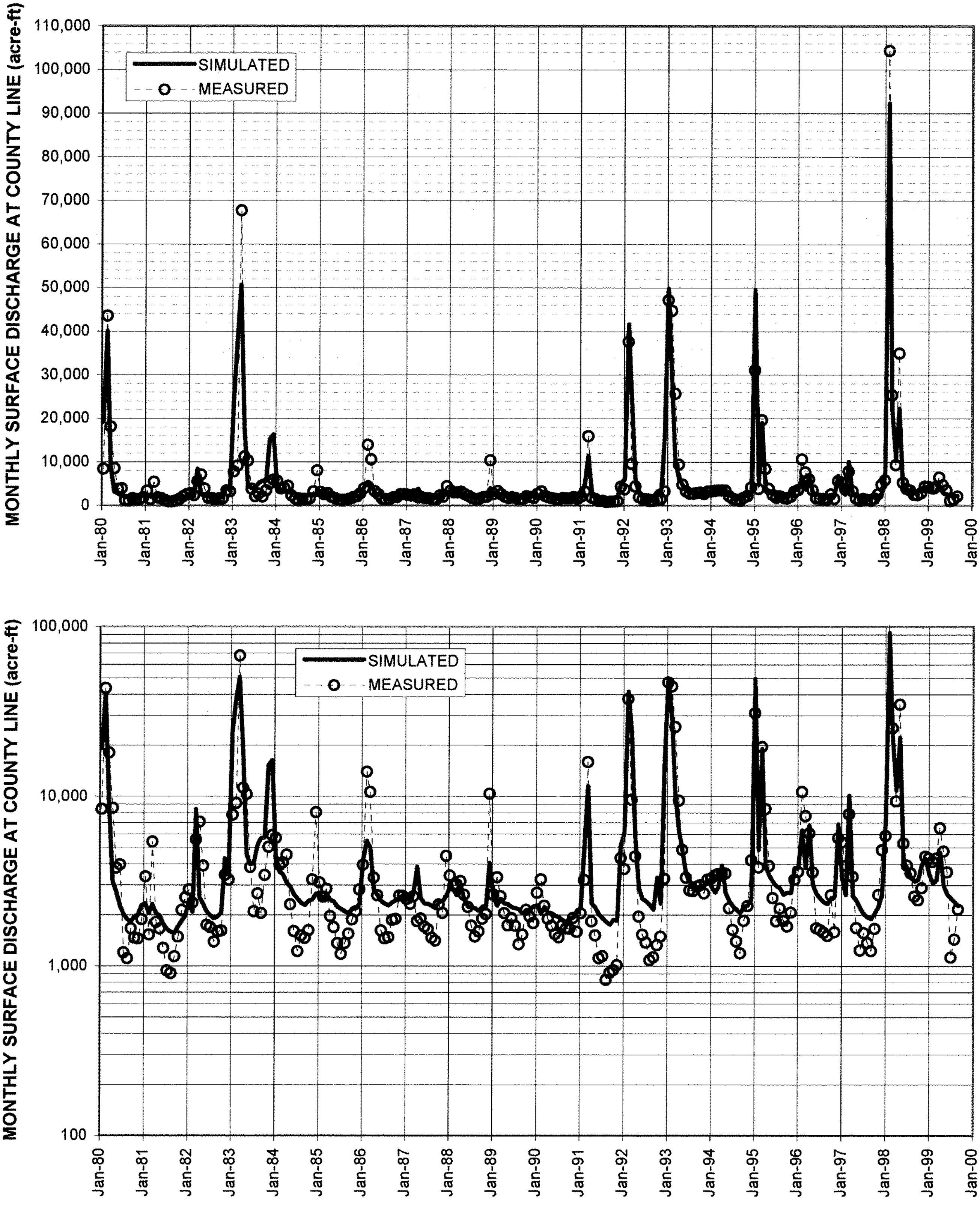


FIGURE 5-26
SIMULATED VERSUS MEASURED HYDROGRAPHS OF SANTA CLARA RIVER FLOW AT COUNTY LINE

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

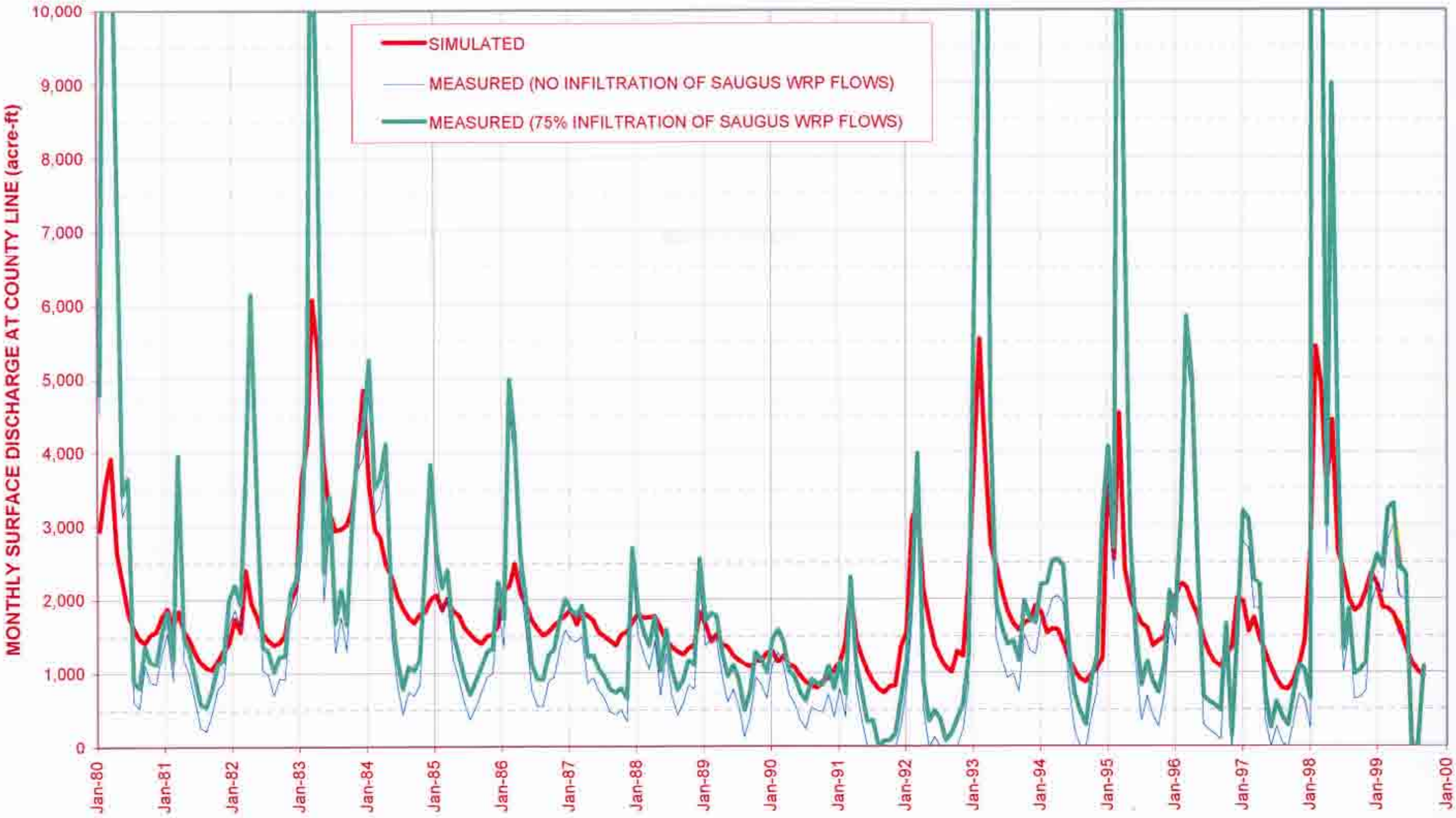


FIGURE 5-27
SIMULATED VERSUS MEASURED HYDROGRAPH OF GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

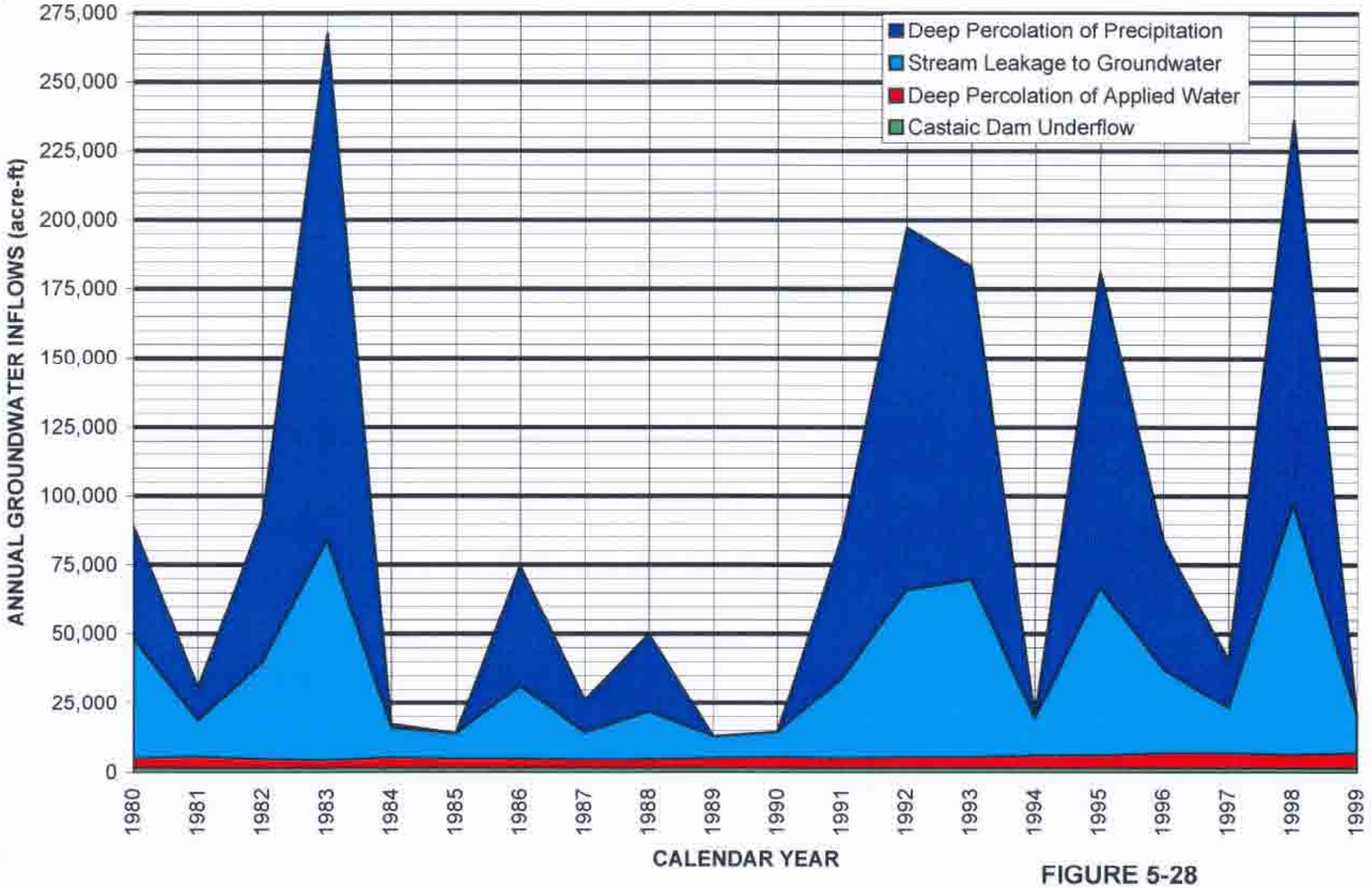


FIGURE 5-28
ANNUAL GROUNDWATER INFLOWS

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

04/04/2004
178973-410.xls/Fig 5-28

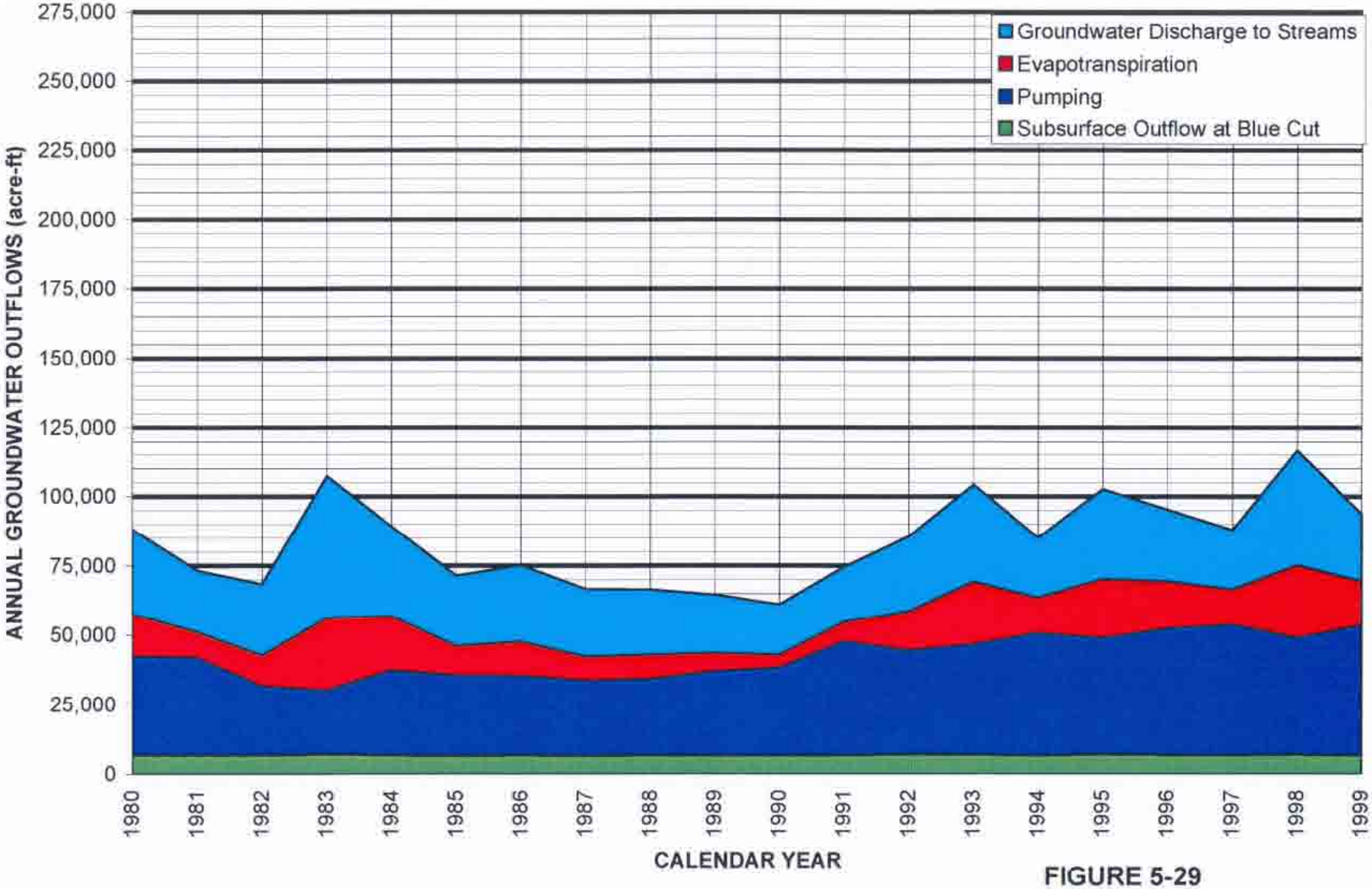


FIGURE 5-29
ANNUAL GROUNDWATER OUTFLOWS

REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

04/04/2004
178973-410.xls/Fig 5-29

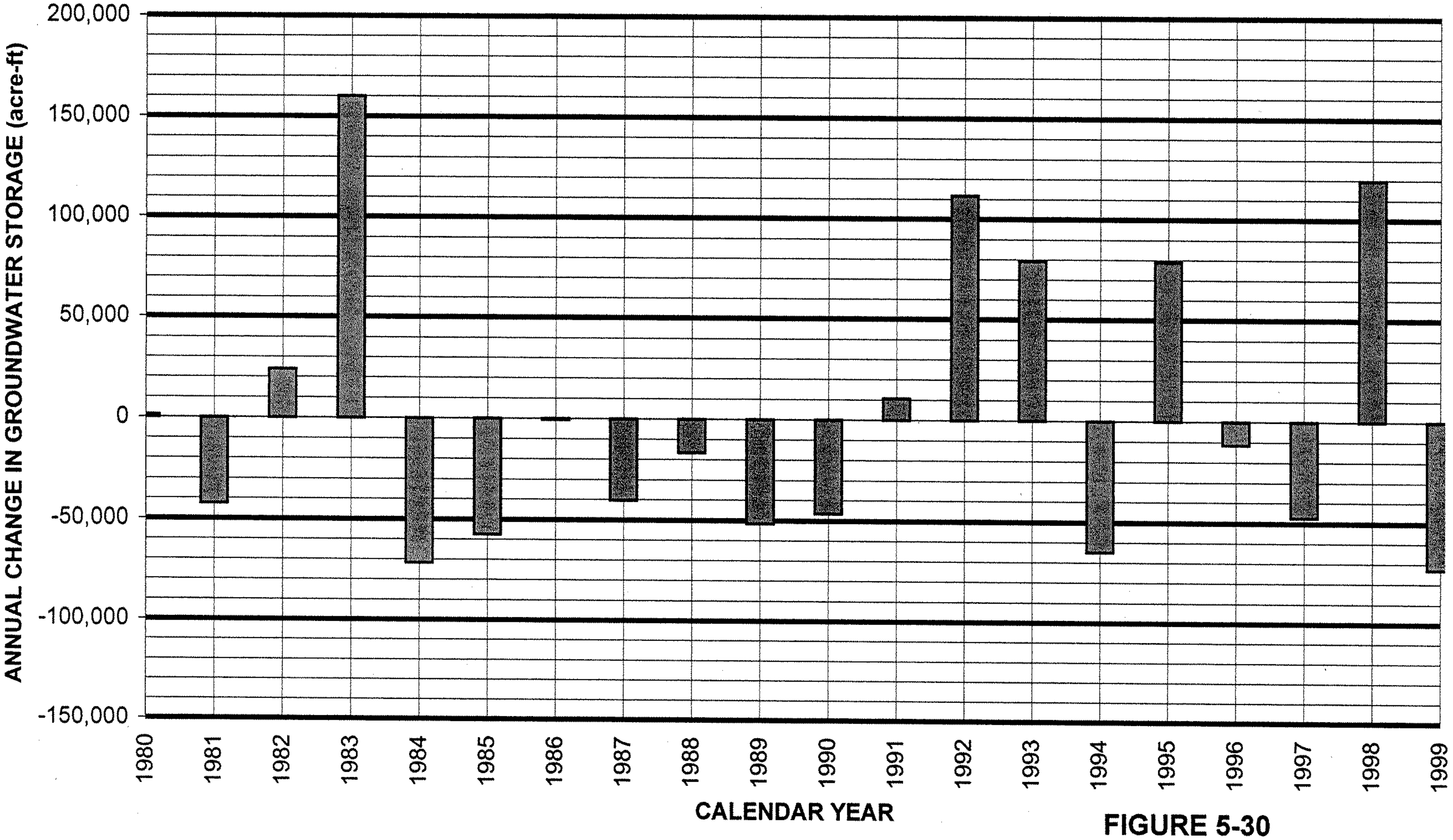


FIGURE 5-30
ANNUAL CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

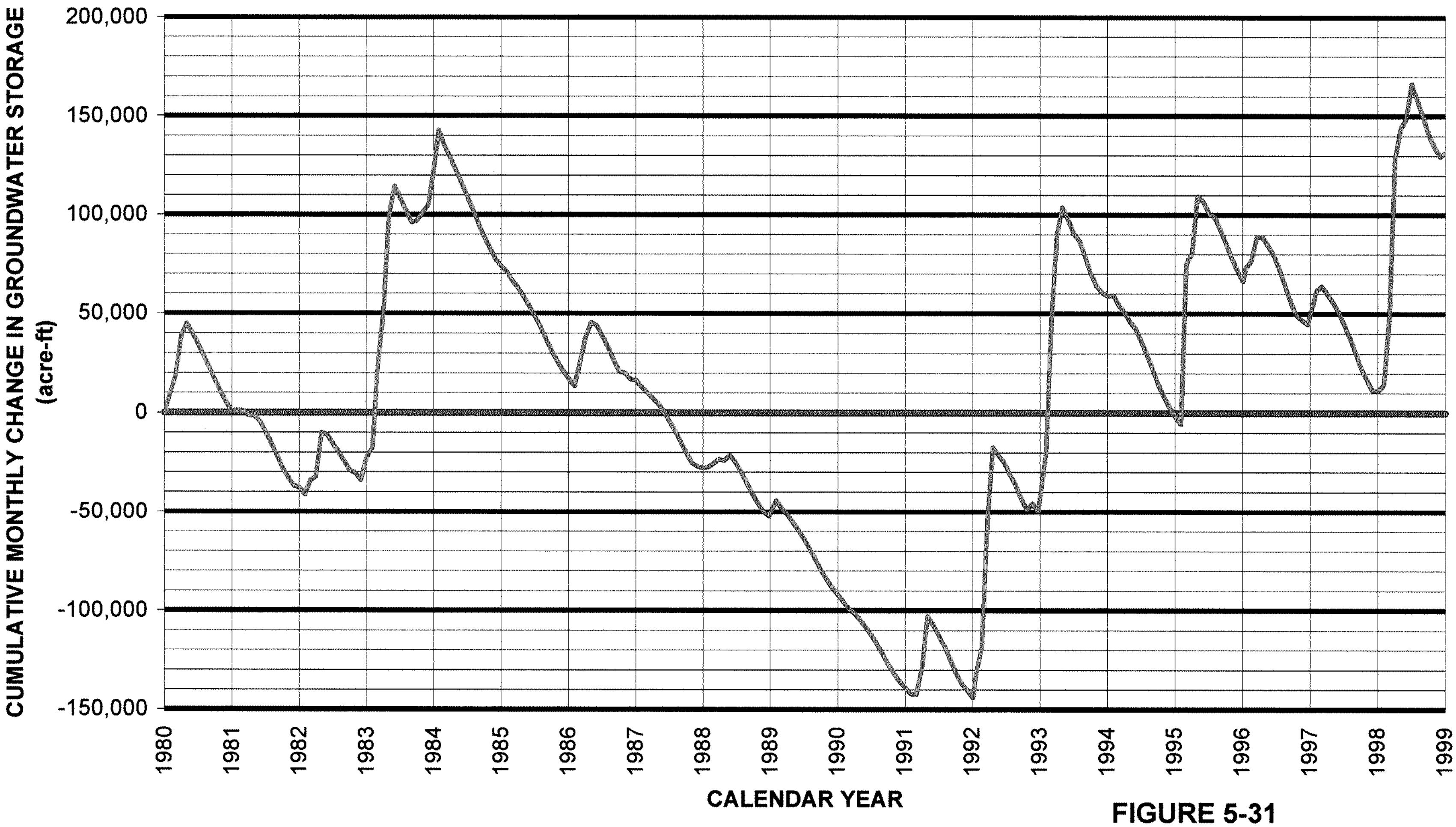
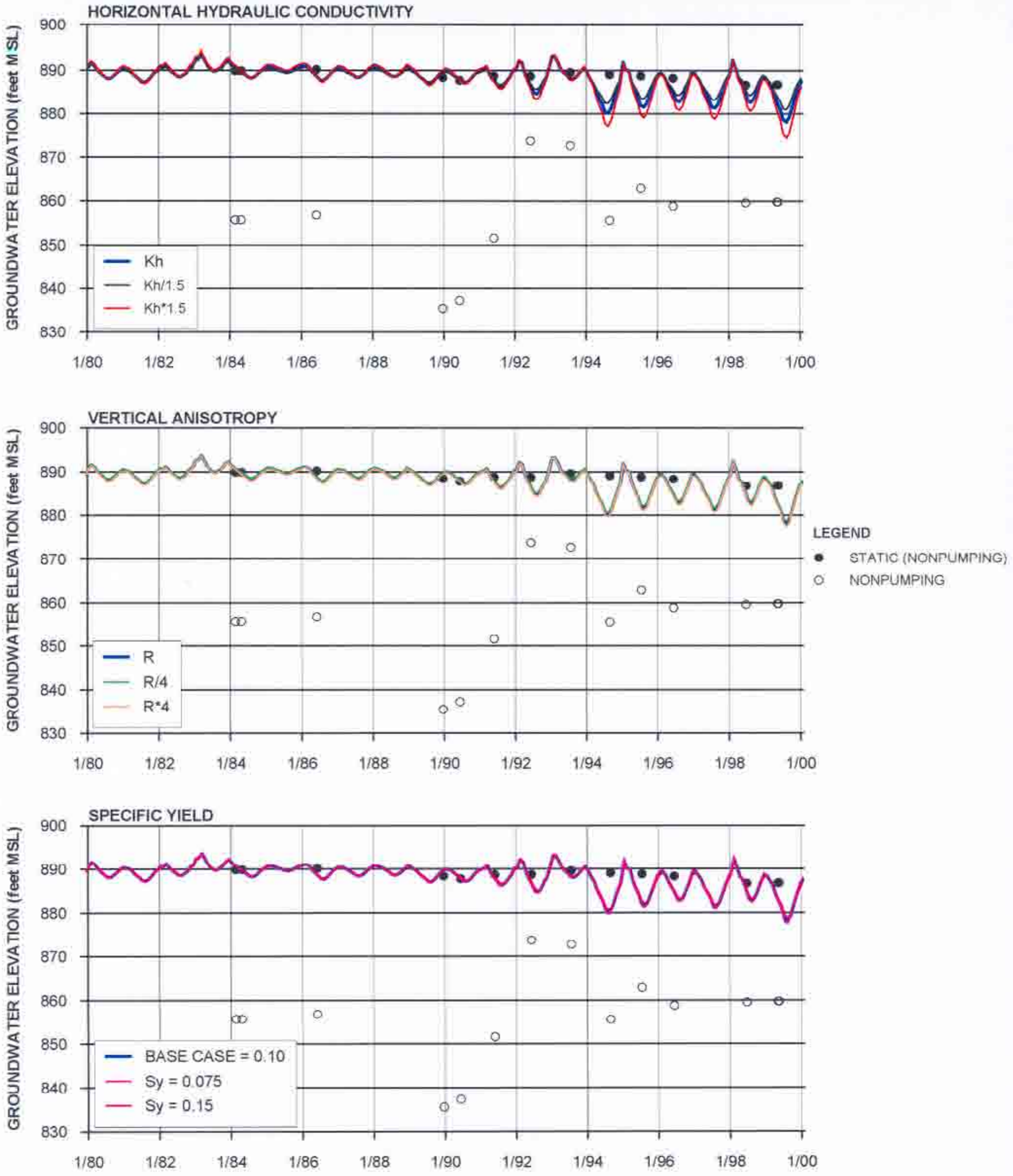


FIGURE 5-31
CUMULATIVE CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

04/04/2004
178973-410.xls/Fig 5-31

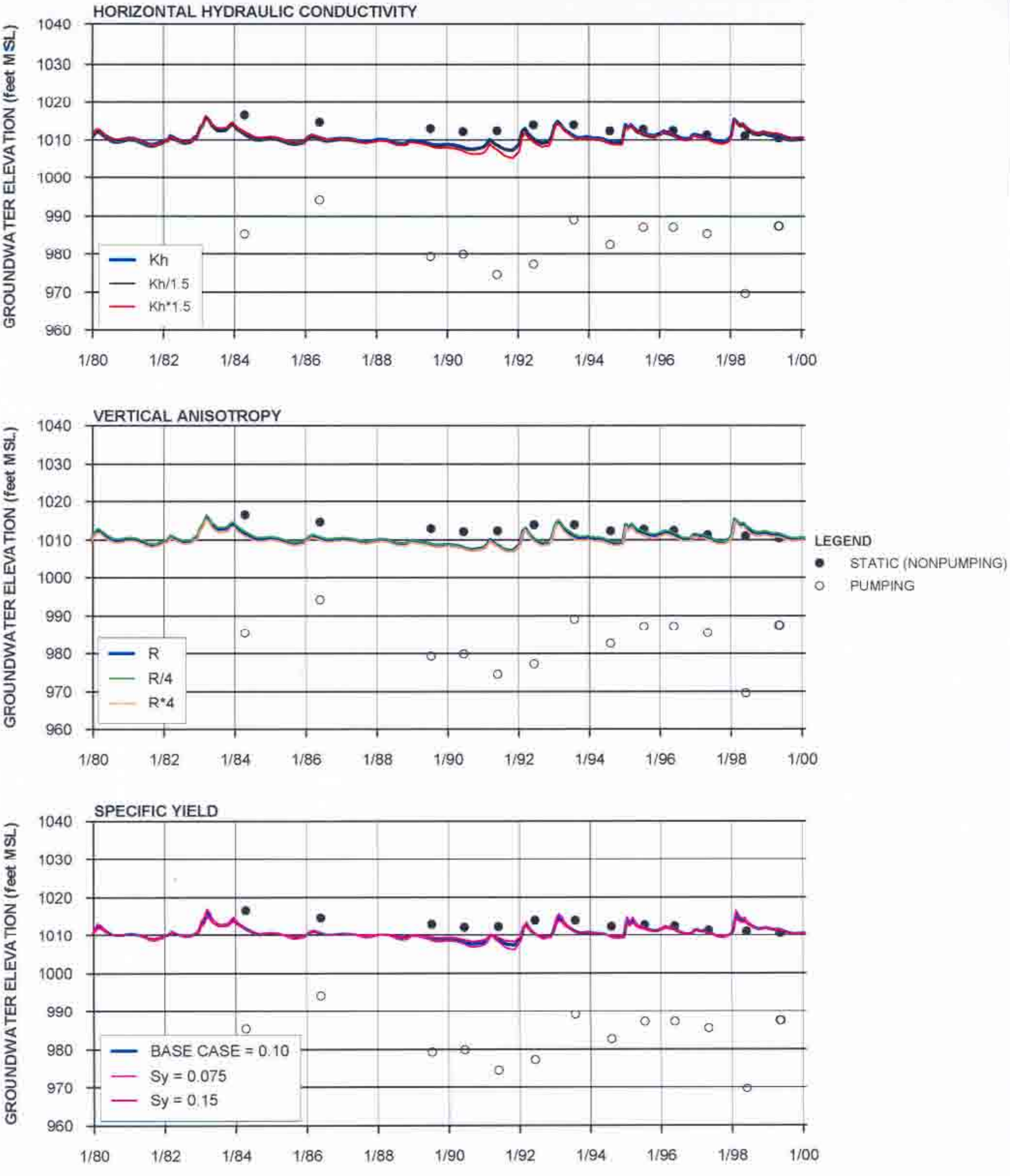


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-32
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-B7 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-311.GRF

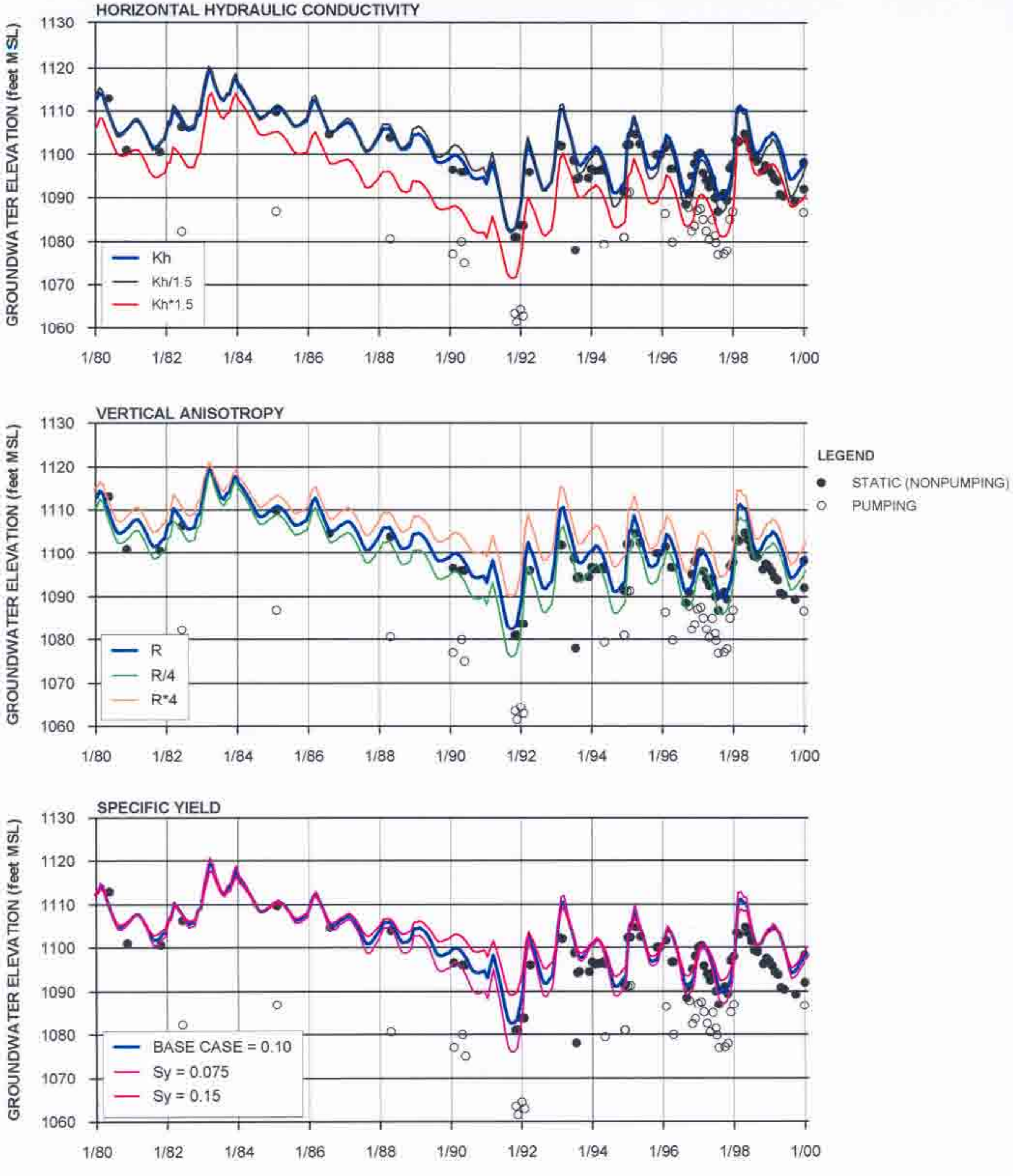


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-33
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-G45 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

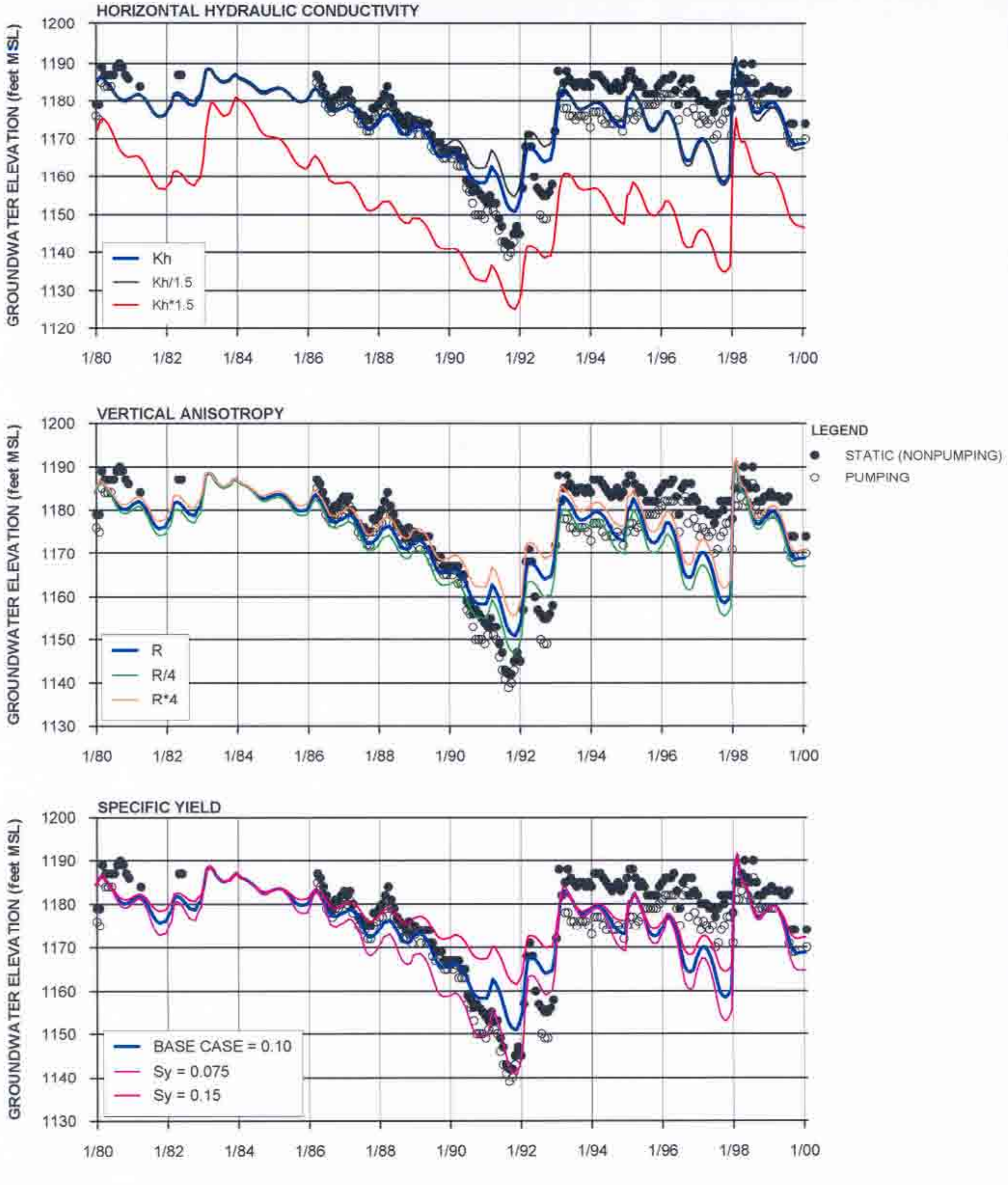
178973-320.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-34
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-N TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

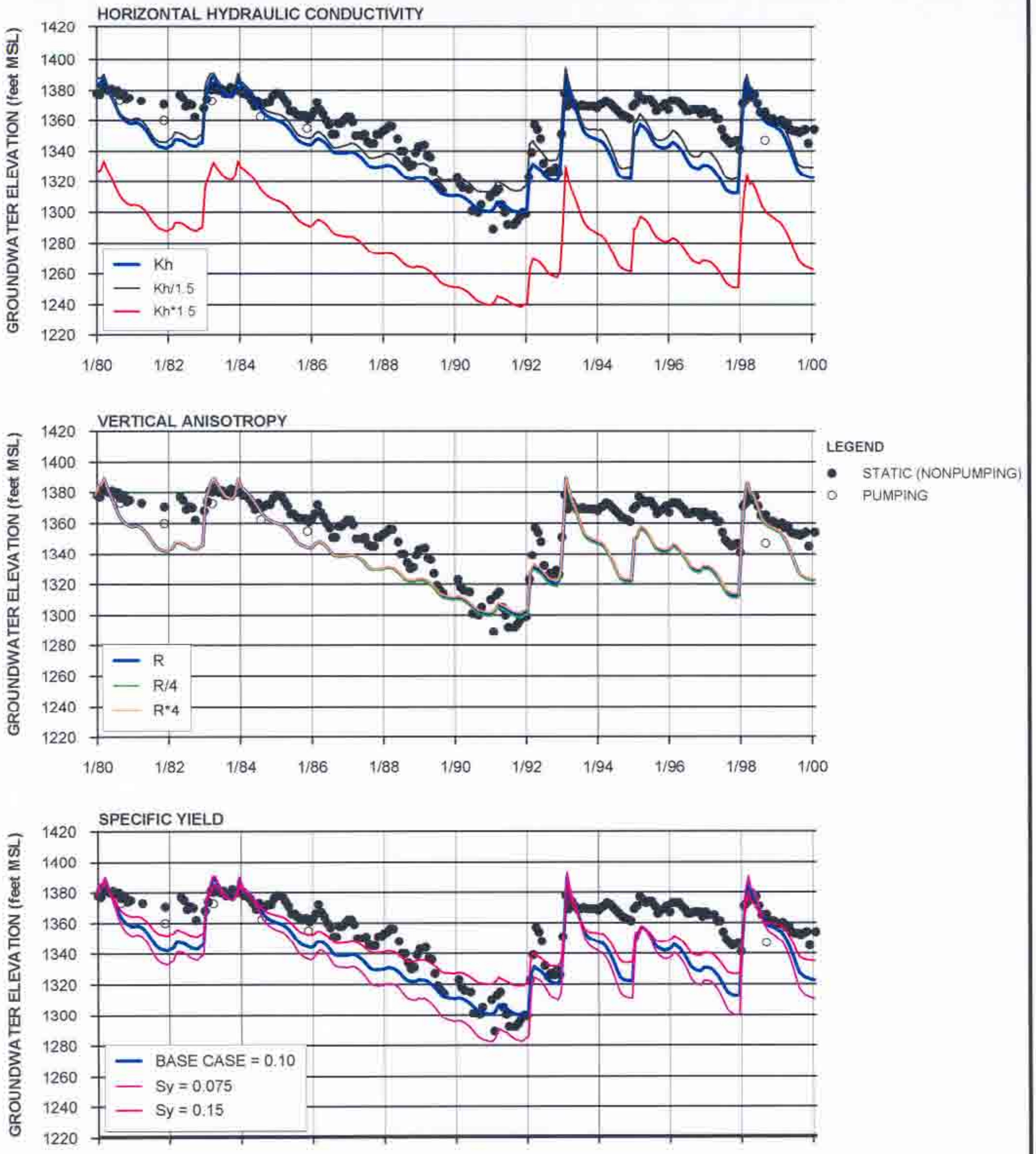


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-35
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-STADIUM TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-322.GRF

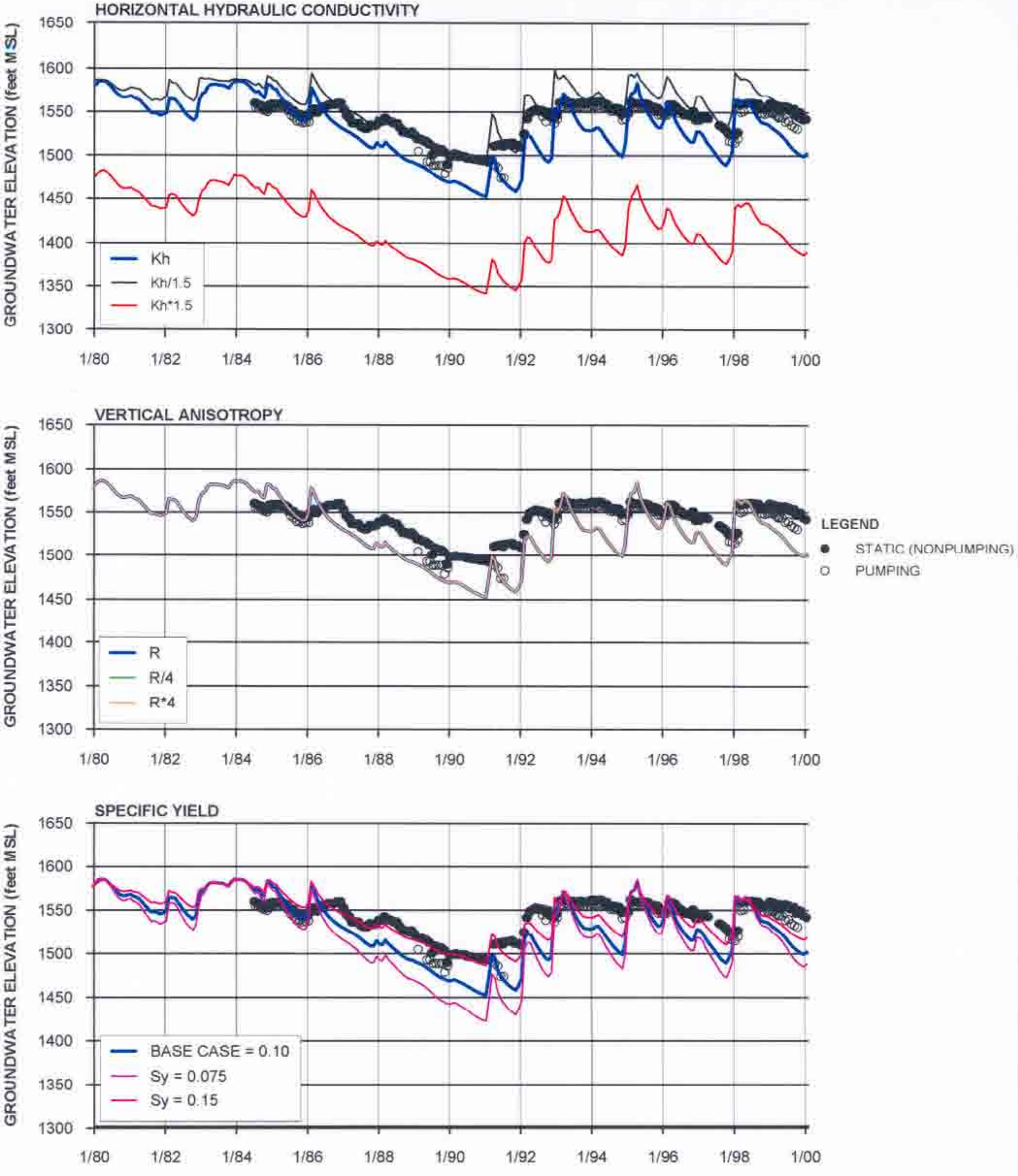


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-36
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-NORTH OAKS EAST TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

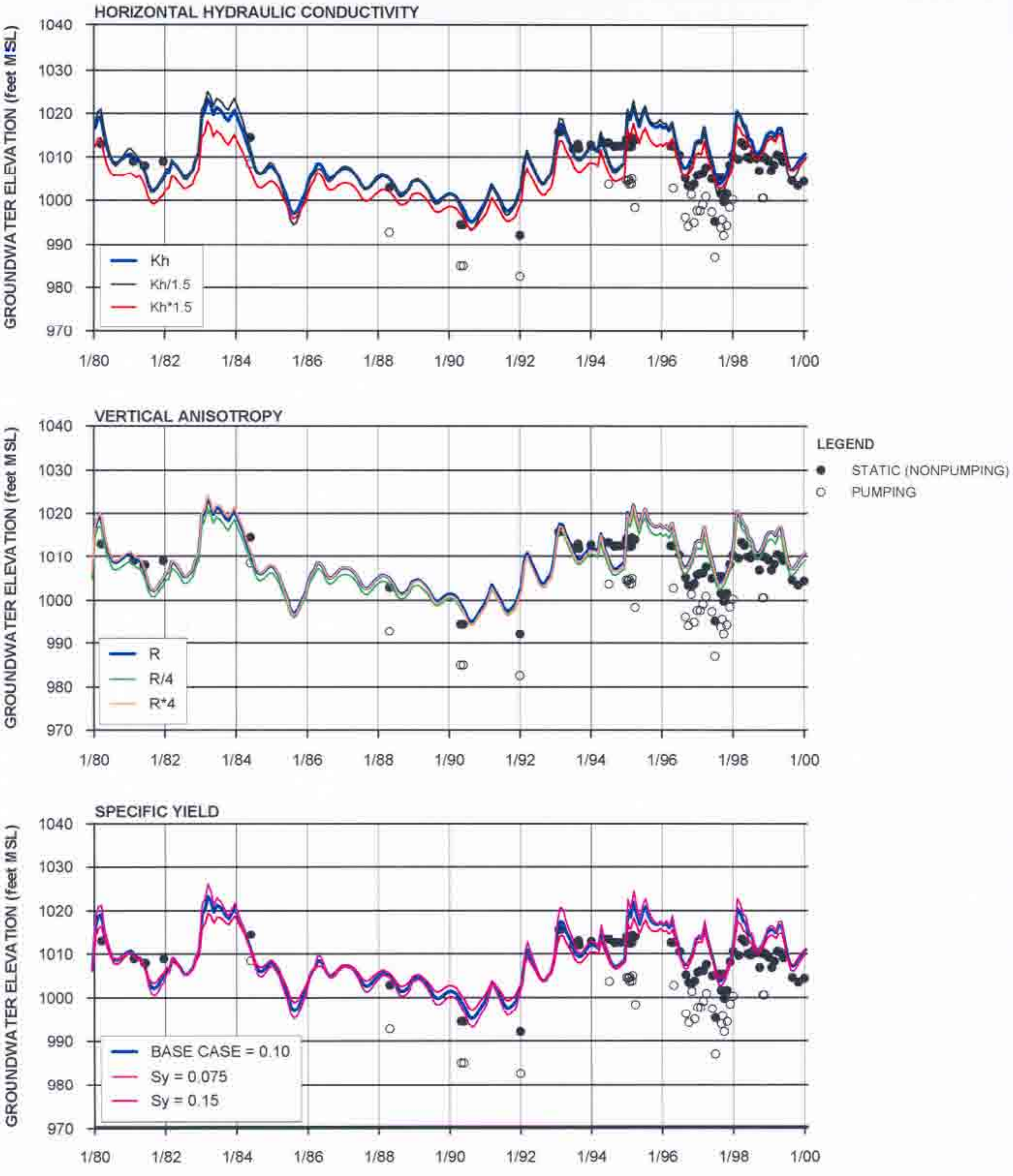
178973-325.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-37
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NCWD-PINETREE1 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

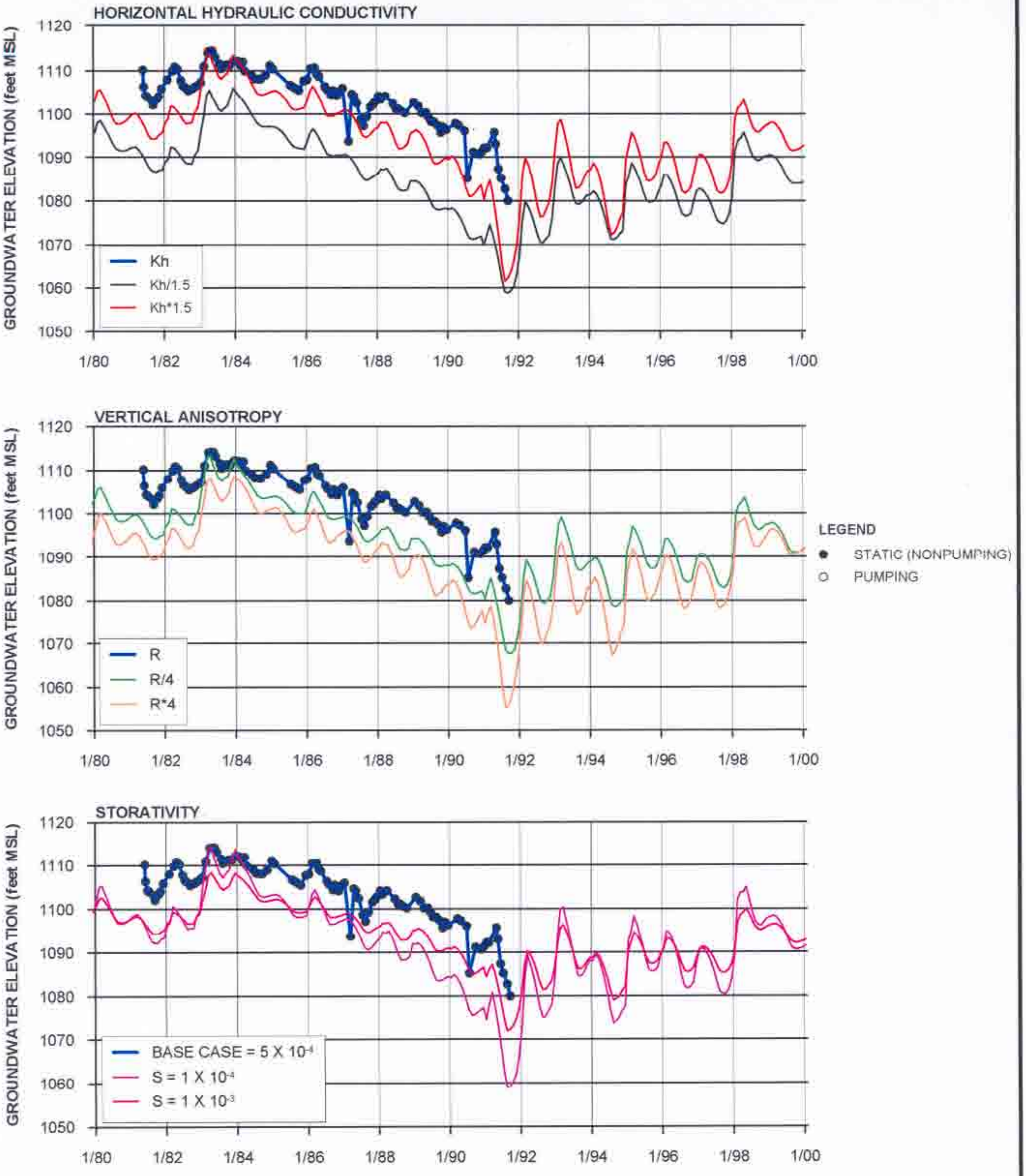


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-38
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-D TO AQUIFER PARAMETERS

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-324.GRF

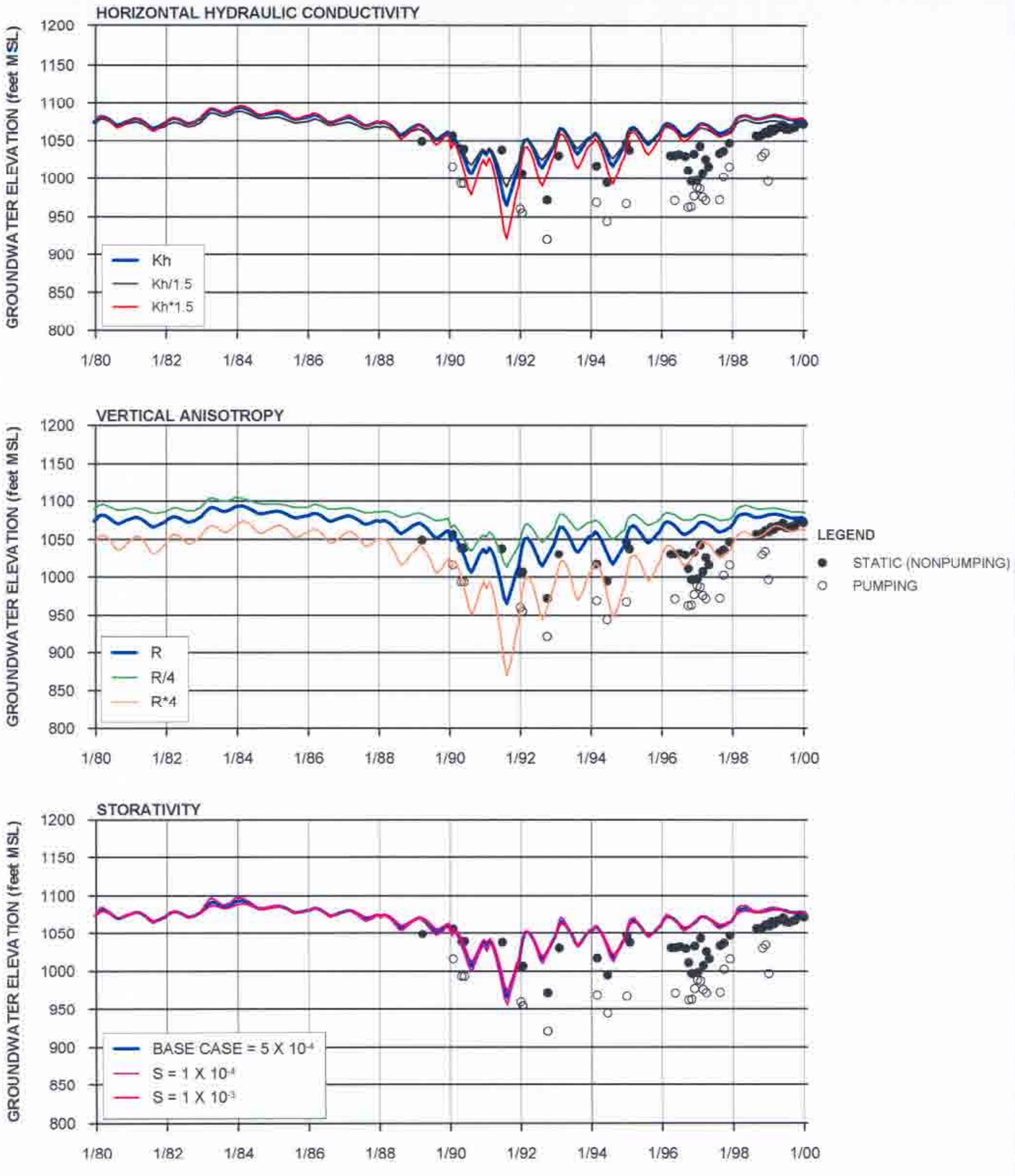


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-39
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 7048C TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-327.GRF

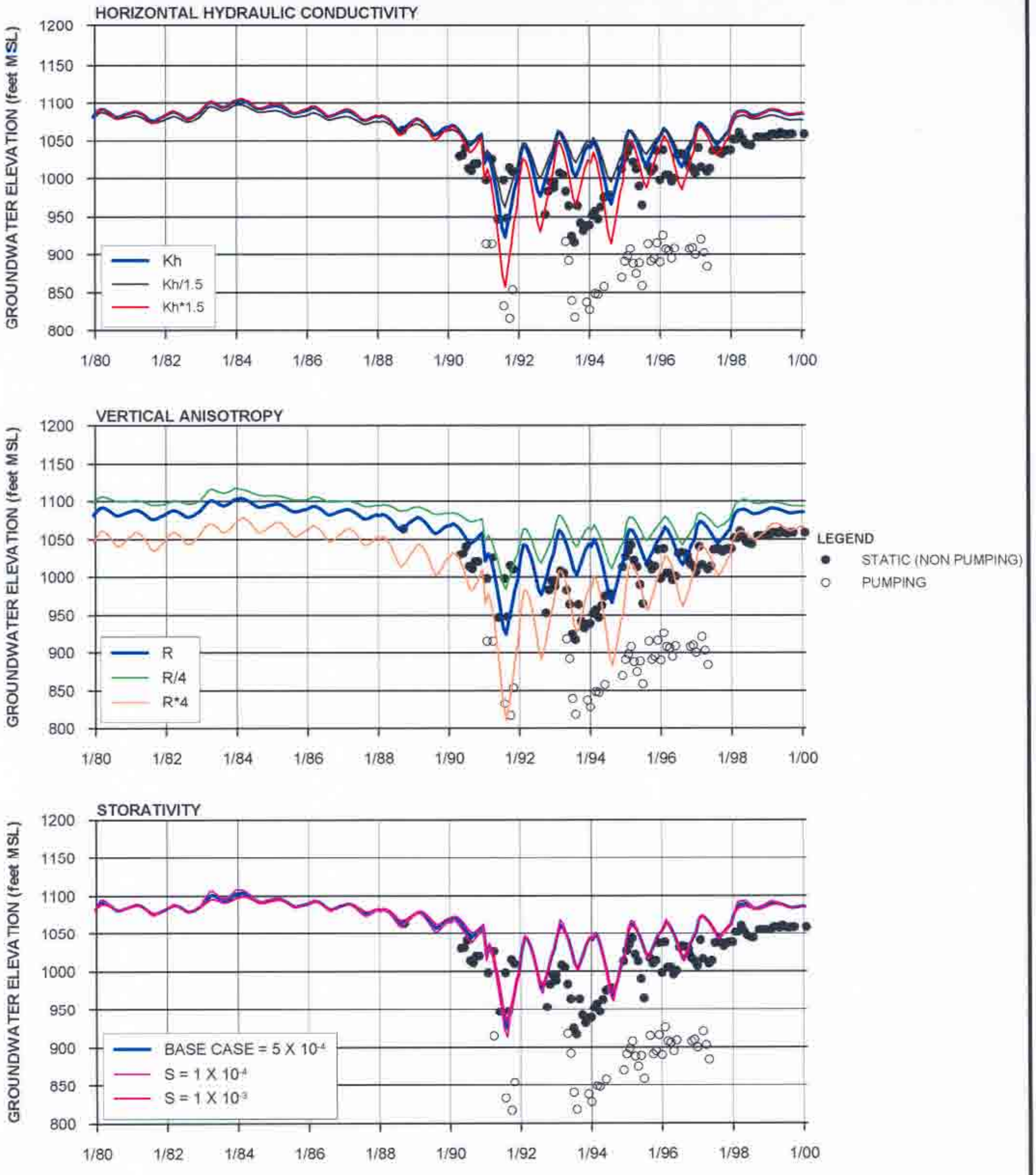


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-40
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT VWC-201 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-328.GRF

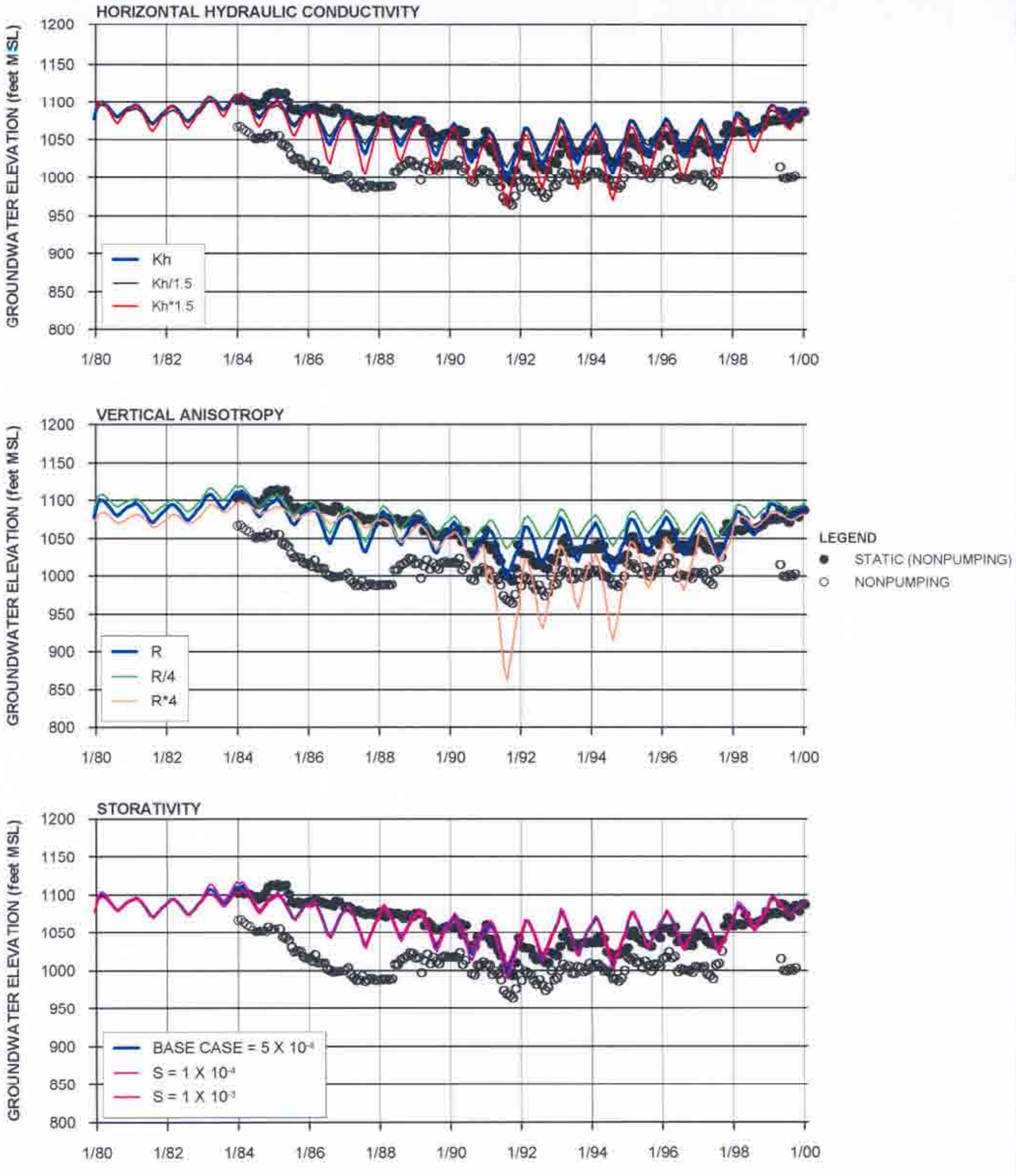


NOTES:

1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-41
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT SCWC-SAUGUS 2 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-329.GRF

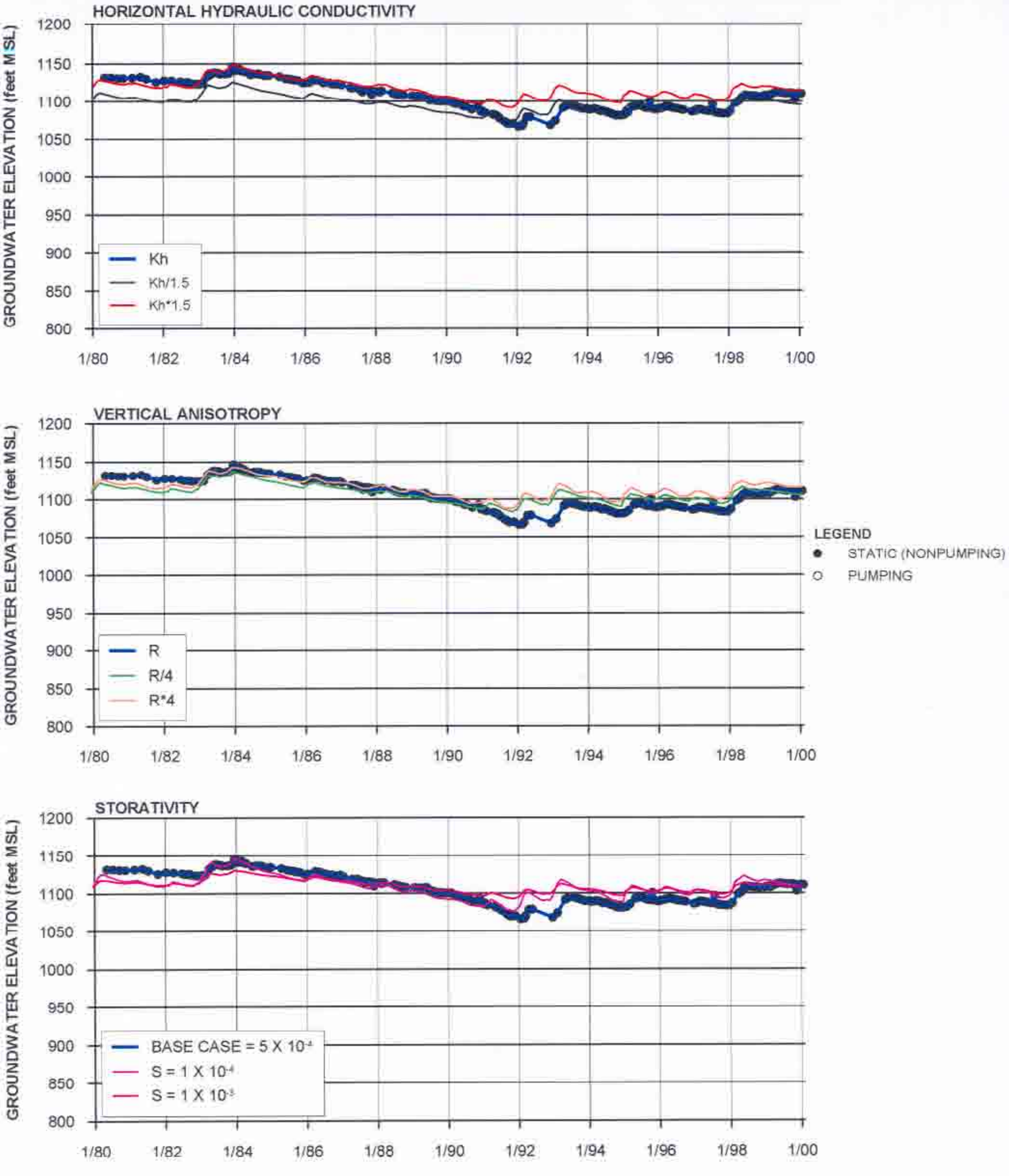


NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-42
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT NCWD-11 TO AQUIFER PARAMETER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-330.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-43
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 5851 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA
CH2MHILL

178973-331.GRF

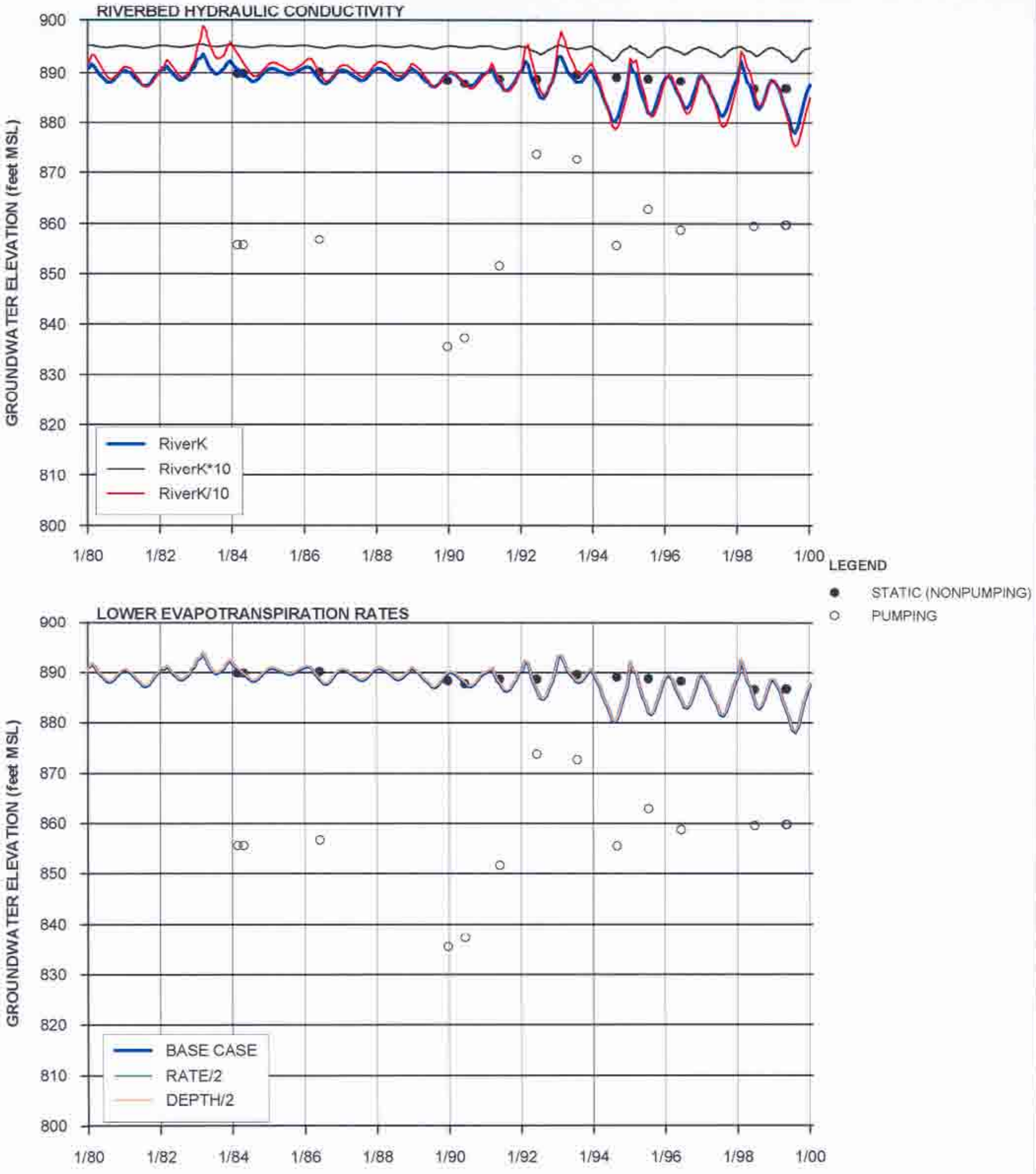


FIGURE 5-44
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-B7 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

CH2MHILL

178973-332.GRF

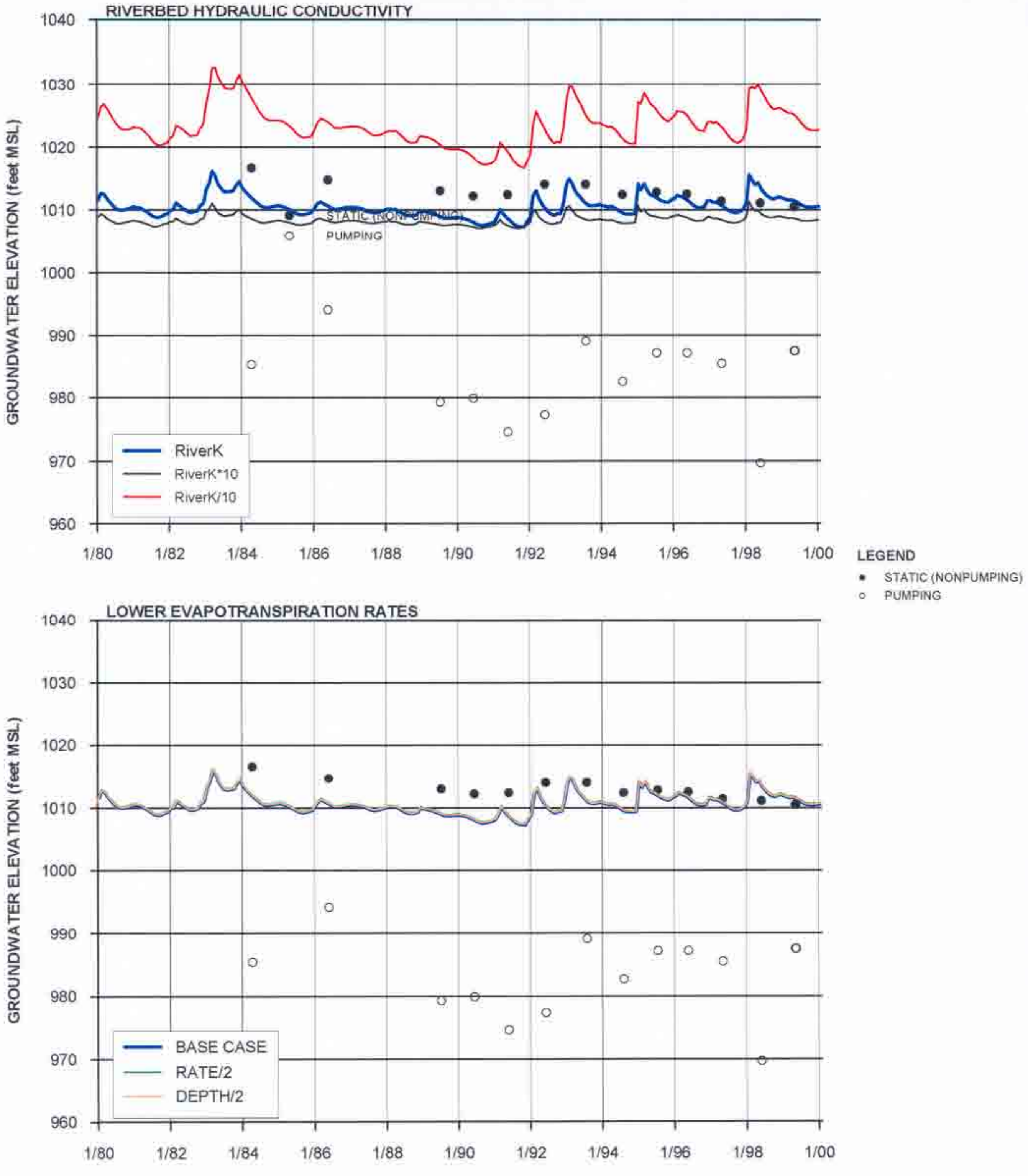


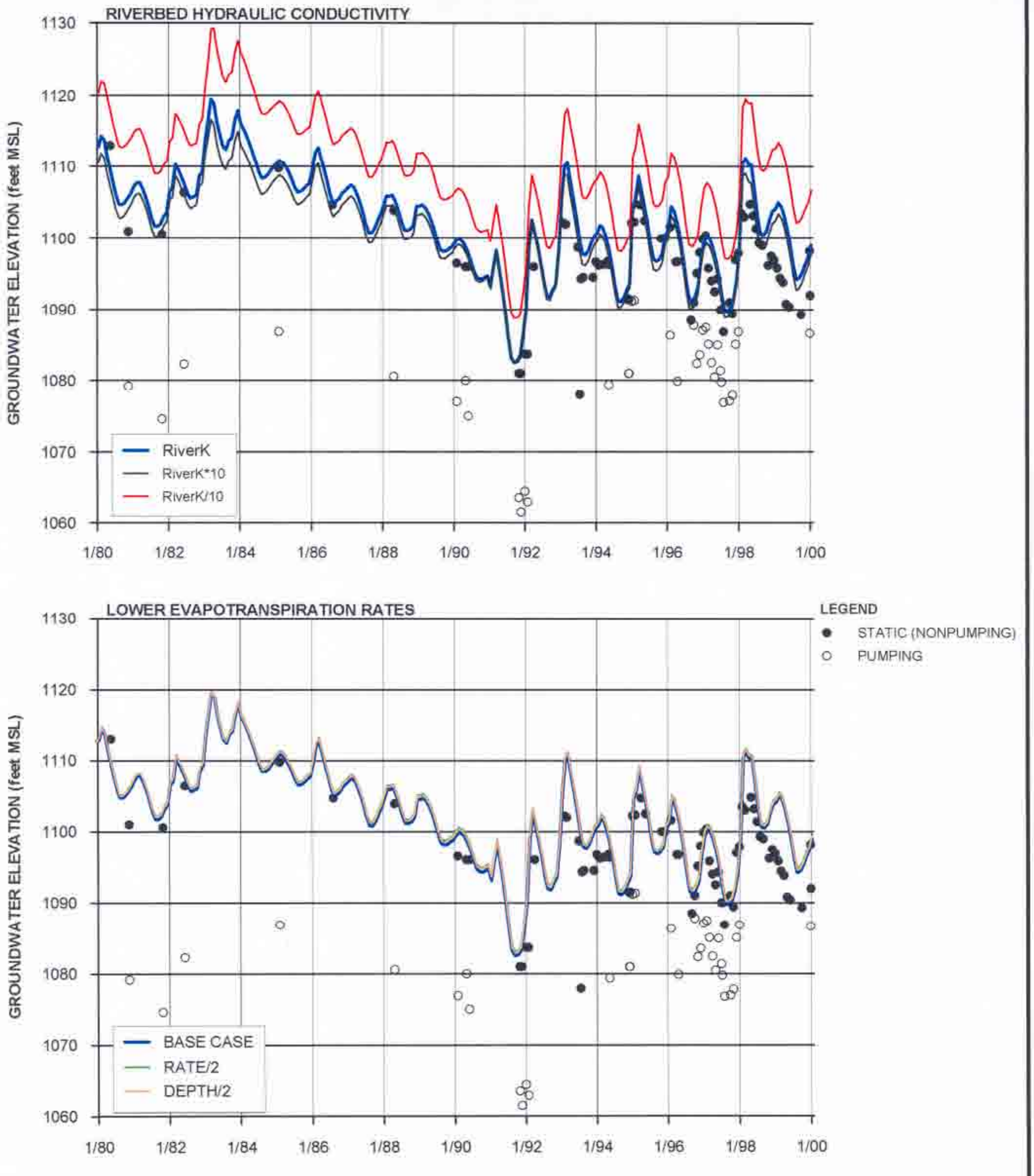
FIGURE 5-45
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-G45 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

NOTES:

1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

CH2MHILL

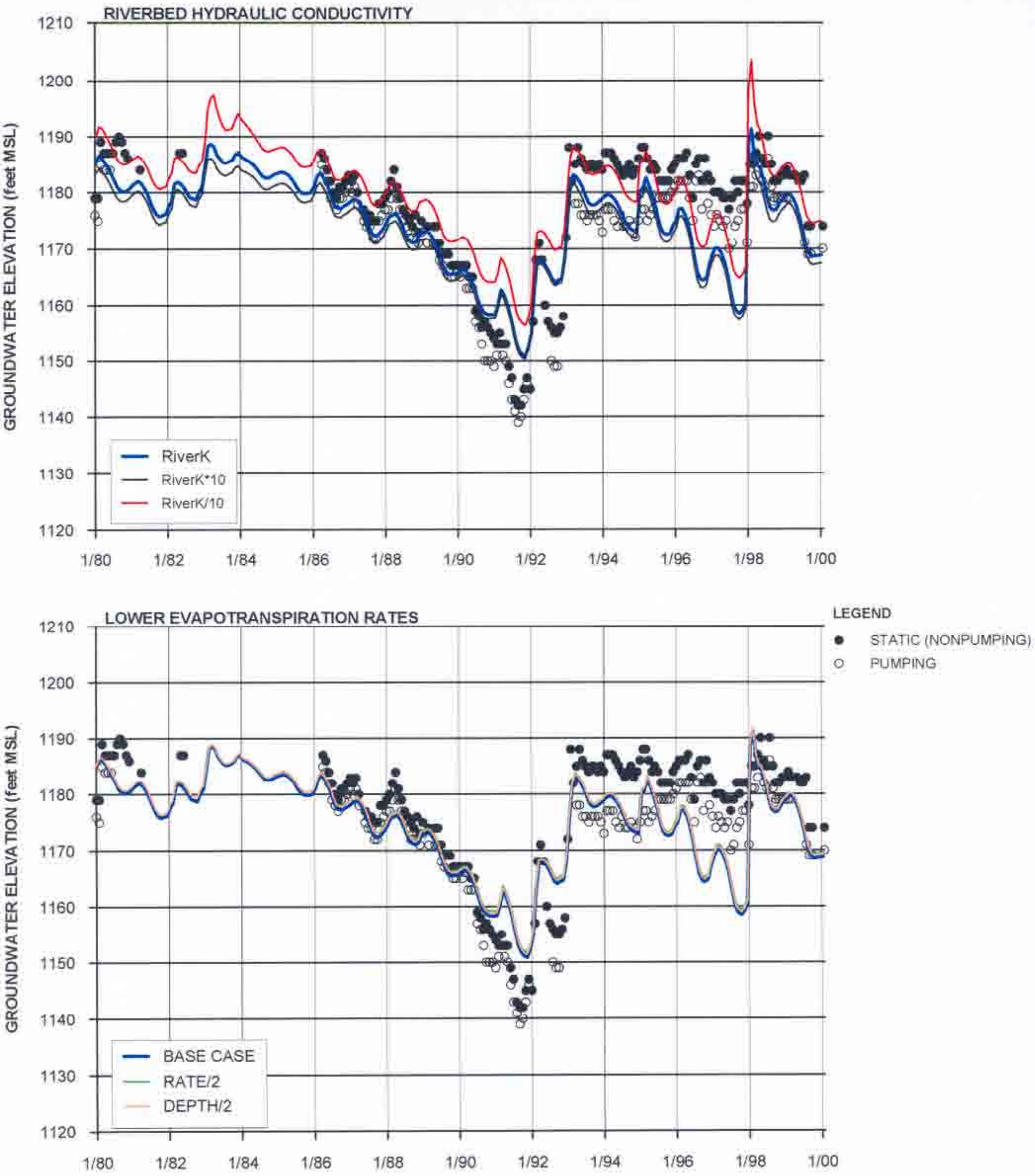


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-46
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-N TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-334.GRF

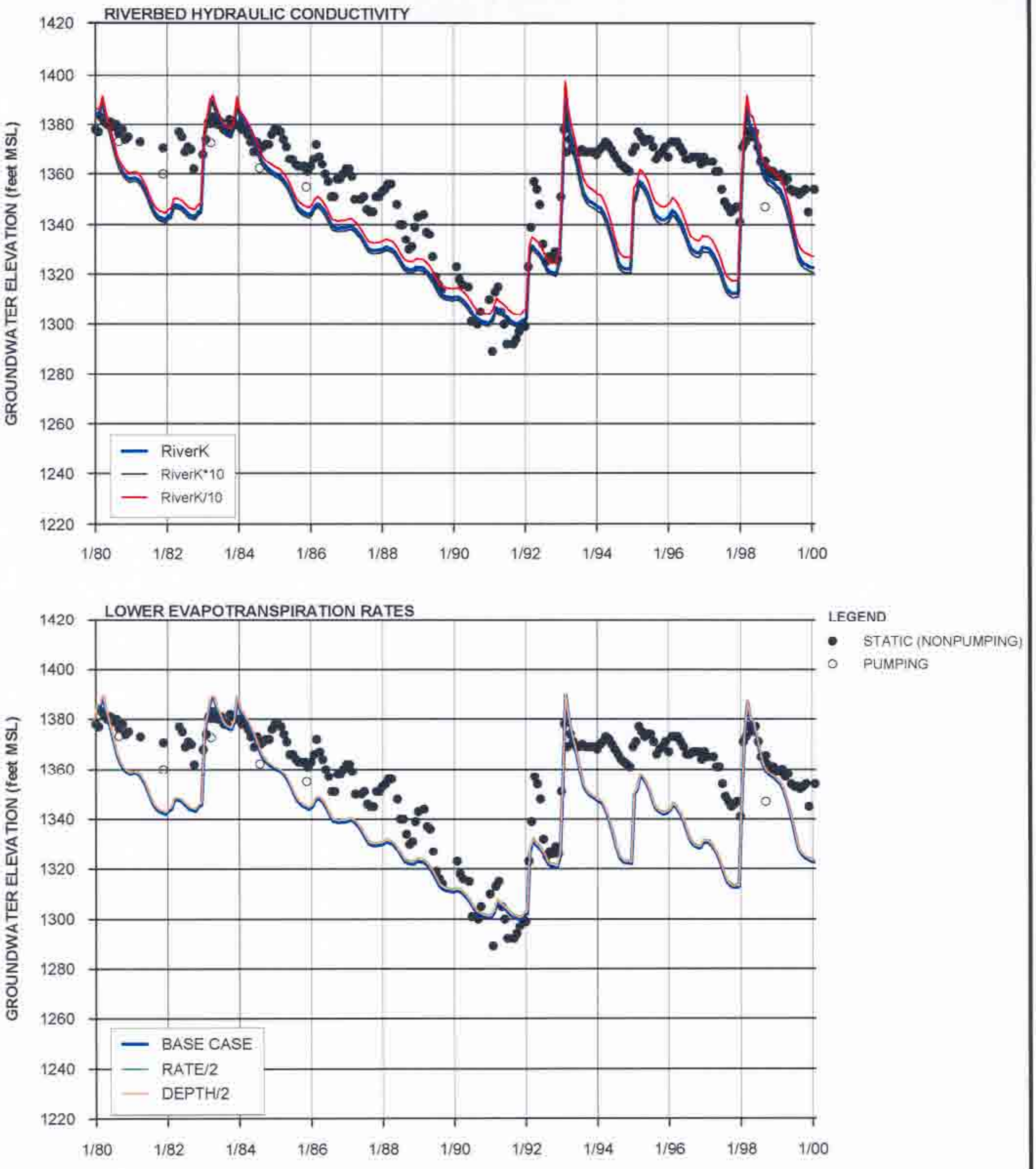


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-47
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-STADIUM TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-335.GRF

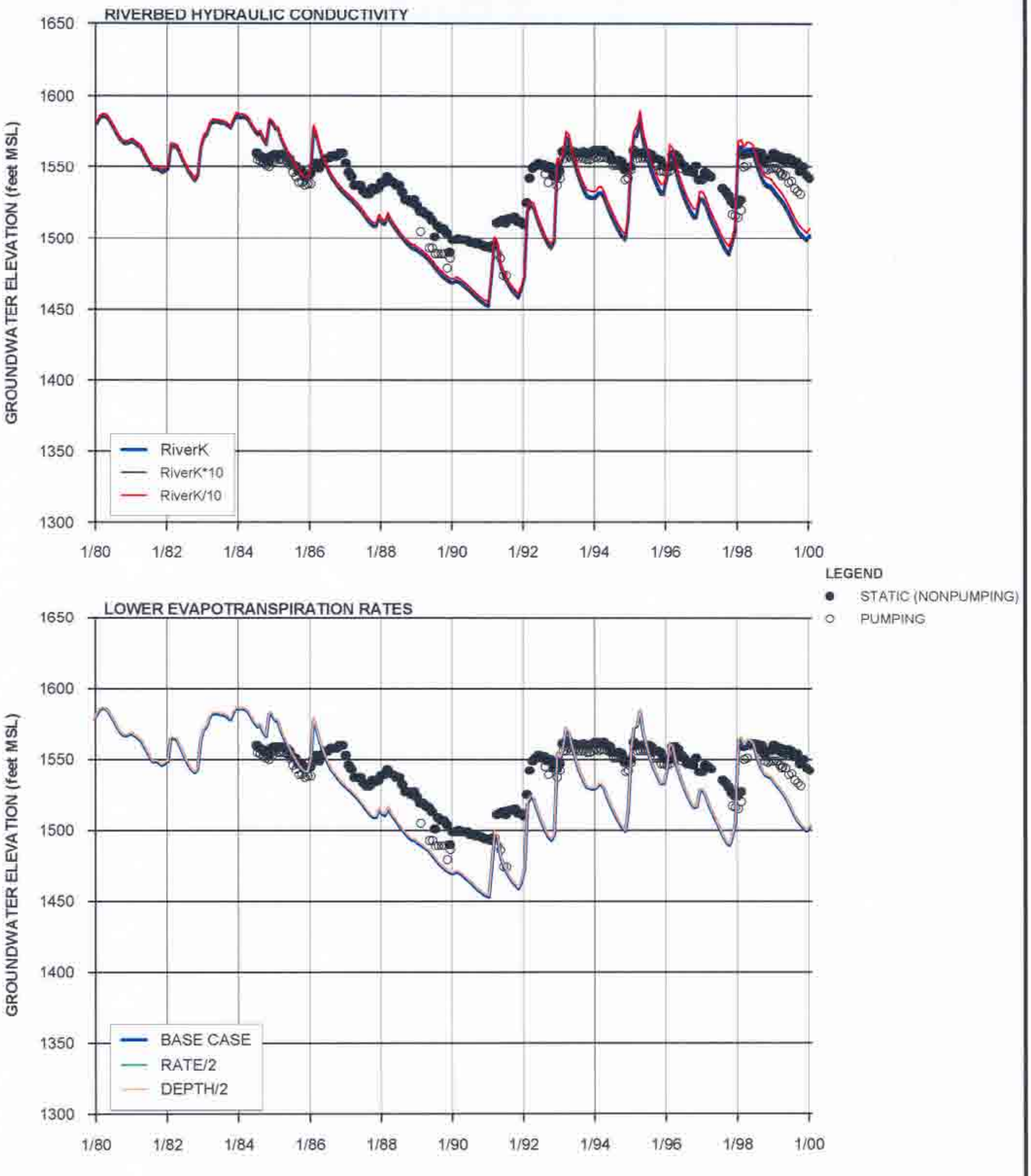


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-48
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-NORTH OAKS EAST TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-336.GRF

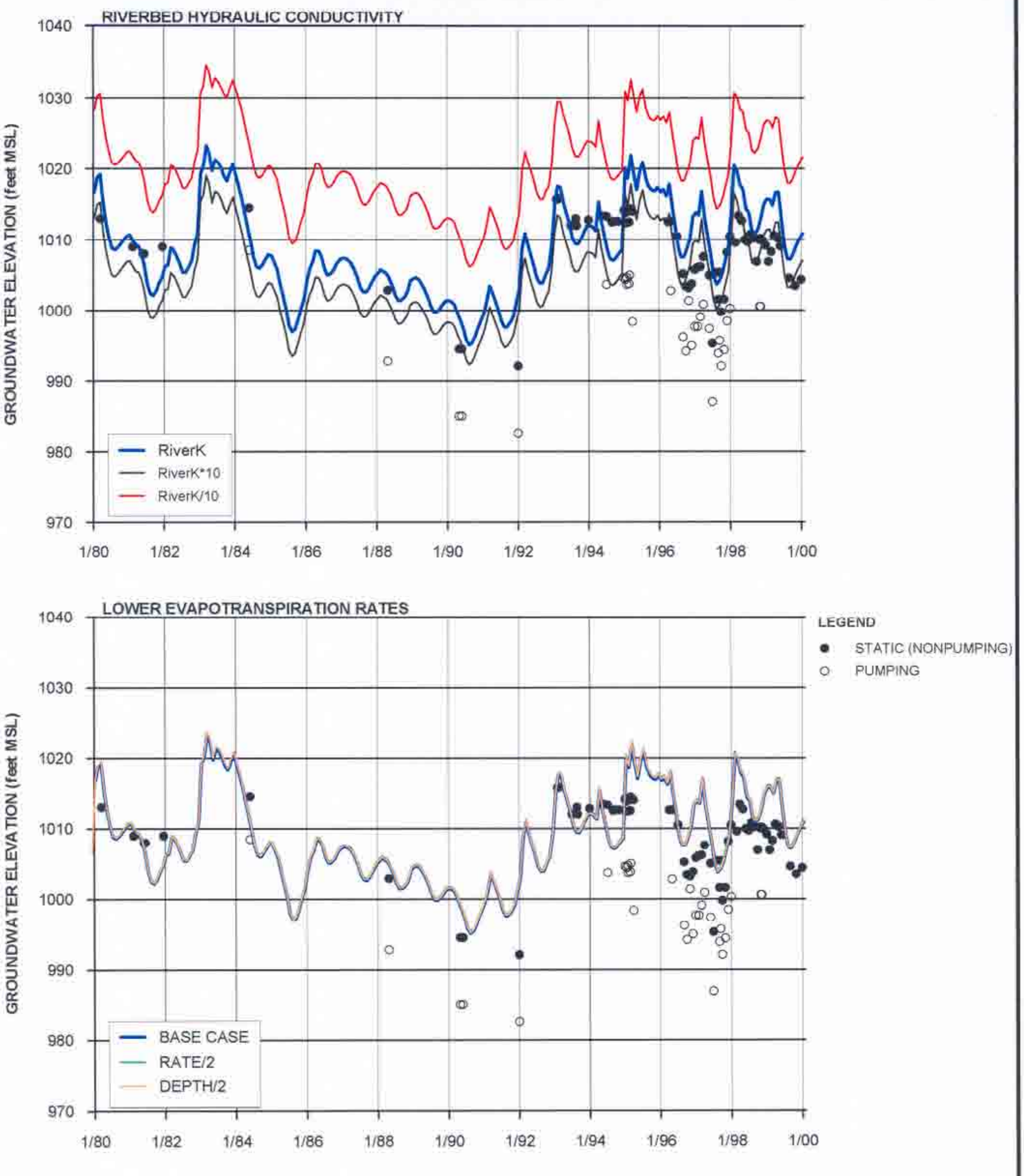


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-49
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-PINETREE1 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-337.GRF

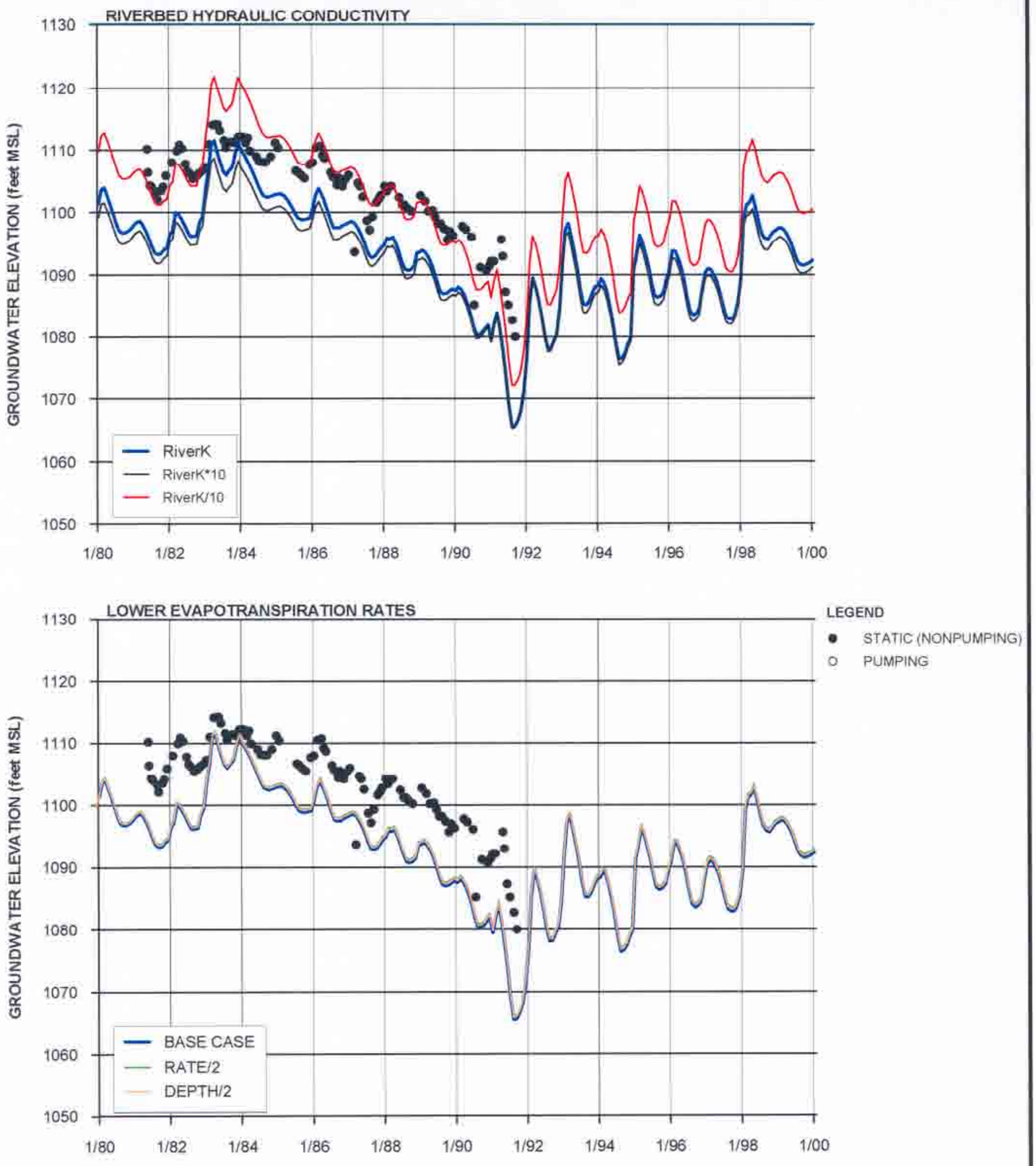


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-50
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-D TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-338.GRF

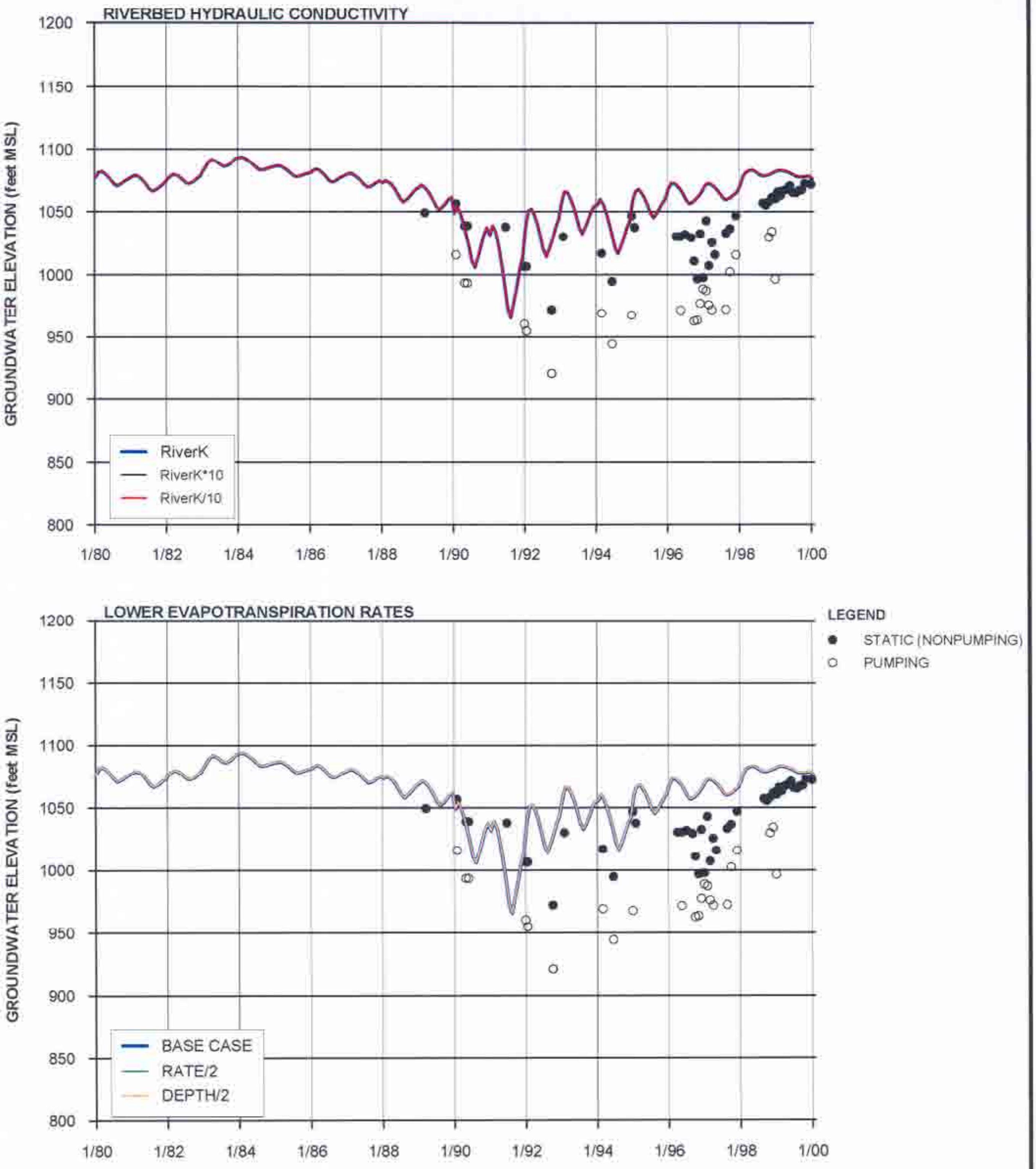


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-51
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 7048C TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-339.GRF



NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-52
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT VWC-201 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-340.GRF

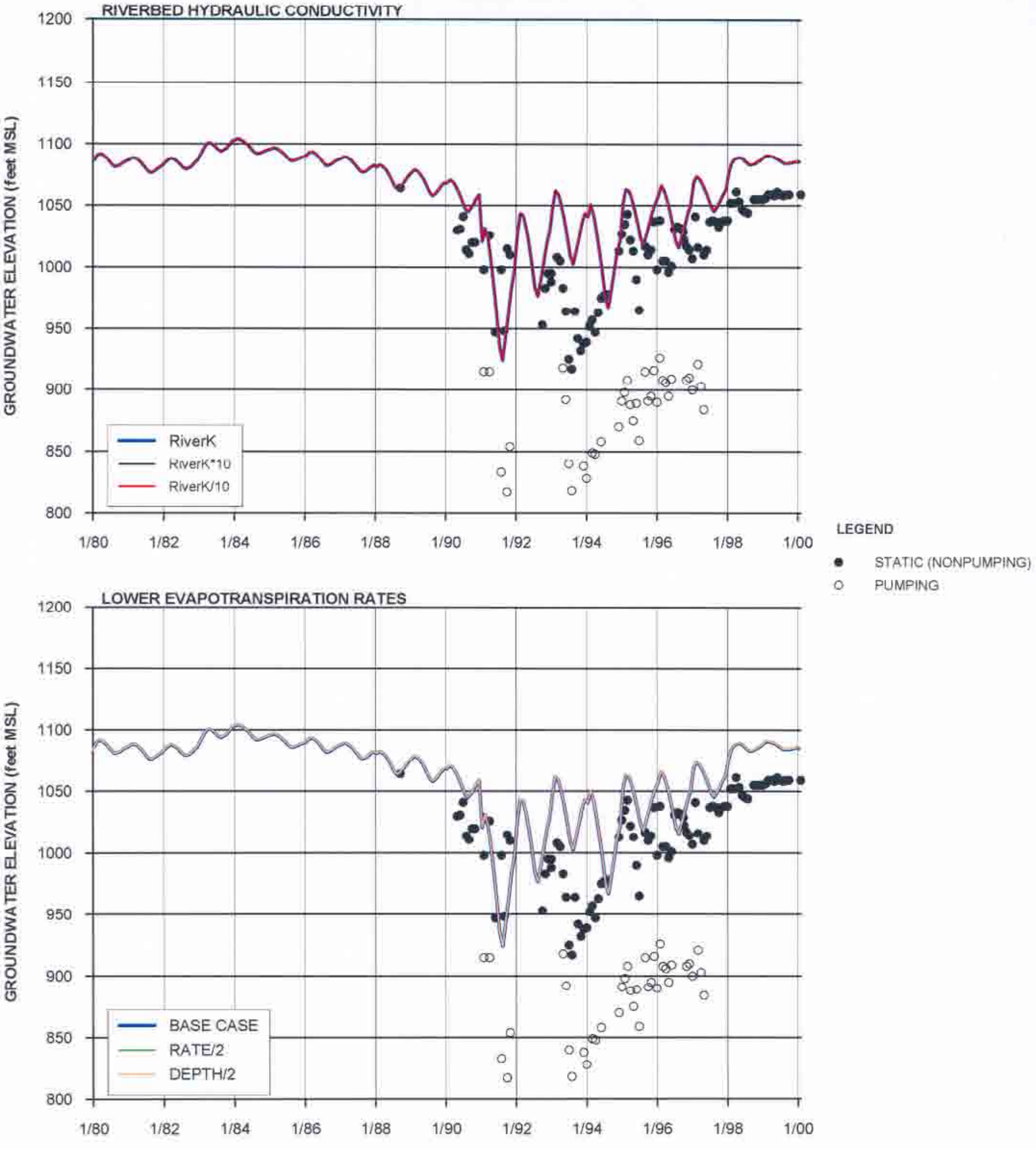
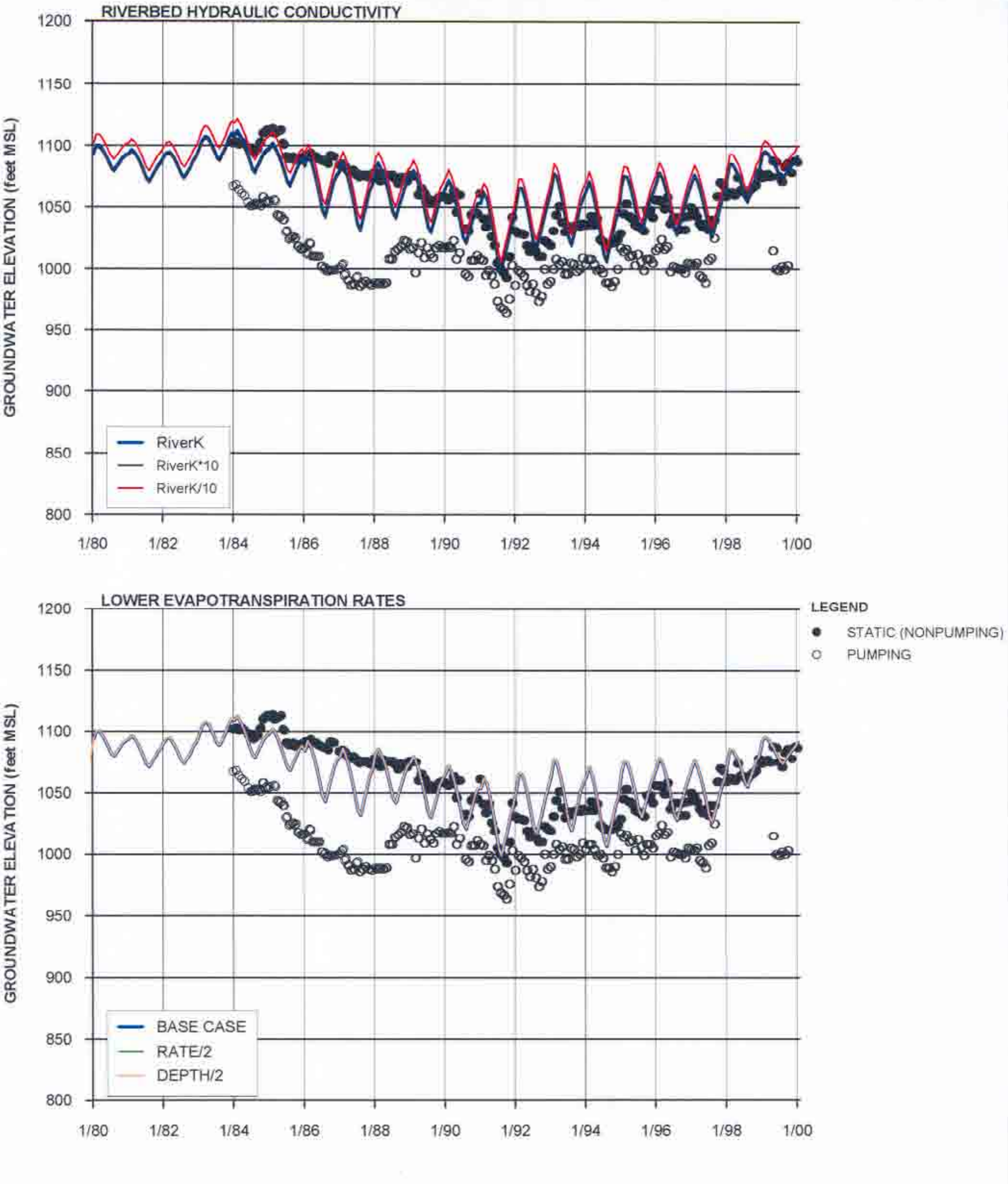


FIGURE 5-53
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT SCWC-SAUGUS 2 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

CH2MHILL

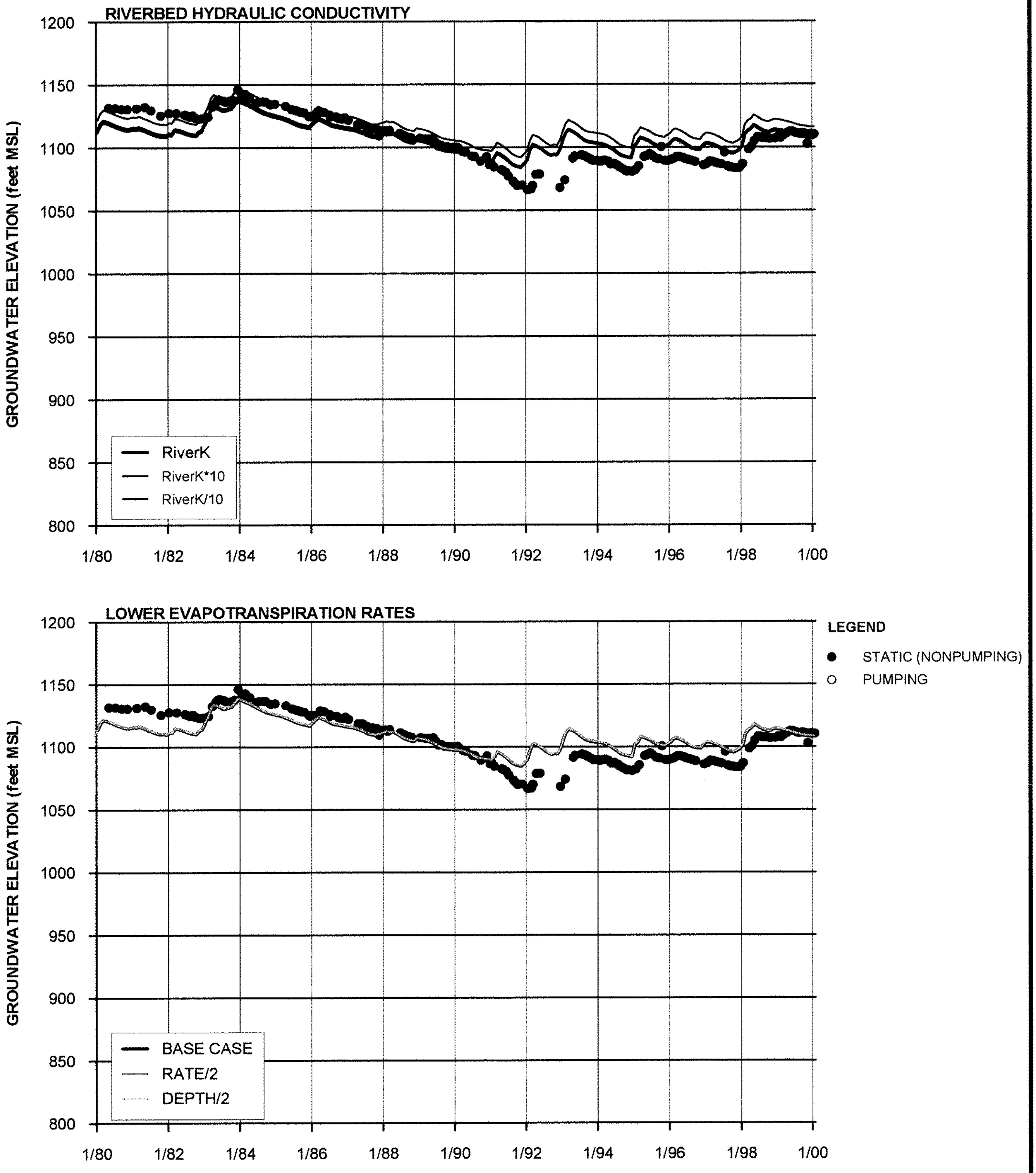


NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-54
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT NCWD-11 TO RIVER AND EVAPORTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

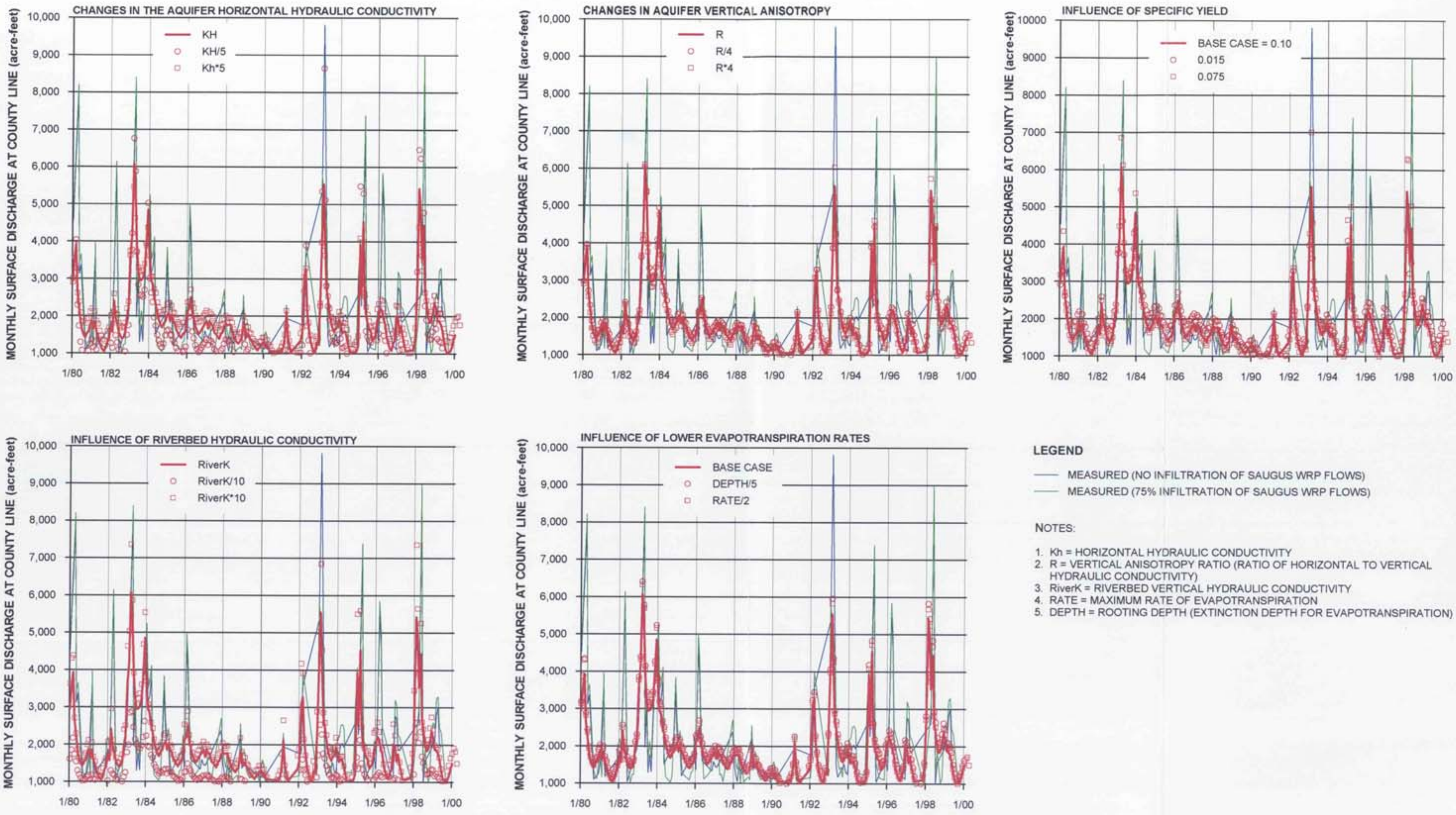
178973-342.GRF



NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-55
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 5851 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



LEGEND

— MEASURED (NO INFILTRATION OF SAUGUS WRP FLOWS)

— MEASURED (75% INFILTRATION OF SAUGUS WRP FLOWS)

NOTES:

1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
4. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
5. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)

FIGURE 5-56
SENSITIVITY OF GROUNDWATER DISCHARGES TO THE SANTA CLARA RIVER TO AQUIFER, RIVER, AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

SECTION 6

Model Applicability to Local Water Resource Management

The Purveyors have developed the Regional Model as the main computer tool for their use in ongoing management of the groundwater resources in the Santa Clarita Valley. Among the objectives in developing the model were (1) to be able to evaluate the long-term sustainability (yield) of the Alluvial and Saugus aquifer systems under a range of existing and potential future water resource management conditions, and (2) to facilitate general management of water quantity and water quality issues.

The Regional Model simulates groundwater flow in the two aquifers that are present in the Santa Clara River Valley East Groundwater Subbasin. It has been developed using the database and GIS that were developed by, and are being used by, the Purveyors to manage the valley's water resources. The modeling effort built upon previous and ongoing hydrogeologic studies in the valley (RCS, 1986, 1988, 2001, 2002; CH2M HILL, 2003), as well as previous modeling efforts (CH2M HILL, 1996, 2001, 2002). Key aspects of the Regional Model's construction and calibration include the following:

a. The Regional Model covers the entire Santa Clara River Valley East Groundwater Subbasin, from the Lang stream gage, at the eastern end of the valley, to Blue Cut, just west of the county line.

b. The Regional Model includes the SWRM, which determines the monthly volume of rainfall that is available to streams that are tributaries to the Santa Clara River. The SWRM also computes how much of the runoff can recharge the Alluvial Aquifer, the locations of the recharge, and the amount of flow that remains in each stream. Further, the SWRM calculates how much flow occurs in the Santa Clara River due to tributary inflows and to WRP discharges. Together, the SWRM and the Regional Model allow for estimation of the time-varying magnitudes of total river flow and groundwater discharges to the river. In summary, the Regional Model is actually a groundwater flow model coupled with an empirical tool that estimates stormwater generation from each watershed lying upstream of, and extending into, the Regional Model's boundaries.

c. The Regional Model has been calibrated on a monthly basis to time-varying hydrologic conditions that were observed from 1980 through 1999. Calibration data consisted of groundwater elevations in both aquifers at production and monitoring wells; estimated fluctuations in groundwater discharges to the Santa Clara River; and gaged flows in the Santa Clara River. Consequently, the Regional Model is calibrated not only to groundwater elevation trends, but also to the flows of water into and out of the valley.

The Regional Model has been specifically designed for use in managing groundwater resources on a local and regional scale. Its design and calibration make it a useful tool for:

a. Evaluating groundwater management strategies, including analyzing basin operations over multi-year wet/dry cycles

b. Evaluating ASR projects or other aquifer recharge projects

c. Evaluating options for locating new or proposed water supply wells, with consideration of the avoidance and management of any contamination in the aquifer system

d. Evaluating the restoration of pumping capacity that has been impacted by perchlorate contamination in the vicinity of the Whittaker-Bermite property in the central part of the valley

Nonetheless, because no model is perfect, it should be used with care, and all model results should be examined by qualified and experienced hydrogeologists and water resource managers. Specific recommendations for the continued use and maintenance of this tool, including hydrogeologic data needs, are as follows:

a. Future predictive modeling activities should include sensitivity analyses on key model variables, particularly the Kh and Kv of both aquifer systems. This recommendation is based on the sensitivity analysis results, which show that groundwater elevations and groundwater discharge to the Santa Clara River are both sensitive to these parameters.

b. Streamflow monitoring should resume at the Lang gage, to better understand the magnitudes and timing of Santa Clara River flows into the valley. Stream gaging was discontinued at this location after October 1989. Because inflow in the Santa Clara River is one of the principal sources of water, the absence of data at this location is likely the primary reason that the Regional Model has difficulties simulating historical water level trends during certain periods at wells in the eastern-most portion of the valley. Without data from the Lang gage, simulations of future water level trends in this area will be uncertain, due to the Regional Model's tendency to under-predict groundwater elevations during drought periods.

c. The Regional Model and the SWRM should both be updated as water use conditions change in the future. Specific activities that merit updates to these tools include the planned implementation of recycled water use in the valley, continued urbanization in currently undeveloped and agricultural lands, and the increasing import of SWP water in response to increasing urban water demands.

d. Transient calibration runs should eventually be performed to test the transient model's ability to simulate conditions after 1999. The success of this activity will be more likely if streamflow data are collected at the Lang gage.

e. The Regional Model's calibration in the Saugus Formation should be tested whenever new wells are completed in this aquifer. Specifically, long-term water level monitoring should commence in these wells, and controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties at new well locations, particularly in areas where wells have not been previously constructed.

f. Other activities described in the MOU between Ventura County and the Purveyors should continue, in order to provide data that can be used to improve the Regional Model and management of the local water resources. These data include pumping, rainfall, WRP discharge, streamflow, and groundwater elevation information. In particular, the groundwater elevation monitoring program that has been conducted for the past several years at production and monitoring wells should continue. Data from this program, collected by the Purveyors and LACFCD, provide valuable information for identifying and understanding the changes that occur in the hydrologic system, including the relationships between groundwater and surface water.

SECTION 7

References

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Memorandum of Understanding
Between the
Santa Clara River Valley
Upper Basin Water Purveyors and
United Water Conservation District

August 2001

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is entered into effective August 20, 2001, by and among Castaic Lake Water Agency ("CLWA"), CLWA's Santa Clarita Water Division ("SCWC"), Newhall County Water District ("NCWD"), Valencia Water Company ("VWC") and Los Angeles County Waterworks District No. 36 ("LACWD"), which are collectively referred to as the "Upper Basin Water Purveyors" and United Water Conservation District "UWCD", hereinafter referred together as the "parties."

RECITALS

WHEREAS, UWCD is a public agency that encompasses approximately 214,000 acres of land located in central Ventura County. UWCD's service area covers the downstream portion of the Santa Clara River Valley in Ventura County, as well as the Oxnard Plain (sometimes referred to as the "Lower Santa Clara River Area"). UWCD manages surface and groundwater resources within seven groundwater basins in the Lower Santa Clara River Valley Area. UWCD's Boundary is shown on Figure 1-1; and,

WHEREAS, the Upper Basin Water Purveyors meet regularly as a technical group to coordinate conjunctive use of imported, recycled and groundwater resources of the water basins east of the Los Angeles/ Ventura County line (sometimes referred to as the "Upper Santa Clara River Area"), which is located almost entirely within northwestern Los Angeles County. The respective services areas of the Upper Basin Water Purveyors members (CLWA, SCWC, NCWD, VWC and LACWD) are shown on Figure 1-2; and,

WHEREAS, UWCD has been involved in the review of water resources in both the Lower Santa Clara River Area and also the Upper Santa Clara River Area as part of UWCD's review of the Newhall Ranch Specific Plan and EIR (NRSP); and,

WHEREAS, litigation of the Newhall Ranch Specific Plan and EIR resulted in preparation of an additional analysis to the previously certified EIR for the NRSP, including the section addressing water resource issues; and,

WHEREAS, the Additional Analysis includes a water flow model and impact analyses of the future water usage projections for the Upper Santa Clara River Area; and,

WHEREAS, UWCD, Newhall Land and Farming Company (NLF) and others have had several technical meetings to further study the Additional Analysis as it relates to the water issues, and, based on this information, and further discussions between UWCD and the Upper Basin Water Purveyors, UWCD believes that it is in the best interests of the parties and the future beneficial water resources management in the upper and lower basins to enter into a cooperative working relationship among the parties; and,

WHEREAS, the parties have determined that this MOU is the best format for establishing a program that would be implemented over time for purposes of agreeing upon overall water resources management techniques and an information database that would benefit the upper and lower basins; and,

WHEREAS, this MOU is prepared by UWCD and the Upper Basin Water Purveyors because the parties believe that a cooperative water resource monitoring program in the Upper and Lower Santa Clara River Areas is desirable to protect and enhance the conjunctive use of imported water, groundwater and surface water resources within the region; and,

WHEREAS, the parties support regional water planning efforts that rely on the provision of accurate and timely information about available water resources; and,

WHEREAS, the parties to this MOU desire to create and maintain a cooperative relationship for purposes of gathering information for UWCD and the Upper Basin Water Purveyors to be used in further assessing imported water, surface water and groundwater conditions in both the Upper and Lower Santa Clara River Areas; and,

WHEREAS, the parties to this MOU intend to form a reciprocal relationship. In order to do this, UWCD will designate an individual or individuals with technical knowledge and experience appointed by the General Manager of UWCD who will be included in discussions and efforts that take place with the Upper Basin Water Purveyors and others regarding the Upper Santa Clara River Area. Likewise, the Upper Basin Water Purveyors will designate an individual or individuals with technical knowledge and experience appointed by the General Managers of the Upper Basin Purveyors who will be included in discussions and efforts with UWCD and others regarding the Lower Santa Clara River Area, and,

WHEREAS, the goal of the MOU is to establish a joint monitoring program, which includes: (a) data collection (monitoring and testing); (b) database management; (c) groundwater flow modeling; (d) assessment of groundwater basin conditions (operational yield); and (e) report preparation and presentation.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained, the parties to this MOU agree as follows:

1.1 **Program Monitoring.** The parties will participate in a joint monitoring program.

1.2 **Program Content.** The technical aspects of this joint monitoring program are set forth in a technical memorandum entitled, "Water Resource Monitoring Program Upper Santa Clara River Area," (Program) which is attached as Exhibit 1 and incorporated by this reference.

1.3 **Program Meetings.** The General Manager or President of each party to this MOU (or their designee) shall meet as the "Program Committee" within 30 days of the execution of this MOU. The "Program Committee" will establish appropriate subcommittees to initiate the Program and determine the meeting times and locations for the committees. The Program Committee and subcommittees will discuss and coordinate technical aspects of the Program, including the gathering, interpretation and reporting of information as outlined in the technical memorandum (Exhibit 1). Other attendees may be permitted by agreement of the parties to this MOU.

1.4 **Monitoring Costs.** The costs incurred in administrating the Monitoring Program will be determined as implementation of the Program takes place. However, it is understood that, unless the parties to this MOU agree otherwise, the Upper River monitoring costs of the program will be borne by the Upper Basin Water Purveyors because such monitoring will take place within their service areas and the Lower River monitoring costs of the program will be borne by UWCD because such monitoring will take place within its service area.

1.5 **Program Implementation.** The parties to this MOU have prepared a schedule, attached as Exhibit 2, that describes the tasks and estimated time to implement the Program. The Parties acknowledge that Program Implementation will be an on-going and evolving process and may change due to future amendments to the Program, challenging technical issues or other unforeseen circumstances.

1.6 **Water Rights.** Notwithstanding the provisions of this MOU, nothing in either this MOU or the technical memorandum (Exhibit 1) shall be construed as affecting the water rights or operations of any party, person or entity.

1.7 **Term.** This MOU shall remain in effect for an initial period of seven (7) years and shall be automatically renewed for additional one year increments unless otherwise unanimously terminated by the members of the Program Committee as that committee exists at the time action is taken to terminate this MOU.

1.8 **Counterparts.** This MOU may be executed in any number of counterparts, each of which, when so executed, will be deemed to be an original and all of which taken together will constitute one and the same agreement.

IN WITNESS WHEREOF, the parties have executed this MOU as of the date first set forth above.

United Water Conservation District

By Dana L Wisehart
General Manager

Newhall County Water District

By Karen J Russell
General Manager

Santa Clarita Water Company

By W. J. Manetta Jr
President

Castaic Lake Water Agency

By Robert C. Sagehorn
General Manager

Valencia Water Company

By Robert J DiPrimio
President

Los Angeles County Waterworks District No. 36

By Dean E Efstathiou
County of Los Angeles

United Water Conservation District Boundary

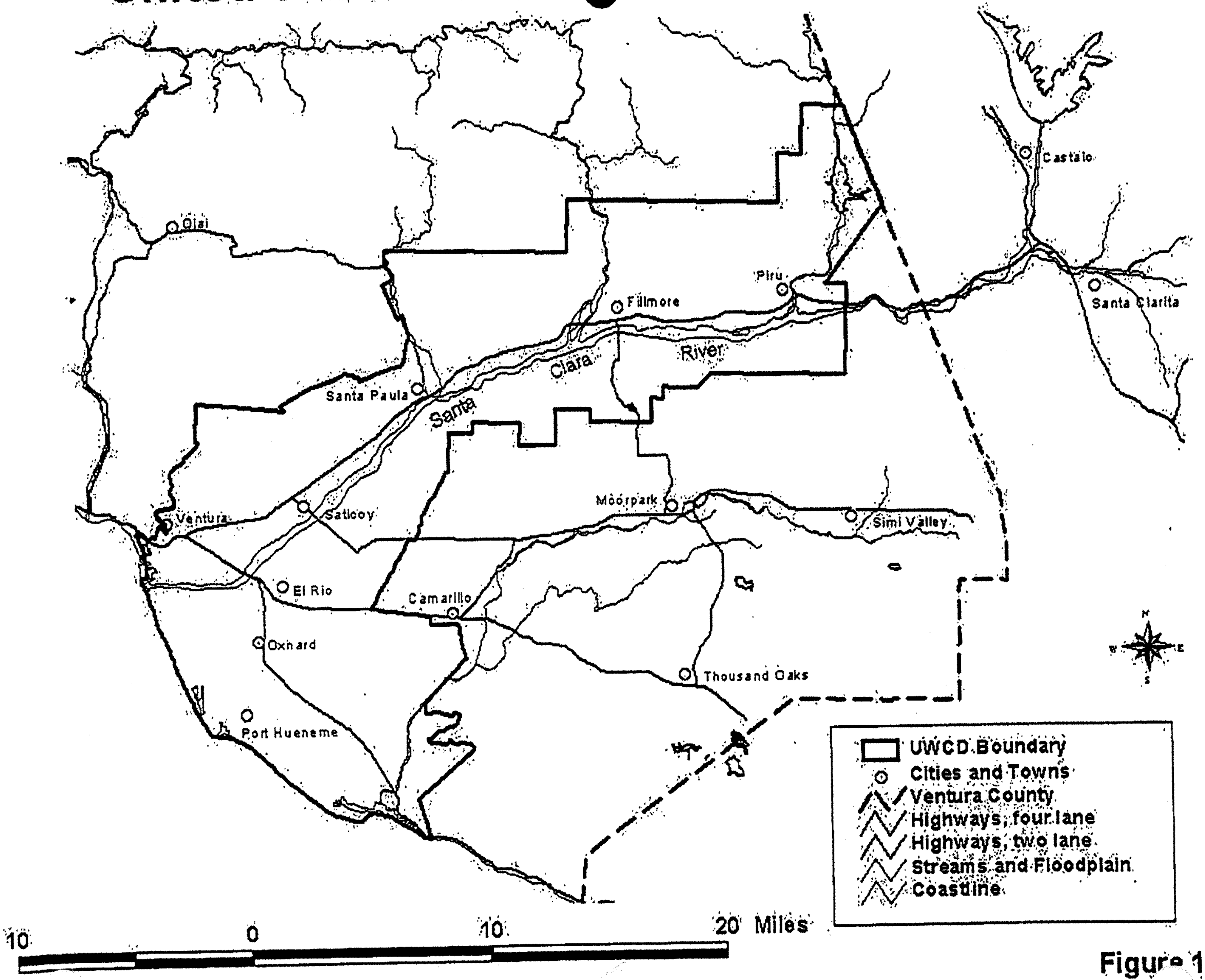
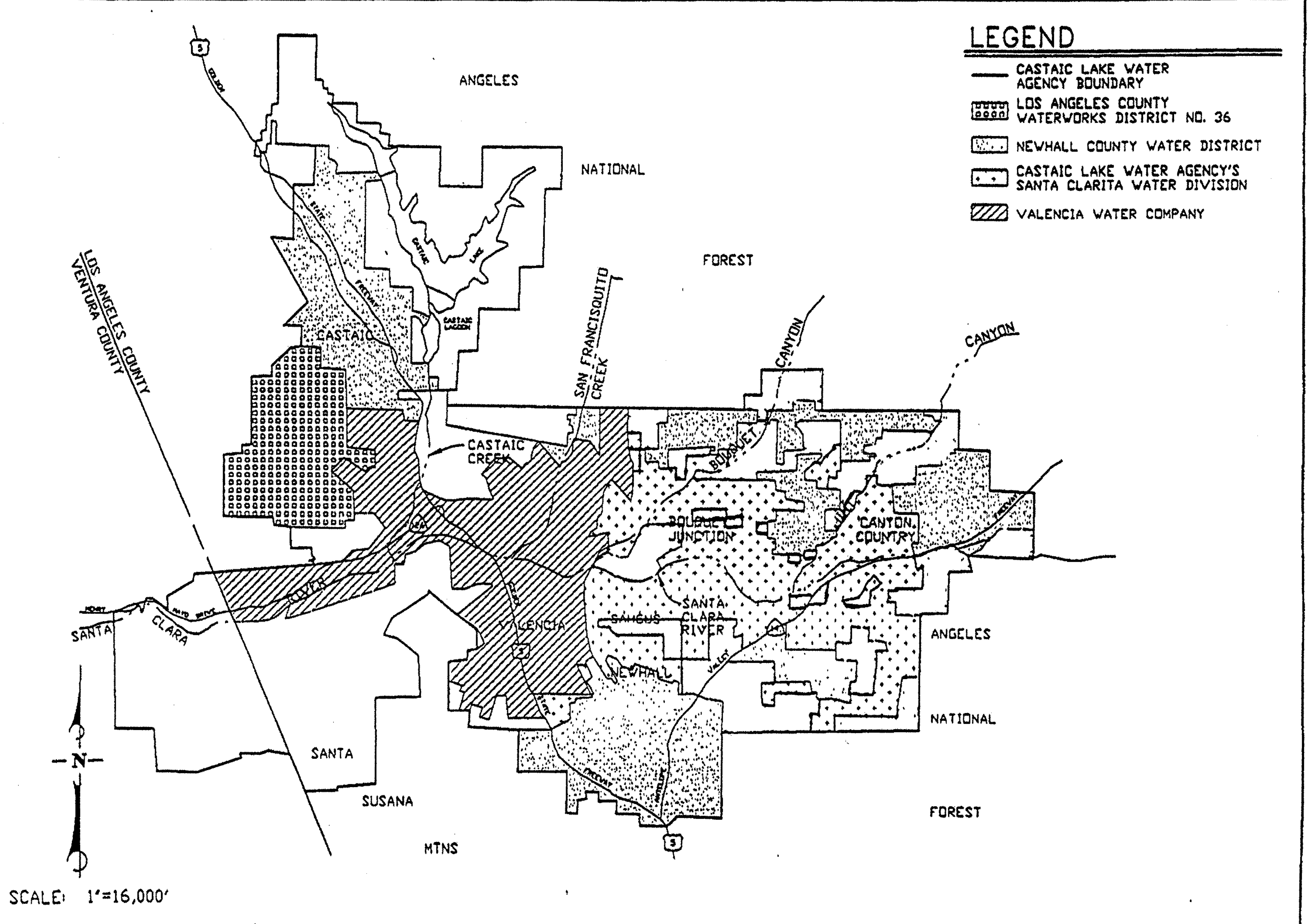


Figure 1-1



CLWA AND WATER PURVEYOR SERVICE AREAS

FIGURE 1-2

Exhibit 1
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA

INTRODUCTION

As part of its ongoing monitoring, interpretation, and reporting on imported water supplies and groundwater conditions in the aquifer systems underlying the Upper Santa Clara River Area, generally east of the Los Angeles County - Ventura County line and extending east to about the vicinity of Lang Station, the principal water purveyors in the area (primarily the municipal water purveyors - Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company) have committed to formalizing the data base on which water supply conditions are analyzed, and expanding the analysis of groundwater conditions such that the adequacy of water supply is well understood, and that both local and regional questions or issues about surface and groundwater can be addressed.

This water monitoring program outline has been prepared as a cooperative effort by the Upper Basin Water Purveyors operating in the Santa Clarita Valley and by the United Water Conservation District in Ventura County, the latter as the primary groundwater resource management entity in the Lower Santa Clara River Area (west of the Los Angeles - Ventura County line). The intent of the program outline is to delineate a series of elements that will be undertaken primarily by the Upper River Area entities, but in cooperation with United such that there is ultimately an integrated and coordinated data base, as well as agreed-upon technical tools such as a numerical groundwater flow model, to allow a continued regional understanding of water resources along the Santa Clara River. In that light, the following program includes elements which address data collection (monitoring and testing), database management, groundwater modeling, operational yield analyses, and report preparation and presentation.

DATA COLLECTION (MONITORING AND TESTING)

Historically, data on groundwater and related hydrologic conditions have been collected on varying frequencies and in varying formats throughout the Upper River Area. Fortunately, more than sufficient data have historically been collected on groundwater levels, quality, and production (pumpage) to permit general assessment of groundwater conditions, in some detail in the widely developed Alluvial aquifer and to a lesser extent the Saugus Formation aquifer. In order to expand on the general assessment of groundwater conditions, historical data collection efforts will be updated and formalized in the following areas.

Groundwater Levels and Quality - Wells in which historical and current water level data are available will be "qualified" (to confirm locations, depths, well completion details, annular seals, etc.) to confirm their utility for ongoing monitoring of water level and/or water quality in a particular aquifer. Based on a combination of qualified well details and available historical and current data, a network of existing and future wells will be developed for ongoing monitoring of groundwater levels (initially on a semi-annual frequency) and groundwater quality (initially on an annual to triennial frequency, depending on the use of the well) in both the Alluvium and the Saugus Formation aquifers. The water level and water quality monitoring networks may not be identical (as with most basins, the number of water level monitoring points will likely be greater than the number of water quality monitoring points). Also, in light of the relative differences in development of the two aquifer systems, there will be more monitoring points in the Alluvium than in the Saugus. However, as future development of the Saugus increases, particularly as the spatial extent of the Saugus "well field" expands, the Saugus monitoring network will evolve and expand accordingly. Water quality details are expected to begin with what historical analyses have been made; monitored details are expected to increase as the use of local Groundwater continues to change from irrigation supply to municipal supply, with the addition of organic and other hazardous chemical analyses of drinking water supplies in recent years. Finally, such as any dedicated monitoring wells are installed in the area, for specific site investigation or other purposes, they will be added to the qualified well network as appropriate.

Groundwater Pumpage - Essentially all pumpage in the Upper Area (except small capacity individual domestic and similar wells) is metered or directly estimated from electrical power records, and the results are maintained in a decentralized data base. Metered measurement of all substantial capacity wells (all municipal and agricultural, as well as other private wells, e.g. golf course irrigation wells) will be continued on at least an annual basis, with progression to monthly data collection as appropriate for particular analyses that may be undertaken.

Surface Water Flows and Quality - Historical stream gage sites will be preserved as possible to allow ongoing surface water gaging of stream inflows to the Upper River area, stream outflows from the Upper River area into Ventura County, and return flows to the River system from in-area wastewater treatment plant discharges. Surface water quality at the same points will also be sampled on some frequency to continue historical records as appropriate or to document episodic or other (e.g. treated wastewater discharges) surface water flows into or out of the Upper River area.

Well and Aquifer Characteristics - Recently constructed wells, in both the Alluvium and Saugus Formation, have been tested, in some cases with the benefit of nearby monitoring wells, to determine well yields and aquifer hydraulic properties (e.g. transmissivity and storage coefficient). In limited cases, production logging and depth-specific water quality sampling has been undertaken to examine variations in aquifer productivity and quality with depth. Such as there is a need for additional spatial or vertical distribution of well yield or aquifer characteristic data, selected qualified wells will be tested in the Alluvium and Saugus aquifers. In general, all new production wells will be tested to determine the yields of the wells and the hydraulic characteristics of the aquifer materials in which they are completed at various locations in the Upper River area.

Precipitation - The locations of historical precipitation gaging will be verified and the quality of the gaging stations will be assessed. Continuation of historical gaging will be a primary goal, with additions as appropriate to assess inflow of water within the Upper River area as well as distribution of precipitation throughout the area.

DATABASE MANAGEMENT

Geographic Information System - There is a good start on a regional GIS from the US Geological Survey's Regional Aquifer Study. For instance, roads, streams and other basic geographic features are in the USGS GIS that has been maintained and expanded by United Water Conservation District. United has commercial digital air photo coverage of Ventura County that includes a small portion of western Los Angeles County; additional digital imagery will be sought from agencies in Los Angeles County.

Most of the wells in the Valencia/Santa Clarita area are also in a USGS GIS coverage that includes well construction information. The wells are identified by owners designations as well as state well number. By using the state well number in identifying all monitoring data, information from the databases can be linked directly to the GIS well coverage.

Water Level Database - Monitoring data will be collected together in common databases, using an easily accessible program such as Microsoft Access. Groundwater level information is presently in a variety of forms, including paper copy, spreadsheet files, and agency databases. The digital information will be incorporated into a master database, but the data on paper copies will have to be entered into a computer. This will be accomplished by prioritizing the order in which this information is entered. Historic groundwater level data will be obtained from as many wells as possible, public and private, to ensure meaningful area coverage.

Water Quality Database - Water quality information may be a larger chore to organize in a database than water levels because each water sample collected is commonly analyzed for a large number of constituents. For water quality data collected in the future, analytical labs can provide results in digital form for ease of integration into a database. Historical water quality information is available digitally from the California Department of Health Services for public water supply wells (data is available for about the past ten years). For the rest of the historical water quality data, prioritizing the order of manual data entry would be necessary. Constituents of concern are obviously the first to be entered. Whether to enter all historical data will need to be addressed; this information is valuable in identifying long-term trends, but data entry takes time. United Water now has all historic water quality data for seven basins in Ventura County in a database, but it took several years to do this.

Water quality data from surface sources such as streams will also be included in the main water quality database. A location identifier can be used to tie the sample to the monitoring location in a GIS coverage. The approximate flow of the surface water source at the time of measurement should accompany each water quality data entry.

Pumpage Database - Pumpage data from individual wells is key to assessing both water level and water quality trends. This information is also required to construct a groundwater model. Some of this information has already been entered in computer files and can be readily imported into a database. Other information will likely have to be obtained on a cooperative basis. If pumpers do not have their own metered pumping records, pumpage will be estimated from other sources such as utility bills. For wells where no records have been kept, probable pumping quantities can be estimated through land use records and, in the case of irrigated agriculture, from irrigation methods and practices. This calculated information should not be entered directly in the pumpage database.

Streamflow Database - There should be a database of streamflow measured at various monitoring points. For USGS gauges, much of this information is already in digital form. Other agencies, such as County Flood Control, may also have digital data.

GROUNDWATER FLOW MODELING

As part of the technical analysis of water supply alternatives to meet projected water demands of the proposed Newhall Ranch project in the Upper River area, a numerical groundwater flow model was prepared for that project's proponent. That model was developed to focus on the feasibility and impacts of a potential storage and recovery project in the Saugus Formation, including the impacts of injection and recovery pumping in the Saugus on the overlying Alluvium, and the resultant impacts on Santa Clara River flows out of the Upper River area. The current model is calibrated for a steady state condition, including the addition of some focused injection and pumping. As a result, it represents a useful initial modeling effort of the overall aquifer system in the Upper River area. Depending on its availability for other uses in the Upper River area, that initial model will be subjected to transient calibration efforts and additional calibration of the Alluvial aquifer. The model will then become an evolving tool for analysis of ongoing groundwater development and recharge, in conjunction with imported surface water, and the resultant impacts on groundwater conditions in the Upper River area, as well as on surface outflows to the downstream basins on the Santa Clara River.

OPERATIONAL YIELD OF THE BASIN

A primary objective of the monitoring efforts, database management efforts, and modeling efforts described above is to assess groundwater basin conditions in the Upper River area in the context of the long term sustainability of the Alluvium aquifer and the generally underlying Saugus Formation, and to operate the basin such that the operating yield is not exceeded over a multi-year wet/dry cycle. This operational yield includes flexibility of groundwater use by allowing increased groundwater use during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is available. The operational yield protects the aquifer by assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. Historical groundwater data demonstrates that the Alluvium has been, and continues to be developed within its long-term sustainability (i.e. no chronic lowering of water levels, no notable trend toward degradation of groundwater quality, etc.). Limited historical data in the Saugus Formation shows no lowering of water levels or degradation of water quality where it has been developed.

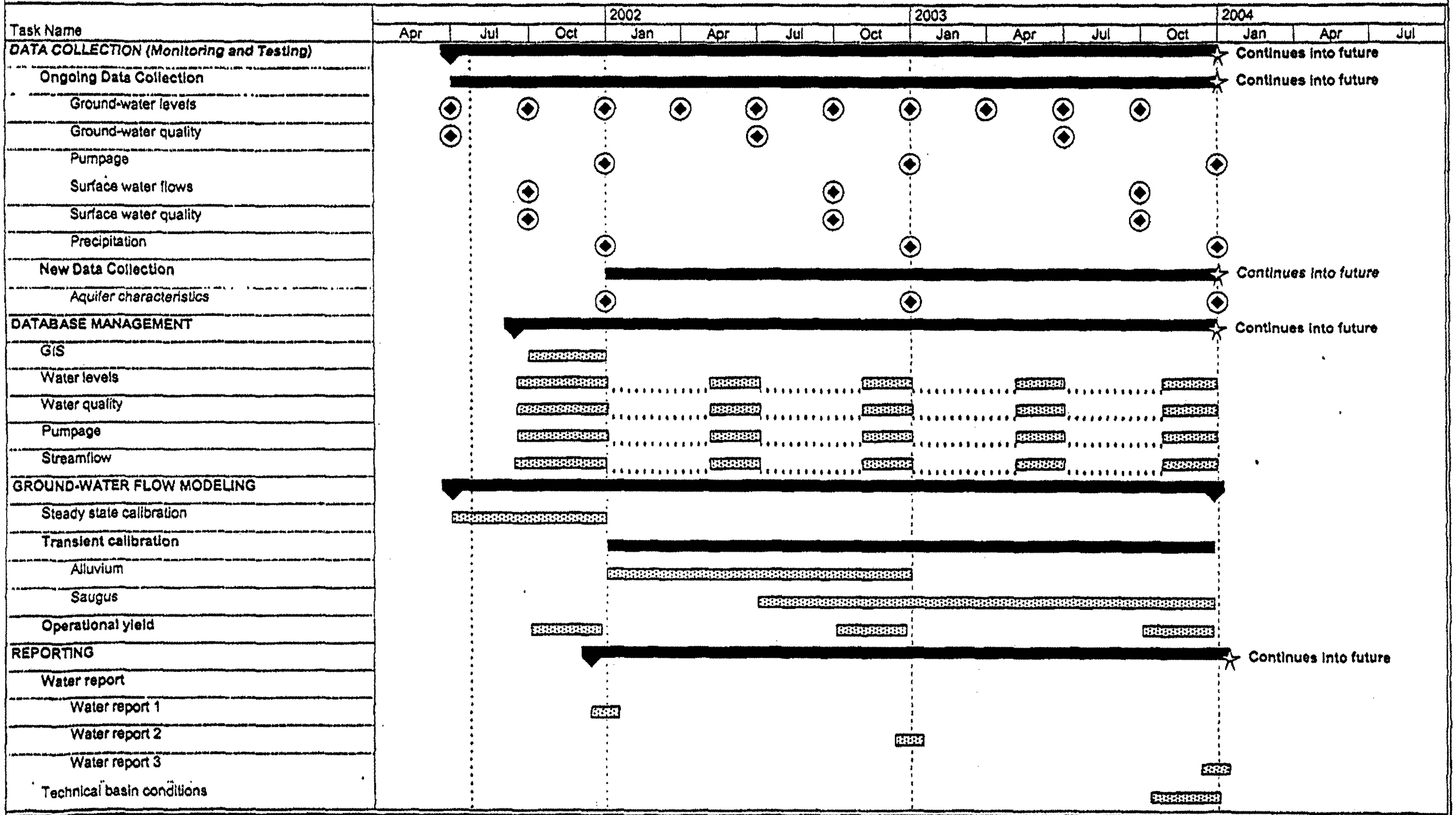
While current planning places future pumping of the Alluvium in the same range as has historically occurred for several decades, with anticipated similar results in terms of Alluvial water levels, storage, and quality, the model described above will be a useful tool to quantify the impacts in water budget terms and to analyze a range of scenarios as appropriate to optimize the use of the high-yielding Alluvium. The Saugus Formation is alternately being considered for short-term dry-period water supply at capacities higher than have historically been pumped from that formation, and for injection, storage and recovery of water as part of the overall water supply of the Upper Santa Clara River area. The model will also be used to determine the operational yield of the Saugus under a wide-ranging set of low to high pumping capacities (during wet to dry years, respectively), and with varying aquifer storage (recharge), to avoid undesirable impacts and assure that the operating yield is not exceeded over a multi-year wet/dry cycle.

REPORTING

Beginning in 1998, an annual report on water supply conditions in the Upper Santa Clara River area has been prepared by the water purveyors in the Upper River area. Those reports have focused on a planning-level discussion of current and immediate future water demands, and the availability of local Groundwater and imported surface water to meet those demands. The overall primary objectives of the reports have been to provide some documentation, to local and County planners as well as County Supervisors, on the water supply conditions in the Santa Clarita Valley and to present a general assessment of the status of groundwater conditions in both the Alluvial and Saugus aquifer systems, with a focus of that assessment on historical and recent groundwater development within operating yield parameters.

As the water resource monitoring program described above is implemented and evolves, it is planned that reporting on groundwater basin conditions will evolve in two generally parallel ways: 1) a continuation of the annual reporting on current water supply conditions, as a basis for current planning and consideration of development proposals; and 2) the addition of less frequent, more technically oriented reports on the geologic and hydrologic aspects of the groundwater resources of the Upper River area, including documentation of: a) groundwater basin conditions, b) development and application of modeling efforts to assess operational yield and the impacts of long-term planned utilization of local groundwater as part of the overall water supply, and c) assessment of actual versus predicted impacts on groundwater and surface water, including basin outflows, combined with ongoing updated assessments of the adequacy of local groundwater management actions and identification of any needed changes which are identified over time. As needed, the resource monitoring program and technical reports will be coordinated with interested regulatory agencies such as the Regional Water Quality Control Board, the California Department of Health Services and the California Department of Toxics and Substance Control.

Exhibit 2
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA



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APPENDIX B

Analyses of Specific Capacity Test Data for the Alluvial Aquifer

Specific capacity data are available for production wells in the Alluvial Aquifer through 2000. Tables B-1 through B-6 present these data and the calculations of estimated transmissivity (T) and horizontal hydraulic conductivity (Kh) values, along with how these values compare with the values used in the calibrated groundwater flow model at each well location. Rows in bold font identify specific capacity tests that were considered to provide the best indications of aquifer properties.

The tables show the testing data for different geographic areas in the Alluvial Aquifer[1], as well as the estimated drawdown in the aquifer formation for different values of well efficiency. Because of the unconfined nature of the Alluvial Aquifer system, the following equations were used to calculate T and Kh (Driscoll, 1986):

$$s = s_{well} * E$$

$$T = 1500 * Q / s \tag{1}$$

$$Kh = T / (7.48 * b_{typical})$$

where:

s = the estimated drawdown in the aquifer formation

s_{well} = the measured drawdown in the well during the efficiency test

E = the well estimated efficiency

T = the transmissivity (gallons per day per foot [gpd/ft])

Q = the pumping rate (gallons per minute [gpm])

Q/s = specific capacity of the well

Kh = the horizontal hydraulic conductivity of the alluvial aquifer (feet per day [ft/day])

$b_{typical}$ = the typical long-term average saturated thickness (feet [ft]) of the alluvial aquifer at the location of the specific well

For each test, Tables B-1 through B-6 show the data and the calculations for drawdown, T, and Kh at different estimated well efficiencies (70 percent is the typical efficiency of a well that is in good condition; 50 percent reflects a well that is less efficient).[2] As shown in the table, the T and Kh values vary widely with location, as well as over time at individual wells. The table uses bold font to identify those tests that are believed to be the least affected

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[1] See Figure 2-3 for well locations. See also Figure 4-1 for the locations of the target wells and zones that were used during calibration of the Alluvial Aquifer in the Santa Clarita Valley Groundwater Model (Regional Model).

[2] Well efficiency is a function of the design, construction, and condition of the well.

by well efficiency issues (i.e., show the highest specific capacity values) and therefore provide the best estimate of aquifer parameter values at each well location. Specific conclusions from this analysis are:

a. In the western alluvium along the main Santa Clara River valley (west of I-5), it appears that few wells have high enough efficiencies to provide estimates of Alluvial Aquifer Kh values. The highest specific capacities for the Alluvial Aquifer are indicated by only about 19 of the 335 tests performed in this area. For these 19 tests and a well efficiency of 70 percent, the Kh ranges from approximately 300 to 1,000 ft/day and is typically approximately 500 to 600 ft/day. The Regional Model uses a Kh of 550 ft/day throughout this area.

b. In the central valley, between I-5 and Soledad Canyon, 8 of the 11 tested wells appear to provide usable estimates of Alluvial Aquifer Kh values. These wells indicate a Kh range typically between 250 and 600 feet/day, though one well (NLF-R2) indicates Kh values potentially as high as 800 ft/day or greater. The Regional Model uses values between 245 and 375 ft/day in most of this area, and 550 ft/day at the very eastern edge of this area, at the mouth of Soledad Canyon.

c. In the lower reach of Soledad Canyon, most wells indicate Kh values ranging from 600 ft/day to more than 1,000 ft/day. Only the SCWC-Honby well suggests lower Kh values of approximately 300 to 550 ft/day. The Regional Model uses a Kh of 550 ft/day throughout this area.

d. In the upper reach of Soledad Canyon, the Kh values show more variability from well to well than lower Soledad Canyon. Kh values in upper Soledad Canyon range from approximately 300 to 700 ft/day at some wells, and 900 to 1,500 ft/day at the other wells. The Regional Model uses Kh values ranging from 350 ft/day at the eastern end of the canyon to 550 ft/day farther west.

e. In the tributary canyons north of the Santa Clara River, Alluvial Aquifer Kh values tend to be slightly lower than along the Santa Clara River main valley.

    1. Along Castaic Creek, Kh values are commonly between 350 and 600 ft/day, though a few tests suggest values as high as 800 to 1,000 ft/day. The Regional Model uses a value of 315 ft/day below Castaic Dam and at the NCWD Castaic wellfield, and 350 ft/day between this wellfield and the alluvial valley containing the Santa Clara River.

    2. In San Francisquito Canyon, the W series wells owned by VWC and NLF suggest Kh values of approximately 200 to 400 ft/day. The Regional Model uses a value of 105 ft/day.

    3. In Bouquet Canyon, the two SCWC wells suggest Kh values of approximately 500 to 900 ft/day. The Regional Model uses a value of 140 ft/day at SCWC-Guida in the central portion of the canyon, and 245 ft/day at SCWC-Clark well in the lower reaches of the canyon.

The estimation of K values from specific capacity test data is a method that provides only an approximation of aquifer properties. This method is valuable for constraining the Regional Model's calibration because specific capacity tests provide the only source of data that allow estimation and comparison of Alluvial Aquifer properties across the valley. Nonetheless, the method is affected by the following factors and uncertainties:

a. The measured drawdown in a well is affected by the radius of the well and the borehole, and the efficiency of the well at the time it is tested.

b. Yield and drawdown are affected by the length of the well screen and the fraction of the aquifer's thickness that is screened.

c. Fluctuations in water levels that occur seasonally and over multi-year periods affect the yield and drawdown of the well, and also the estimates of saturated thickness that are necessary for performing the calculations.

Reference

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Tables

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	B5	**04/24/1984**	**1988**	**6.9**	**288.1**	**6.9**	**4.83**	**3.45**	**82,534**	**115,548**	**60,500**	**110**	**750**	**1,050**	**550**
		06/09/1986	1816	5.6	324.3	5.6	3.92	2.8	92,905	130,067		110	845	1,182	
		10/15/1987	1878	6.6	284.5	6.6	4.62	3.3	81,503	114,104		110	741	1,037	
		10/04/1988	1342	6.7	200.3	6.7	4.69	3.35	57,382	80,334		110	522	730	
		07/20/1989	1659	8.6	192.9	8.6	6.02	4.3	55,262	77,366		110	502	703	
		06/13/1990	1699	8	212.4	8	5.6	4	60,848	85,187		110	553	774	
		05/28/1991	**2013**	**7.6**	**264.9**	**7.6**	**5.32**	**3.8**	**75,888**	**106,243**	**60,500**	**110**	**690**	**966**	**550**
		07/26/1993	1895	7.2	263.2	7.2	5.04	3.6	75,401	105,561		110	685	960	
		08/15/1994	1870	6.3	296.8	6.3	4.41	3.15	85,027	119,037		110	773	1,082	
		07/18/1995	2081	6.5	320.2	6.5	4.55	3.25	91,730	128,422		110	834	1,167	
		06/10/1996	**2045**	**6.5**	**314.6**	**6.5**	**4.55**	**3.25**	**90,126**	**126,176**	**60,500**	**110**	**819**	**1,147**	**550**
		05/08/1997	1898	6.6	287.6	6.6	4.62	3.3	82,391	115,348		110	749	1,049	
		03/28/2000	**2357**	**6**	**392.8**	**6**	**4.2**	**3**	**112,529**	**157,540**	**60,500**	**110**	**1,023**	**1,432**	**550**
NLF	B6	05/21/1984	1473	12.1	121.7	12.1	8.47	6.05	34,864	48,810		110	317	444	
		06/09/1986	1886	15	125.7	15	10.5	7.5	36,010	50,414		110	327	458	
		10/15/1987	1190	10.4	114.4	10.4	7.28	5.2	32,773	45,882		110	298	417	
		07/20/1989	1043	8.4	124.2	8.4	5.88	4.2	35,581	49,813		110	323	453	
		06/13/1990	1083	10.4	104.1	10.4	7.28	5.2	29,822	41,751		110	271	380	
		05/30/1991	1603	11.9	134.7	11.9	8.33	5.95	38,589	54,024		110	351	491	
		06/10/1992	**1746**	**11.6**	**150.5**	**11.6**	**8.12**	**5.8**	**43,115**	**60,361**	**60,500**	**110**	**392**	**549**	**550**
		07/26/1993	1473	6.7	219.9	6.7	4.69	3.35	62,997	88,195		110	573	802	
		08/15/1994	1460	15.5	94.2	15.5	10.85	7.75	26,986	37,781		110	245	343	
		07/19/1995	**1600**	**9.2**	**173.9**	**9.2**	**6.44**	**4.6**	**49,819**	**69,746**	**60,500**	**110**	**453**	**634**	**550**
		06/10/1996	1274	18.6	68.5	18.6	13.02	9.3	19,624	27,473		110	178	250	
		05/08/1997	1394	15.6	89.4	15.6	10.92	7.8	25,611	35,856		110	233	326	
		06/26/1998	1554	15	103.6	15	10.5	7.5	29,679	41,551		110	270	378	
		05/06/1999	1504	13.3	113.1	13.3	9.31	6.65	32,401	45,361		110	295	412	
		05/21/1999	1504	13.3	113.1	13.3	9.31	6.65	32,401	45,361		110	295	412	
		04/21/2000	1086	22.4	48.5	22.4	15.68	11.2	13,894	19,452		110	126	177	
NLF	B7	02/24/1984	832	34.2	24.3	34.2	23.94	17.1	6,961	9,746	60,500	110	63	89	550
		04/24/1984	832	34.2	24.3	34.2	23.94	17.1	6,961	9,746		110	63	89	
		06/03/1986	766	33.4	22.9	33.4	23.38	16.7	6,560	9,184		110	60	83	
		12/21/1989	700	52.9	13.2	52.9	37.03	26.45	3,782	5,294		110	34	48	
		06/12/1990	766	50.5	15.2	50.5	35.35	25.25	4,354	6,096		110	40	55	
		05/29/1991	878	37.1	23.7	37.1	25.97	18.55	6,790	9,505		110	62	86	
		06/10/1992	837	14.9	56.2	14.9	10.43	7.45	16,100	22,540		110	146	205	
		07/23/1993	911	16.9	53.9	16.9	11.83	8.45	15,441	21,618		110	140	197	
		08/30/1994	730	33.5	21.8	33.5	23.45	16.75	6,245	8,743		110	57	79	
		07/17/1995	720	25.9	27.8	25.9	18.13	12.95	7,964	11,150		110	72	101	
		06/11/1996	725	29.5	24.6	29.5	20.65	14.75	7,047	9,866		110	64	90	
		06/26/1998	689	27.1	25.4	27.1	18.97	13.55	7,277	10,187		110	66	93	
		05/10/1999	915	27	33.9	27	18.9	13.5	9,712	13,596		110	88	124	
		05/21/1999	915	27	33.9	27	18.9	13.5	9,712	13,596		110	88	124	
		04/21/2000	945	49.6	19.1	49.6	34.72	24.8	5,472	7,660		110	50	70	
NLF	B10	07/13/1982	1325	33.2	39.9	33.2	23.24	16.6	11,430	16,003	60,500	110	104	145	550
		05/29/1991	1556	38.7	40.2	38.7	27.09	19.35	11,516	16,123		110	105	147	
		07/26/1993	1637	41	39.9	41	28.7	20.5	11,430	16,003		110	104	145	
		08/10/1994	1328	31.9	41.6	31.9	22.33	15.95	11,917	16,684		110	108	152	
		07/18/1995	1409	37.2	37.9	37.2	26.04	18.6	10,858	15,201		110	99	138	
		06/10/1996	1339	40	33.5	40	28	20	9,597	13,436		110	87	122	
		05/08/1997	1316	45.7	28.8	45.7	31.99	22.85	8,251	11,551		110	75	105	
		06/04/1998	1263	36.5	34.6	36.5	25.55	18.25	9,912	13,877		110	90	126	

TABLE B-1
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Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/06/1999	1259	43.4	29	43.4	30.38	21.7	8,308	11,631		110	76	106	
		05/21/1999	1259	43.4	29	43.4	30.38	21.7	8,308	11,631		110	76	106	
		04/21/2000	1259	39.4	32	39.4	27.58	19.7	9,167	12,834		110	83	117	
NLF	B11	07/27/1993	219	14.9	14.7	14.9	10.43	7.45	4,211	5,896	60,500	110	38	54	550
		08/17/1994	226	15.5	14.6	15.5	10.85	7.75	4,183	5,856		110	38	53	
		07/17/1995	429	12.4	34.6	12.4	8.68	6.2	9,912	13,877		110	90	126	
		05/14/1997	950	28	33.9	28	19.6	14	9,712	13,596		110	88	124	
		06/26/1998	817	22.9	35.7	22.9	16.03	11.45	10,227	14,318		110	93	130	
		05/10/1999	714	19.5	36.6	19.5	13.65	9.75	10,485	14,679		110	95	133	
		05/21/1999	714	19.5	36.6	19.5	13.65	9.75	10,485	14,679		110	95	133	
		04/21/2000	860	26.2	32.8	26.2	18.34	13.1	9,396	13,155		110	85	120	
NLF	C	04/09/1984	1351	49.4	27.3	49.4	34.58	24.7	7,821	10,949	60,500	110	71	100	550
		05/21/1986	1325	54.2	24.4	54.2	37.94	27.1	6,990	9,786		110	64	89	
		10/19/1987	1342	46	29.2	46	32.2	23	8,365	11,711		110	76	106	
		10/04/1988	1336	45	29.7	45	31.5	22.5	8,508	11,912		110	77	108	
		07/10/1989	1360	35.2	38.6	35.2	24.64	17.6	11,058	15,481		110	101	141	
		06/11/1990	1331	36.6	36.4	36.6	25.62	18.3	10,428	14,599		110	95	133	
		05/06/1991	1342	48.3	27.8	48.3	33.81	24.15	7,964	11,150		110	72	101	
		06/08/1992	1257	48	26.2	48	33.6	24	7,506	10,508		110	68	96	
		07/30/1993	1178	26.6	44.3	26.6	18.62	13.3	12,691	17,767		110	115	162	
		08/02/1994	1318	24.6	53.6	24.6	17.22	12.3	15,355	21,497		110	140	195	
		06/28/1995	1290	29	44.5	29	20.3	14.5	12,748	17,848		110	116	162	
		05/30/1996	1238	35.6	34.8	35.6	24.92	17.8	9,969	13,957		110	91	127	
		04/24/1997	1247	34	36.7	34	23.8	17	10,514	14,719		110	96	134	
		05/27/1998	1282	36.3	35.3	36.3	25.41	18.15	10,113	14,158		110	92	129	
		04/27/1999	1152	37.6	30.6	37.6	26.32	18.8	8,766	12,273		110	80	112	
		05/21/1999	1152	37.6	30.6	37.6	26.32	18.8	8,766	12,273		110	80	112	
		04/21/2000	1195	34	35.1	34	23.8	17	10,055	14,078		110	91	128	
NLF	C3	04/17/1984	935	42.4	22.1	42.4	29.68	21.2	6,331	8,864	60,500	110	58	81	550
		05/14/1986	870	54.7	15.9	54.7	38.29	27.35	4,555	6,377		110	41	58	
		07/12/1989	908	37.3	24.3	37.3	26.11	18.65	6,961	9,746		110	63	89	
		06/11/1990	549	25.1	21.9	25.1	17.57	12.55	6,274	8,783		110	57	80	
		05/07/1991	573	24.3	23.6	24.3	17.01	12.15	6,761	9,465		110	61	86	
		06/09/1992	814	45.5	17.9	45.5	31.85	22.75	5,128	7,179		110	47	65	
		07/31/1993	633	31.4	20.2	31.4	21.98	15.7	5,787	8,102		110	53	74	
		08/05/1994	739	19.2	38.5	19.2	13.44	9.6	11,029	15,441		110	100	140	
		07/11/1995	638	23.3	27.4	23.3	16.31	11.65	7,850	10,989		110	71	100	
		06/04/1996	553	30.9	17.9	30.9	21.63	15.45	5,128	7,179		110	47	65	
		05/07/1997	894	62.4	14.3	62.4	43.68	31.2	4,097	5,735		110	37	52	
		06/03/1998	754	64.1	11.8	64.1	44.87	32.05	3,380	4,733		110	31	43	
		05/03/1999	653	74.7	8.7	74.7	52.29	37.35	2,492	3,489		110	23	32	
		05/21/1999	653	74.7	8.7	74.7	52.29	37.35	2,492	3,489		110	23	32	
		04/21/2000	573	53.2	10.8	53.2	37.24	26.6	3,094	4,332		110	28	39	
NLF	C4	04/17/1984	1280	43.2	29.6	43.2	30.24	21.6	8,480	11,872		110	77	108	
		05/14/1986	1056	41	25.8	41	28.7	20.5	7,391	10,348		110	67	94	
		06/11/1990	1130	30	37.7	30	21	15	10,800	15,120		110	98	137	
		05/07/1991	1348	35.9	37.5	35.9	25.13	17.95	10,743	15,040		110	98	137	
		06/09/1992	1225	36.7	33.4	36.7	25.69	18.35	9,568	13,396		110	87	122	
		07/29/1993	834	21.3	39.2	21.3	14.91	10.65	11,230	15,722		110	102	143	
		08/05/1994	**1038**	**12.6**	**82.4**	**12.6**	**8.82**	**6.3**	**23,606**	**33,048**	**60,500**	**110**	**215**	**300**	**550**
		07/11/1995	1248	24.9	50.1	24.9	17.43	12.45	14,353	20,094		110	130	183	
		06/04/1996	1279	25.1	51	25.1	17.57	12.55	14,610	20,455		110	133	186	

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		05/07/1997	1310	27.8	47.1	27.8	19.46	13.9	13,493	18,890		110	123	172	
		06/03/1998	1279	29.4	43.5	29.4	20.58	14.7	12,462	17,447		110	113	159	
		05/03/1999	1072	32	33.5	32	22.4	16	9,597	13,436		110	87	122	
		05/21/1999	1072	32	33.5	32	22.4	16	9,597	13,436		110	87	122	
		04/21/2000	1156	30	38.5	30	21	15	11,029	15,441		110	100	140	
NLF	C5	04/09/1984	674	56.9	11.8	56.9	39.83	28.45	3,380	4,733	60,500	110	31	43	550
		05/15/1986	592	88.2	6.7	88.2	61.74	44.1	1,919	2,687		110	17	24	
		10/19/1987	587	84.3	7	84.3	59.01	42.15	2,005	2,807		110	18	26	
		07/18/1989	697	49.9	14	49.9	34.93	24.95	4,011	5,615		110	36	51	
		06/12/1990	638	68.3	9.3	68.3	47.81	34.15	2,664	3,730		110	24	34	
		05/08/1991	715	63.5	11.3	63.5	44.45	31.75	3,237	4,532		110	29	41	
		06/09/1992	722	63.9	11.3	63.9	44.73	31.95	3,237	4,532		110	29	41	
		07/30/1993	715	41.9	17.1	41.9	29.33	20.95	4,899	6,858		110	45	62	
		08/08/1994	796	13.6	58.5	13.6	9.52	6.8	16,759	23,463		110	152	213	
		07/07/1995	802	14.9	53.8	14.9	10.43	7.45	15,413	21,578		110	140	196	
		05/30/1996	945	21.6	43.8	21.6	15.12	10.8	12,548	17,567		110	114	160	
		05/06/1997	880	18.2	48.4	18.2	12.74	9.1	13,866	19,412		110	126	176	
		06/01/1998	885	21.5	41.2	21.5	15.05	10.75	11,803	16,524		110	107	150	
		04/27/1999	895	21.2	42.2	21.2	14.84	10.6	12,089	16,925		110	110	154	
		05/21/1999	895	21.2	42.2	21.2	14.84	10.6	12,089	16,925		110	110	154	
		04/21/2000	804	17.2	46.7	17.2	12.04	8.6	13,379	18,730		110	122	170	
NLF	C6	04/09/1984	153	29.9	5.1	29.9	20.93	14.95	1,461	2,045	60,500	110	13	19	550
		05/15/1986	137	34.2	4	34.2	23.94	17.1	1,146	1,604		110	10	15	
		10/19/1987	147	33.7	4.4	33.7	23.59	16.85	1,261	1,765		110	11	16	
		07/12/1989	124	31.4	3.9	31.4	21.98	15.7	1,117	1,564		110	10	14	
		06/06/1990	141	36.4	3.9	36.4	25.48	18.2	1,117	1,564		110	10	14	
		05/08/1991	133	41	3.2	41	28.7	20.5	917	1,283		110	8	12	
		12/21/1994	445	33.8	13.2	33.8	23.66	16.9	3,782	5,294		110	34	48	
		07/07/1995	459	33.2	13.8	33.2	23.24	16.6	3,953	5,535		110	36	50	
		05/28/1996	405	39.7	10.2	39.7	27.79	19.85	2,922	4,091		110	27	37	
		04/24/1997	364	44.6	8.2	44.6	31.22	22.3	2,349	3,289		110	21	30	
		05/27/1998	349	49.2	7.1	49.2	34.44	24.6	2,034	2,848		110	18	26	
		04/27/1999	305	50	6.1	50	35	25	1,748	2,447		110	16	22	
		05/21/1999	305	50	6.1	50	35	25	1,748	2,447		110	16	22	
		04/21/2000	260	50.5	5.1	50.5	35.35	25.25	1,461	2,045		110	13	19	
NLF	C7	04/10/1984	1118	44.5	25.1	44.5	31.15	22.25	7,191	10,067	60,500	110	65	92	550
		05/15/1986	1050	42.4	24.8	42.4	29.68	21.2	7,105	9,947		110	65	90	
		10/14/1987	1104	38.5	28.7	38.5	26.95	19.25	8,222	11,511		110	75	105	
		07/10/1989	434	38.3	11.3	38.3	26.81	19.15	3,237	4,532		110	29	41	
		06/11/1990	1067	32.8	32.5	32.8	22.96	16.4	9,311	13,035		110	85	118	
		05/28/1991	1082	37.6	28.8	37.6	26.32	18.8	8,251	11,551		110	75	105	
		06/08/1992	1047	47.1	22.2	47.1	32.97	23.55	6,360	8,904		110	58	81	
		07/31/1993	1054	37.9	27.8	37.9	26.53	18.95	7,964	11,150		110	72	101	
		08/01/1994	1008	39.5	25.5	39.5	27.65	19.75	7,305	10,227		110	66	93	
		06/28/1995	1082	38.1	28.4	38.1	26.67	19.05	8,136	11,390		110	74	104	
		06/03/1996	1032	43.7	23.6	43.7	30.59	21.85	6,761	9,465		110	61	86	
		05/06/1997	995	44.4	22.4	44.4	31.08	22.2	6,417	8,984		110	58	82	
		06/03/1998	919	50.9	18.1	50.9	35.63	25.45	5,185	7,259		110	47	66	
		05/03/1999	944	44.6	21.2	44.6	31.22	22.3	6,073	8,503		110	55	77	
		05/21/1999	944	44.6	21.2	44.6	31.22	22.3	6,073	8,503		110	55	77	
		04/21/2000	914	42.5	21.5	42.5	29.75	21.25	6,159	8,623		110	56	78	

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Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	C8	10/19/1950	318	76.3	4.2	76.3	53.41	38.15	1,203	1,684	60,500	110	11	15	550
		09/26/1951	365	52.5	7	52.5	36.75	26.25	2,005	2,807		110	18	26	
		10/01/1952	434	39.4	11	39.4	27.58	19.7	3,151	4,412		110	29	40	
		02/08/1955	548	56.4	9.7	56.4	39.48	28.2	2,779	3,890		110	25	35	
		10/04/1956	351	76.4	4.6	76.4	53.48	38.2	1,318	1,845		110	12	17	
		07/05/1957	260	92	2.8	92	64.4	46	802	1,123		110	7	10	
		09/12/1957	522	77	6.8	77	53.9	38.5	1,948	2,727		110	18	25	
		07/30/1958	394	49	8	49	34.3	24.5	2,292	3,209		110	21	29	
		10/31/1958	493	69.3	7.1	69.3	48.51	34.65	2,034	2,848		110	18	26	
		08/05/1959	443	76	5.8	76	53.2	38	1,662	2,326		110	15	21	
		07/06/1960	443	78.4	5.7	78.4	54.88	39.2	1,633	2,286		110	15	21	
		07/20/1961	329	72.3	4.6	72.3	50.61	36.15	1,318	1,845		110	12	17	
		05/31/1962	318	97.2	3.3	97.2	68.04	48.6	945	1,324		110	9	12	
		05/09/1963	271	104.6	2.6	104.6	73.22	52.3	745	1,043		110	7	9	
		07/14/1964	365	87.2	4.2	87.2	61.04	43.6	1,203	1,684		110	11	15	
		08/04/1965	362	88.9	4.1	88.9	62.23	44.45	1,175	1,644		110	11	15	
		11/01/1966	410	85	4.8	85	59.5	42.5	1,375	1,925		110	13	18	
		08/09/1967	377	104	3.6	104	72.8	52	1,031	1,444		110	9	13	
		08/28/1968	332	96.6	3.4	96.6	67.62	48.3	974	1,364		110	9	12	
		08/19/1969	410	75.4	5.4	75.4	52.78	37.7	1,547	2,166		110	14	20	
		07/09/1970	351	71.5	4.9	71.5	50.05	35.75	1,404	1,965		110	13	18	
		08/04/1971	572	76.4	7.5	76.4	53.48	38.2	2,149	3,008		110	20	27	
		01/12/1972	373	122.8	3	122.8	85.96	61.4	859	1,203		110	8	11	
		05/18/1972	414	110.9	3.7	110.9	77.63	55.45	1,060	1,484		110	10	13	
		07/17/1973	439	90.8	4.8	90.8	63.56	45.4	1,375	1,925		110	13	18	
		07/01/1974	419	108.8	3.9	108.8	76.16	54.4	1,117	1,564		110	10	14	
		05/03/1976	363	99.8	3.6	99.8	69.86	49.9	1,031	1,444		110	9	13	
		05/21/1984	546	59	9.3	59	41.3	29.5	2,664	3,730		110	24	34	
		07/10/1989	477	52.7	9.1	52.7	36.89	26.35	2,607	3,650		110	24	33	
		06/12/1990	488	52.2	9.3	52.2	36.54	26.1	2,664	3,730		110	24	34	
		05/06/1991	525	49.4	10.6	49.4	34.58	24.7	3,037	4,251		110	28	39	
		06/08/1992	477	48.6	9.8	48.6	34.02	24.3	2,807	3,930		110	26	36	
		07/30/1993	488	51.6	9.5	51.6	36.12	25.8	2,722	3,810		110	25	35	
		08/02/1994	520	30.4	17.1	30.4	21.28	15.2	4,899	6,858		110	45	62	
		07/11/1995	503	24.6	20.4	24.6	17.22	12.3	5,844	8,182		110	53	74	
		06/03/1996	535	29.3	18.3	29.3	20.51	14.65	5,243	7,340		110	48	67	
		05/06/1997	476	36.9	12.9	36.9	25.83	18.45	3,696	5,174		110	34	47	
		06/01/1998	478	34.5	13.9	34.5	24.15	17.25	3,982	5,575		110	36	51	
		05/03/1999	475	32.7	14.5	32.7	22.89	16.35	4,154	5,816		110	38	53	
		05/21/1999	475	32.7	14.5	32.7	22.89	16.35	4,154	5,816		110	38	53	
		04/21/2000	455	30.8	14.8	30.8	21.56	15.4	4,240	5,936		110	39	54	
NLF	E4	05/24/1984	1473	39.5	37.3	39.5	27.65	19.75	10,686	14,960	71,500	130	82	115	550
		06/02/1986	1511	41	36.9	41	28.7	20.5	10,571	14,799		130	81	114	
		10/03/1988	1897	42.9	44.2	42.9	30.03	21.45	12,662	17,727		130	97	136	
		07/18/1989	1576	35.5	44.4	35.5	24.85	17.75	12,720	17,807		130	98	137	
		06/04/1991	1225	17.5	70	17.5	12.25	8.75	20,053	28,075		130	154	216	
		07/23/1993	1944	38.2	50.9	38.2	26.74	19.1	14,582	20,414		130	112	157	
		05/22/1997	1956	37.2	52.6	37.2	26.04	18.6	15,069	21,096		130	116	162	
		05/11/1999	1868	39.7	47.1	39.7	27.79	19.85	13,493	18,890		130	104	145	
		05/21/1999	1868	39.7	47.1	39.7	27.79	19.85	13,493	18,890		130	104	145	
		04/21/2000	1691	30.5	55.4	30.5	21.35	15.25	15,871	22,219		130	122	171	

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	E5	06/10/1992	1320	84	15.7	84	58.8	42	4,498	6,297		130	35	48	
		08/11/1993	1274	63.3	20.1	63.3	44.31	31.65	5,758	8,061		130	44	62	
		12/21/1994	1203	24.9	48.3	24.9	17.43	12.45	13,837	19,372		130	106	149	
		07/25/1995	1191	23.8	50	23.8	16.66	11.9	14,324	20,053		130	110	154	
		05/28/1996	824	13.6	60.6	13.6	9.52	6.8	17,361	24,305		130	134	187	
		05/12/1997	1179	15.1	78.1	15.1	10.57	7.55	22,374	31,324		130	172	241	
		06/04/1998	1022	22.7	45	22.7	15.89	11.35	12,892	18,048		130	99	139	
		06/05/1998	1022	22.7	45	22.7	15.89	11.35	12,892	18,048		130	99	139	
		08/18/2000	**705**	**5.1**	**138.2**	**5.1**	**3.57**	**2.55**	**39,591**	**55,428**	**71,500**	**130**	**305**	**426**	**550**
NLF	E7	08/11/1993	263	2.5	105.2	2.5	1.75	1.25	30,138	42,193	71,500	130	232	325	550
		08/08/1994	328	2.5	131.2	2.5	1.75	1.25	37,586	52,620		130	289	405	
		07/03/1995	325	2.4	135.4	2.4	1.68	1.2	38,789	54,305		130	298	418	
		06/05/1996	334	2.7	123.7	2.7	1.89	1.35	35,437	49,612		130	273	382	
		05/12/1997	320	2.6	123.1	2.6	1.82	1.3	35,265	49,372		130	271	380	
		05/16/1997	320	2.6	123.1	2.6	1.82	1.3	35,265	49,372		130	271	380	
NLF	E9	04/11/1984	601	75.6	7.9	75.6	52.92	37.8	2,263	3,168	63,250	130	17	24	550
		05/20/1986	578	76.2	7.6	76.2	53.34	38.1	2,177	3,048		130	17	23	
		12/11/1986	1190	57.1	20.8	57.1	39.97	28.55	5,959	8,342		130	46	64	
		10/13/1987	1069	59.9	17.8	59.9	41.93	29.95	5,099	7,139		130	39	55	
		09/28/1988	894	61.2	14.6	61.2	42.84	30.6	4,183	5,856		130	32	45	
		07/11/1989	897	60	15	60	42	30	4,297	6,016		130	33	46	
		05/29/1990	876	60.3	14.5	60.3	42.21	30.15	4,154	5,816		130	32	45	
		04/18/1991	970	60.3	16.1	60.3	42.21	30.15	4,612	6,457		130	35	50	
		06/04/1992	897	62.4	14.4	62.4	43.68	31.2	4,125	5,775		130	32	44	
		07/22/1993	1021	55.6	18.4	55.6	38.92	27.8	5,271	7,380		130	41	57	
		07/19/1994	1053	52.1	20.2	52.1	36.47	26.05	5,787	8,102		130	45	62	
		07/03/1995	1058	51.5	20.5	51.5	36.05	25.75	5,873	8,222		130	45	63	
		05/23/1996	1073	49.7	21.6	49.7	34.79	24.85	6,188	8,663		130	48	67	
		04/23/1997	1050	50.1	21	50.1	35.07	25.05	6,016	8,422		130	46	65	
		06/03/1998	1021	50.8	20.1	50.8	35.56	25.4	5,758	8,061		130	44	62	
		05/04/1999	1107	39.8	27.8	39.8	27.86	19.9	7,964	11,150		130	61	86	
		04/21/2000	1117	29.6	37.7	29.6	20.72	14.8	10,800	15,120		130	83	116	
NLF	G45	04/16/1984	1590	31.2	51	31.2	21.84	15.6	14,610	20,455	63,250	115	127	178	550
		05/27/1986	1008	20.5	49.2	20.5	14.35	10.25	14,095	19,733		115	123	172	
		07/13/1989	1379	33.7	40.9	33.7	23.59	16.85	11,717	16,404		115	102	143	
		06/14/1990	1399	32.3	43.3	32.3	22.61	16.15	12,405	17,366		115	108	151	
		05/30/1991	1456	37.8	38.5	37.8	26.46	18.9	11,029	15,441		115	96	134	
		06/10/1992	1434	36.7	39.1	36.7	25.69	18.35	11,201	15,682		115	97	136	
		07/29/1993	1172	24.9	47.1	24.9	17.43	12.45	13,493	18,890		115	117	164	
		08/08/1994	1325	29.7	44.6	29.7	20.79	14.85	12,777	17,888		115	111	156	
		07/19/1995	1140	25.6	44.5	25.6	17.92	12.8	12,748	17,848		115	111	155	
		05/23/1996	1130	25.3	44.7	25.3	17.71	12.65	12,806	17,928		115	111	156	
		05/07/1997	1162	25.9	44.9	25.9	18.13	12.95	12,863	18,008		115	112	157	
		06/04/1998	1396	41.4	33.7	41.4	28.98	20.7	9,654	13,516		115	84	118	
		05/10/1999	1030	23	44.8	23	16.1	11.5	12,834	17,968		115	112	156	
		05/21/1999	1030	23	44.8	23	16.1	11.5	12,834	17,968		115	112	156	
		04/21/2000	1257	26.9	46.7	26.9	18.83	13.45	13,379	18,730		115	116	163	
NLF	X3	04/11/1984	802	41	19.6	41	28.7	20.5	5,615	7,861	63,250	115	49	68	550
		05/20/1986	505	53.4	9.5	53.4	37.38	26.7	2,722	3,810		115	24	33	
		10/13/1987	740	40.6	18.2	40.6	28.42	20.3	5,214	7,299		115	45	63	
		09/28/1988	477	45.5	10.5	45.5	31.85	22.75	3,008	4,211		115	26	37	
		07/11/1989	572	61.4	9.3	61.4	42.98	30.7	2,664	3,730		115	23	32	

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/29/1990	444	47.5	9.3	47.5	33.25	23.75	2,664	3,730		115	23	32	
		04/18/1991	475	48.6	9.8	48.6	34.02	24.3	2,807	3,930		115	24	34	
		06/04/1992	587	46.1	12.7	46.1	32.27	23.05	3,638	5,094		115	32	44	
		07/22/1993	496	54	9.2	54	37.8	27	2,636	3,690		115	23	32	
		07/18/1994	465	52.2	8.9	52.2	36.54	26.1	2,550	3,570		115	22	31	
		07/03/1995	490	49.4	9.9	49.4	34.58	24.7	2,836	3,971		115	25	35	
		05/14/1996	449	53.9	8.3	53.9	37.73	26.95	2,378	3,329		115	21	29	
		04/23/1997	485	53.8	9	53.8	37.66	26.9	2,578	3,610		115	22	31	
		05/06/1998	531	47.9	11.1	47.9	33.53	23.95	3,180	4,452		115	28	39	
		05/04/1999	493	43.2	11.4	43.2	30.24	21.6	3,266	4,572		115	28	40	
		05/21/1999	493	43.2	11.4	43.2	30.24	21.6	3,266	4,572		115	28	40	
		04/21/2000	513	43.2	11.9	43.2	30.24	21.6	3,409	4,773		115	30	42	

Notes:

E = well efficiency
Kh = horizontal hydraulic conductivity
T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	I	**05/23/1984**	**993**	**8.7**	**114.1**	**8.7**	**6.09**	**4.35**	**32,687**	**45,762**	**22,500**	**130**	**251**	**352**	**375**
		06/09/1986	**1058**	**9.6**	**110.2**	**9.6**	**6.72**	**4.8**	**31,570**	**44,198**	**22,500**	**130**	**243**	**340**	**375**
		02/03/1992	140	73	1.9	73	51.1	36.5	544	762		130	4	6	
		07/06/1994	129	86.2	1.5	86.2	60.34	43.1	430	602		130	3	5	
		08/01/1994	129	86.2	1.5	86.2	60.34	43.1	430	602		130	3	5	
VWC	K2	**01/29/1992**	**1563**	**7.1**	**220.1**	**7.1**	**4.97**	**3.55**	**63,054**	**88,275**	**54,375**	**145**	**435**	**609**	**375**
		05/13/1994	1365	7.1	192.3	7.1	4.97	3.55	55,090	77,126		145	380	532	
		04/17/1996	1650	8.6	191.9	8.6	6.02	4.3	54,975	76,965		145	379	531	
		07/11/1997	**1333**	**6.3**	**211.6**	**6.3**	**4.41**	**3.15**	**60,619**	**84,866**	**54,375**	**145**	**418**	**585**	**375**
		12/30/1998	1409	6.7	210.3	6.7	4.69	3.35	60,246	84,345		145	415	582	
VWC	L2	04/26/1984	2197	28.3	77.6	28.3	19.81	14.15	22,231	31,123	54,375	145	153	215	375
		11/21/1991	1400	19	73.7	19	13.3	9.5	21,113	29,559		145	146	204	
		01/29/1992	1466	26.1	56.2	26.1	18.27	13.05	16,100	22,540		145	111	155	
		05/13/1994	1256	32.8	38.3	32.8	22.96	16.4	10,972	15,361		145	76	106	
		04/17/1996	1210	29.6	40.9	29.6	20.72	14.8	11,717	16,404		145	81	113	
		07/14/1997	851	17.6	48.4	17.6	12.32	8.8	13,866	19,412		145	96	134	
		12/11/1998	931	24.5	38	24.5	17.15	12.25	10,886	15,241		145	75	105	
VWC	N	08/05/1969	1891	31.6	59.8	31.6	22.12	15.8	17,131	23,984	54,375	145	118	165	375
		08/27/1970	1787	27	66.2	27	18.9	13.5	18,965	26,551		145	131	183	
		07/21/1977	1427	15.2	93.9	15.2	10.64	7.6	26,900	37,660		145	186	260	
		05/23/1978	1448	14.6	99.2	14.6	10.22	7.3	28,419	39,786		145	196	274	
		11/05/1979	1427	15.4	92.7	15.4	10.78	7.7	26,557	37,179		145	183	256	
		11/17/1980	1450	21.8	66.5	21.8	15.26	10.9	19,051	26,671		145	131	184	
		10/26/1981	1427	26	54.9	26	18.2	13	15,728	22,019		145	108	152	
		06/10/1982	1427	24.1	59.2	24.1	16.87	12.05	16,960	23,743		145	117	164	
		02/04/1985	1562	22.9	68.2	22.9	16.03	11.45	19,538	27,353		145	135	189	
		08/07/1986	1450	23	63	23	16.1	11.5	18,048	25,267		145	124	174	
		04/25/1988	1404	23.3	60.3	23.3	16.31	11.65	17,275	24,184		145	119	167	
		02/01/1990	1380	22.5	61.3	22.5	15.75	11.25	17,561	24,586		145	121	170	
		05/30/1990	1350	21	64.3	21	14.7	10.5	18,421	25,789		145	127	178	
		11/21/1991	1320	19.5	67.7	19.5	13.65	9.75	19,395	27,152		145	134	187	
		01/30/1992	1378	20.8	66.3	20.8	14.56	10.4	18,994	26,591		145	131	183	
		05/13/1994	1328	16.9	78.6	16.9	11.83	8.45	22,517	31,524		145	155	217	
		04/18/1996	1320	16.8	78.6	16.8	11.76	8.4	22,517	31,524		145	155	217	
		07/11/1997	927	10.2	90.9	10.2	7.14	5.1	26,041	36,457		145	180	251	
		12/01/1998	1086	11.5	94.4	11.5	8.05	5.75	27,044	37,861		145	187	261	
VWC	N3	**11/21/1991**	**1550**	**8**	**193.8**	**8**	**5.6**	**4**	**55,519**	**77,727**	**79,750**	**145**	**383**	**536**	**550**
		05/12/1994	1520	11.3	134.5	11.3	7.91	5.65	38,531	53,944		145	266	372	
		04/18/1996	1294	7	184.9	7	4.9	3.5	52,970	74,158		145	365	511	
		07/14/1997	1121	6.5	172.5	6.5	4.55	3.25	49,417	69,184		145	341	477	
		12/11/1998	1319	8.5	155.2	8.5	5.95	4.25	44,461	62,246		145	307	429	
VWC	N4	**11/21/1991**	**1510**	**5.5**	**274.5**	**5.5**	**3.85**	**2.75**	**78,638**	**110,094**	**54,375**	**145**	**542**	**759**	**375**
		01/28/1992	1474	6.5	226.8	6.5	4.55	3.25	64,973	90,963		145	448	627	
		05/12/1994	1303	6.3	206.8	6.3	4.41	3.15	59,244	82,941		145	409	572	
		04/17/1996	1384	5.3	261.1	5.3	3.71	2.65	74,799	104,719		145	516	722	
		07/14/1997	1171	5	234.2	5	3.5	2.5	67,093	93,930		145	463	648	
		12/11/1998	1249	4.6	271.5	4.6	3.22	2.3	77,779	108,890		145	536	751	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft²/day) (E=70%)	T (ft²/day) (E=50%)	Modeled T (ft²/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	Q2	02/17/1955	2343	24.2	96.8	24.2	16.94	12.1	27,731	38,824		145	191	268	
		03/09/1955	2310	23.5	98.3	23.5	16.45	11.75	28,161	39,425		145	194	272	
		10/21/1955	2103	21.5	97.8	21.5	15.05	10.75	28,018	39,225		145	193	271	
		08/01/1957	1589	28.9	55	28.9	20.23	14.45	15,756	22,059		145	109	152	
		11/18/1958	1696	26.3	64.5	26.3	18.41	13.15	18,478	25,869		145	127	178	
		07/26/1960	1073	17.9	59.9	17.9	12.53	8.95	17,160	24,024		145	118	166	
		06/27/1962	1349	34.6	39	34.6	24.22	17.3	11,173	15,642		145	77	108	
		06/19/1963	1920	25.5	75.3	25.5	17.85	12.75	21,572	30,201		145	149	208	
		09/21/1964	1611	24.3	66.3	24.3	17.01	12.15	18,994	26,591		145	131	183	
		09/17/1965	1414	17.7	79.9	17.7	12.39	8.85	22,890	32,045		145	158	221	
		07/26/1967	1806	16	112.9	16	11.2	8	32,343	45,281		145	223	312	
		10/05/1970	1711	15.6	109.7	15.6	10.92	7.8	31,427	43,997		145	217	303	
		08/16/1971	1880	17.2	109.3	17.2	12.04	8.6	31,312	43,837		145	216	302	
		07/03/1974	2022	25.9	78.1	25.9	18.13	12.95	22,374	31,324		145	154	216	
		10/21/1975	1552	37.9	40.9	37.9	26.53	18.95	11,717	16,404		145	81	113	
		08/03/1976	1688	19.7	85.7	19.7	13.79	9.85	24,551	34,372		145	169	237	
		06/14/1977	1688	19.7	85.7	19.7	13.79	9.85	24,551	34,372		145	169	237	
		05/24/1978	1626	20.5	79.3	20.5	14.35	10.25	22,718	31,805		145	157	219	
		12/03/1979	1542	29.4	52.4	29.4	20.58	14.7	15,011	21,016		145	104	145	
		11/13/1980	1752	33.2	52.8	33.2	23.24	16.6	15,126	21,176		145	104	146	
		06/09/1982	1898	43.5	43.6	43.5	30.45	21.75	12,490	17,487		145	86	121	
		02/25/1985	1960	54.8	35.8	54.8	38.36	27.4	10,256	14,358		145	71	99	
		08/07/1986	1804	72.4	24.9	72.4	50.68	36.2	7,133	9,987		145	49	69	
		04/28/1988	**2297**	**18.4**	**124.8**	**18.4**	**12.88**	**9.2**	**35,752**	**50,053**	**79,750**	**145**	**247**	**345**	**550**
		02/01/1990	1965	19.5	100.8	19.5	13.65	9.75	28,877	40,428		145	199	279	
		05/29/1990	1890	18	105	18	12.6	9	30,080	42,112		145	207	290	
		03/19/1992	1874	19	98.6	19	13.3	9.5	28,247	39,545		145	195	273	
		05/24/1994	1637	15.3	107	15.3	10.71	7.65	30,653	42,914		145	211	296	
		04/05/1996	1466	15.9	92.2	15.9	11.13	7.95	26,413	36,979		145	182	255	
		07/23/1997	1206	14	86.1	14	9.8	7	24,666	34,532		145	170	238	
		12/17/1998	1225	19.1	64.1	19.1	13.37	9.55	18,363	25,709		145	127	177	
NLF	R2	07/23/1941	1730	29.5	58.6	29.5	20.65	14.75	16,788	23,503		90	187	261	
		06/21/1945	1520	8	190	8	5.6	4	54,431	76,203		90	605	847	
		12/18/1946	1352	6	225.3	6	4.2	3	64,544	90,361		90	717	1,004	
		10/29/1947	**1680**	**6.4**	**262.5**	**6.4**	**4.48**	**3.2**	**75,201**	**105,281**	**22,050**	**90**	**836**	**1,170**	**245**
		06/20/1949	**1672**	**9**	**185.8**	**9**	**6.3**	**4.5**	**53,228**	**74,519**	**22,050**	**90**	**591**	**828**	**245**
		05/23/1950	1152	45.5	25.3	45.5	31.85	22.75	7,248	10,147		90	81	113	
		10/16/1950	672	8.1	83	8.1	5.67	4.05	23,778	33,289		90	264	370	
		01/19/1951	1310	6	218.3	6	4.2	3	62,538	87,553		90	695	973	
		09/28/1951	328	4	82	4	2.8	2	23,491	32,888		90	261	365	
		06/06/1952	1200	11	109.1	11	7.7	5.5	31,255	43,757		90	347	486	
		01/15/1955	1010	19.5	51.8	19.5	13.65	9.75	14,840	20,775		90	165	231	
		03/03/1955	1119	19.1	58.6	19.1	13.37	9.55	16,788	23,503		90	187	261	
		10/18/1955	620	38.7	16	38.7	27.09	19.35	4,584	6,417		90	51	71	
		09/19/1956	588	22.4	26.3	22.4	15.68	11.2	7,534	10,548		90	84	117	
		08/01/1957	429	8.3	51.7	8.3	5.81	4.15	14,811	20,735		90	165	230	
		09/24/1957	600	28	21.4	28	19.6	14	6,131	8,583		90	68	95	
		08/18/1959	660	34.7	19	34.7	24.29	17.35	5,443	7,620		90	60	85	
		08/18/1960	538	32.4	16.6	32.4	22.68	16.2	4,756	6,658		90	53	74	
		09/11/1961	362	7.6	47.6	7.6	5.32	3.8	13,636	19,091		90	152	212	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		06/13/1962	660	11.6	56.9	11.6	8.12	5.8	16,301	22,821		90	181	254	
		05/06/1963	880	14.6	60.3	14.6	10.22	7.3	17,275	24,184		90	192	269	
		09/21/1964	725	16.4	44.2	16.4	11.48	8.2	12,662	17,727		90	141	197	
		08/05/1965	491	12.1	40.6	12.1	8.47	6.05	11,631	16,283		90	129	181	
		10/12/1967	523	10.2	51.3	10.2	7.14	5.1	14,696	20,575		90	163	229	
		08/07/1968	588	8.5	69.2	8.5	5.95	4.25	19,824	27,754		90	220	308	
		08/16/1971	545	2.1	259.5	2.1	1.47	1.05	74,341	104,078		90	826	1,156	
		06/21/1972	548	1.9	288.4	1.9	1.33	0.95	82,620	115,668		90	918	1,285	
		10/20/1975	460	1.8	255.6	1.8	1.26	0.9	73,224	102,513		90	814	1,139	
		04/07/1977	714	3.4	210	3.4	2.38	1.7	60,160	84,225		90	668	936	
		09/30/1980	708	2.7	262.2	2.7	1.89	1.35	75,115	105,160		90	835	1,168	
NLF	S	08/25/1937	1220	15	81.3	15	10.5	7.5	23,291	32,607		145	161	225	
		08/01/1938	1113	10.9	102.1	10.9	7.63	5.45	29,249	40,949		145	202	282	
		08/03/1938	1195	12	99.6	12	8.4	6	28,533	39,947		145	197	275	
		07/17/1940	1052	11.3	93.1	11.3	7.91	5.65	26,671	37,340		145	184	258	
		09/25/1940	1173	13	90.2	13	9.1	6.5	25,840	36,176		145	178	249	
		07/23/1941	1278	12	106.5	12	8.4	6	30,510	42,714		145	210	295	
		06/28/1945	1183	14.5	81.6	14.5	10.15	7.25	23,377	32,727		145	161	226	
		07/01/1946	1135	23.5	48.3	23.5	16.45	11.75	13,837	19,372		145	95	134	
		12/18/1946	**1028**	**5**	**205.6**	**5**	**3.5**	**2.5**	**58,900**	**82,460**	**54,375**	**145**	**406**	**569**	**375**
		10/17/1947	1400	22.5	62.2	22.5	15.75	11.25	17,819	24,947		145	123	172	
		09/15/1948	1350	26	51.9	26	18.2	13	14,868	20,816		145	103	144	
		06/17/1949	1415	24	59	24	16.8	12	16,902	23,663		145	117	163	
		05/24/1950	1385	25	55.4	25	17.5	12.5	15,871	22,219		145	109	153	
		10/03/1950	1120	29.5	38	29.5	20.65	14.75	10,886	15,241		145	75	105	
		07/17/1952	1146	24.5	46.8	24.5	17.15	12.25	13,407	18,770		145	92	129	
		07/07/1953	913	13.5	67.6	13.5	9.45	6.75	19,366	27,112		145	134	187	
		05/14/1954	1320	24	55	24	16.8	12	15,756	22,059		145	109	152	
		02/23/1955	1101	20.8	52.9	20.8	14.56	10.4	15,155	21,217		145	105	146	
		03/07/1955	1293	21	61.6	21	14.7	10.5	17,647	24,706		145	122	170	
		11/14/1955	457	7.6	60.1	7.6	5.32	3.8	17,217	24,104		145	119	166	
		07/03/1958	1330	12	110.8	12	8.4	6	31,742	44,439		145	219	306	
		10/15/1958	726	7.5	96.8	7.5	5.25	3.75	27,731	38,824		145	191	268	
		07/23/1959	731	8.1	90.2	8.1	5.67	4.05	25,840	36,176		145	178	249	
		07/26/1960	695	7.8	89.1	7.8	5.46	3.9	25,525	35,735		145	176	246	
		08/17/1961	669	6.8	98.4	6.8	4.76	3.4	28,189	39,465		145	194	272	
		05/29/1962	721	6.2	116.3	6.2	4.34	3.1	33,317	46,644		145	230	322	
		04/22/1963	726	6.4	113.4	6.4	4.48	3.2	32,487	45,481		145	224	314	
		08/19/1964	658	6.4	102.8	6.4	4.48	3.2	29,450	41,230		145	203	284	
		08/18/1965	674	6.2	108.7	6.2	4.34	3.1	31,140	43,596		145	215	301	
		10/12/1967	638	5.6	113.9	5.6	3.92	2.8	32,630	45,682		145	225	315	
		08/06/1968	716	6.2	115.5	6.2	4.34	3.1	33,088	46,324		145	228	319	
		09/10/1968	721	6.4	112.7	6.4	4.48	3.2	32,286	45,201		145	223	312	
		08/06/1969	783	6.8	115.1	6.8	4.76	3.4	32,974	46,163		145	227	318	
		08/24/1970	1047	8.8	119	8.8	6.16	4.4	34,091	47,727		145	235	329	
		08/19/1971	1021	8.6	118.7	8.6	6.02	4.3	34,005	47,607		145	235	328	
		06/21/1972	1139	10.8	105.5	10.8	7.56	5.4	30,223	42,313		145	208	292	
		08/14/1973	**1169**	**9**	**129.9**	**9**	**6.3**	**4.5**	**37,214**	**52,099**	**54,375**	**145**	**257**	**359**	**375**
		01/14/1975	1082	9	120.2	9	6.3	4.5	34,435	48,209		145	237	332	
		05/13/1976	1115	44.2	25.2	44.2	30.94	22.1	7,219	10,107		145	50	70	

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Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		04/07/1977	1011	9.4	107.6	9.4	6.58	4.7	30,825	43,155		145	213	298	
		08/15/1978	1035	45.5	22.7	45.5	31.85	22.75	6,503	9,104		145	45	63	
		09/24/1981	937	11.4	82.2	11.4	7.98	5.7	23,549	32,968		145	162	227	
		08/19/1982	1078	9.5	113.5	9.5	6.65	4.75	32,515	45,521		145	224	314	
NLF	S2	09/20/1940	2630	26	101.2	26	18.2	13	28,992	40,588	54,375	145	200	280	375
		07/24/1941	3055	32.2	94.9	32.2	22.54	16.1	27,187	38,061		145	187	262	
		06/12/1945	2775	50.4	55.1	50.4	35.28	25.2	15,785	22,099		145	109	152	
		07/24/1946	2630	28	93.9	28	19.6	14	26,900	37,660		145	186	260	
		12/17/1946	2380	49.8	47.8	49.8	34.86	24.9	13,694	19,171		145	94	132	
		03/31/1947	2940	40	73.5	40	28	20	21,056	29,479		145	145	203	
		10/18/1947	2630	48	54.8	48	33.6	24	15,699	21,979		145	108	152	
		09/15/1948	2130	54	39.4	54	37.8	27	11,287	15,802		145	78	109	
		06/17/1949	2090	46	45.4	46	32.2	23	13,006	18,209		145	90	126	
		05/24/1950	1970	41	48	41	28.7	20.5	13,751	19,251		145	95	133	
		10/03/1950	1420	45.3	31.3	45.3	31.71	22.65	8,967	12,553		145	62	87	
		01/19/1951	2130	50	42.6	50	35	25	12,204	17,086		145	84	118	
		05/15/1954	2040	32.5	62.8	32.5	22.75	16.25	17,991	25,187		145	124	174	
		02/16/1955	1466	28.3	51.8	28.3	19.81	14.15	14,840	20,775		145	102	143	
		03/07/1955	1692	27.3	62	27.3	19.11	13.65	17,762	24,866		145	122	171	
		11/04/1955	1201	31	38.7	31	21.7	15.5	11,087	15,521		145	76	107	
		12/30/1955	1950	20	97.5	20	14	10	27,932	39,104		145	193	270	
		09/27/1956	1448	43.5	33.3	43.5	30.45	21.75	9,540	13,356		145	66	92	
		08/02/1957	1337	35.9	37.2	35.9	25.13	17.95	10,657	14,920		145	73	103	
		10/09/1957	1605	43	37.3	43	30.1	21.5	10,686	14,960		145	74	103	
		07/03/1958	1800	44	40.9	44	30.8	22	11,717	16,404		145	81	113	
		10/10/1958	1485	39.4	37.7	39.4	27.58	19.7	10,800	15,120		145	74	104	
		07/23/1959	1305	39.6	33	39.6	27.72	19.8	9,454	13,235		145	65	91	
		07/19/1960	1120	31	36.1	31	21.7	15.5	10,342	14,479		145	71	100	
		08/17/1961	1178	27	43.6	27	18.9	13.5	12,490	17,487		145	86	121	
		06/14/1962	1225	30.9	39.6	30.9	21.63	15.45	11,345	15,882		145	78	110	
		04/22/1963	1406	30	46.9	30	21	15	13,436	18,810		145	93	130	
		07/28/1964	1016	29	35	29	20.3	14.5	10,027	14,037		145	69	97	
		08/18/1965	1142	24.8	46	24.8	17.36	12.4	13,178	18,449		145	91	127	
		01/09/1967	1748	26	67.2	26	18.2	13	19,251	26,952		145	133	186	
		10/12/1967	1634	26	62.8	26	18.2	13	17,991	25,187		145	124	174	
		08/05/1968	1455	24.8	58.7	24.8	17.36	12.4	16,816	23,543		145	116	162	
		08/06/1969	1490	30.6	48.7	30.6	21.42	15.3	13,951	19,532		145	96	135	
		08/24/1970	2194	29.8	73.6	29.8	20.86	14.9	21,085	29,519		145	145	204	
		08/19/1971	2308	32.2	71.7	32.2	22.54	16.1	20,540	28,757		145	142	198	
		07/26/1972	2206	30.6	72.1	30.6	21.42	15.3	20,655	28,917		145	142	199	
		08/14/1973	1783	18	99.1	18	12.6	9	28,390	39,746		145	196	274	
		01/15/1975	2251	52.2	43.1	52.2	36.54	26.1	12,347	17,286		145	85	119	
		05/13/1976	1554	47.6	32.6	47.6	33.32	23.8	9,339	13,075		145	64	90	
		04/06/1977	2001	22	91	22	15.4	11	26,070	36,497		145	180	252	
		06/21/1978	2613	48	54.4	48	33.6	24	15,584	21,818		145	107	150	
		09/24/1981	1824	21.8	83.7	21.8	15.26	10.9	23,978	33,570		145	165	232	
		07/27/1982	1790	21.9	81.7	21.9	15.33	10.95	23,405	32,767		145	161	226	
		05/30/1984	1813	22.2	81.7	22.2	15.54	11.1	23,405	32,767		145	161	226	

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Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	S3	04/11/1951	939	57	16.5	57	39.9	28.5	4,727	6,618		145	33	46	
		07/07/1953	766	72.3	10.6	72.3	50.61	36.15	3,037	4,251		145	21	29	
		07/23/1954	844	57	14.8	57	39.9	28.5	4,240	5,936		145	29	41	
		03/03/1955	928	45.5	20.4	45.5	31.85	22.75	5,844	8,182		145	40	56	
		03/07/1955	871	45	19.4	45	31.5	22.5	5,558	7,781		145	38	54	
		11/04/1955	736	53.5	13.8	53.5	37.45	26.75	3,953	5,535		145	27	38	
		08/03/1956	700	60.5	11.6	60.5	42.35	30.25	3,323	4,652		145	23	32	
		07/24/1957	674	57.5	11.7	57.5	40.25	28.75	3,352	4,693		145	23	32	
		10/02/1957	594	82	7.2	82	57.4	41	2,063	2,888		145	14	20	
		08/16/1961	576	58.1	9.9	58.1	40.67	29.05	2,836	3,971		145	20	27	
		06/14/1962	695	50.8	13.7	50.8	35.56	25.4	3,925	5,495		145	27	38	
		06/06/1963	786	31.2	25.2	31.2	21.84	15.6	7,219	10,107		145	50	70	
		08/19/1964	716	36.5	19.6	36.5	25.55	18.25	5,615	7,861		145	39	54	
		08/18/1965	720	35.2	20.5	35.2	24.64	17.6	5,873	8,222		145	41	57	
		09/11/1968	**945**	**7.3**	**129.5**	**7.3**	**5.11**	**3.65**	**37,099**	**51,939**	**79,750**	**145**	**256**	**358**	**550**
		08/06/1969	1033	8.4	123	8.4	5.88	4.2	35,237	49,332		145	243	340	
		08/24/1970	1047	8.8	119	8.8	6.16	4.4	34,091	47,727		145	235	329	
		08/19/1971	1040	8.4	123.8	8.4	5.88	4.2	35,466	49,652		145	245	342	
		06/12/1972	1042	8.8	118.4	8.8	6.16	4.4	33,919	47,487		145	234	327	
		08/14/1973	1045	8.8	118.8	8.8	6.16	4.4	34,034	47,647		145	235	329	
		01/14/1975	**1016**	**7.9**	**128.6**	**7.9**	**5.53**	**3.95**	**36,841**	**51,578**	**79,750**	**145**	**254**	**356**	**550**
		04/14/1977	1007	8.6	117.1	8.6	6.02	4.3	33,547	46,965		145	231	324	
		06/21/1978	587	6.1	96.2	6.1	4.27	3.05	27,559	38,583		145	190	266	
		09/24/1981	632	6.8	92.9	6.8	4.76	3.4	26,614	37,259		145	184	257	
		07/26/1982	649	6	108.2	6	4.2	3	30,997	43,396		145	214	299	
		05/29/1984	649	6.9	94.1	6.9	4.83	3.45	26,958	37,741		145	186	260	
		05/22/1986	639	8	79.9	8	5.6	4	22,890	32,045		145	158	221	
		06/14/1990	433	5	86.6	5	3.5	2.5	24,809	34,733		145	171	240	
		06/04/1991	520	6.1	85.2	6.1	4.27	3.05	24,408	34,171		145	168	236	

Notes:
Kh = horizontal hydraulic conductivity
T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-3
Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Lower Soledad Canyon, Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	Stadium	07/20/1965	812	8.3	97.8	8.3	5.81	4.15	28,018	39,225		90	311	436	
		06/06/1972	531	1.6	331.9	1.6	1.12	0.8	95,082	133,115		90	1,056	1,479	
		03/19/1974	**1046**	**2.8**	**373.6**	**2.8**	**1.96**	**1.4**	**107,028**	**149,840**	**63,250**	**90**	**1,189**	**1,665**	**550**
		04/10/1975	**965**	**2.8**	**344.6**	**2.8**	**1.96**	**1.4**	**98,720**	**138,209**	**63,250**	**90**	**1,097**	**1,536**	**550**
		04/12/1976	901	3.4	265	3.4	2.38	1.7	75,917	106,283		90	844	1,181	
		07/11/1977	836	4	209	4	2.8	2	59,874	83,824		90	665	931	
		05/10/1978	942	3.9	241.5	3.9	2.73	1.95	69,184	96,858		90	769	1,076	
		04/01/1979	930	3.1	300	3.1	2.17	1.55	85,943	120,321		90	955	1,337	
		09/01/1979	**937**	**3.1**	**302.3**	**3.1**	**2.17**	**1.55**	**86,602**	**121,243**	**63,250**	**90**	**962**	**1,347**	**550**
		09/22/1998	945	3.6	262.5	3.6	2.52	1.8	75,201	105,281		90	836	1,170	
VWC	U4	07/27/1967	1383	13.1	105.6	13.1	9.17	6.55	30,252	42,353		115	263	368	
		08/07/1968	1686	12.4	136	12.4	8.68	6.2	38,961	54,545		115	339	474	
		08/18/1969	**2621**	**10.2**	**257**	**10.2**	**7.14**	**5.1**	**73,625**	**103,075**	**63,250**	**115**	**640**	**896**	**550**
		08/13/1973	**2679**	**8**	**334.9**	**8**	**5.6**	**4**	**95,942**	**134,318**	**63,250**	**115**	**834**	**1,168**	**550**
		10/31/1979	1021	3.8	268.7	3.8	2.66	1.9	76,977	107,767		115	669	937	
		11/10/1980	1123	4.1	273.9	4.1	2.87	2.05	78,466	109,853		115	682	955	
		06/08/1982	1144	4.4	260	4.4	3.08	2.2	74,484	104,278		115	648	907	
		01/29/1985	962	3.8	253.2	3.8	2.66	1.9	72,536	101,551		115	631	883	
		08/18/1986	941	3.9	241.3	3.9	2.73	1.95	69,127	96,778		115	601	842	
		04/21/1988	1080	4.2	257.1	4.2	2.94	2.1	73,654	103,115		115	640	897	
		02/01/1990	1073	3.5	306.6	3.5	2.45	1.75	87,834	122,968		115	764	1,069	
		05/29/1990	1073	3.5	306.6	3.5	2.45	1.75	87,834	122,968		115	764	1,069	
		01/23/1992	978	4.5	217.3	4.5	3.15	2.25	62,252	87,152		115	541	758	
		06/14/1994	1057	4.2	251.7	4.2	2.94	2.1	72,107	100,949		115	627	878	
		04/04/1996	958	3.5	273.7	3.5	2.45	1.75	78,409	109,773		115	682	955	
		07/17/1997	919	3.3	278.5	3.3	2.31	1.65	79,784	111,698		115	694	971	
		12/29/1998	**1198**	**5.3**	**226**	**5.3**	**3.71**	**2.65**	**64,744**	**90,642**		**115**	**563**	**788**	
VWC	U3	07/27/1967	1389	9	154.3	9	6.3	4.5	44,204	61,885		115	384	538	
		08/07/1968	784	9	87.1	9	6.3	4.5	24,952	34,933		115	217	304	
		08/15/1973	**1997**	**4.7**	**424.9**	**4.7**	**3.29**	**2.35**	**121,725**	**170,414**	**63,250**	**115**	**1,058**	**1,482**	**550**
		10/21/1975	1087	3	362.3	3	2.1	1.5	103,791	145,307		115	903	1,264	
		08/02/1976	997	2.9	343.8	2.9	2.03	1.45	98,491	137,888		115	856	1,199	
		06/13/1977	907	4.1	221.2	4.1	2.87	2.05	63,369	88,717		115	551	771	
		05/31/1978	1074	4.3	249.8	4.3	3.01	2.15	71,562	100,187		115	622	871	
		10/31/1979	939	3.5	268.3	3.5	2.45	1.75	76,862	107,607		115	668	936	
		11/10/1980	898	3.4	264.1	3.4	2.38	1.7	75,659	105,922		115	658	921	
		06/08/1982	1181	4	295.3	4	2.8	2	84,597	118,436		115	736	1,030	
		01/28/1985	**1276**	**4**	**319**	**4**	**2.8**	**2**	**91,387**	**127,941**	**63,250**	**115**	**795**	**1,113**	**550**
		08/18/1986	961	3.2	300.3	3.2	2.24	1.6	86,029	120,441		115	748	1,047	
		04/21/1988	**1249**	**3.6**	**346.9**	**3.6**	**2.52**	**1.8**	**99,379**	**139,131**	**63,250**	**115**	**864**	**1,210**	**550**
		02/01/1990	**1253**	**3**	**417.7**	**3**	**2.1**	**1.5**	**119,662**	**167,527**	**63,250**	**115**	**1,041**	**1,457**	**550**
		05/29/1990	1162	3	387.3	3	2.1	1.5	110,953	155,334		115	965	1,351	
		01/24/1992	1078	5.2	207.3	5.2	3.64	2.6	59,387	83,142		115	516	723	
		07/18/1994	1217	3.9	312.1	3.9	2.73	1.95	89,410	125,174		115	777	1,088	
		04/04/1996	979	2.9	337.6	2.9	2.03	1.45	96,715	135,401		115	841	1,177	
		07/17/1997	861	2.6	331.2	2.6	1.82	1.3	94,882	132,834		115	825	1,155	
		01/18/1999	**1224**	**3.6**	**340**	**3.6**	**2.52**	**1.8**	**97,403**	**136,364**	**63,250**	**115**	**847**	**1,186**	**550**
SCWC	Honby	07/23/1965	613	26.4	23.2	26.4	18.48	13.2	6,646	9,305		90	74	103	
		06/02/1972	712	4	178	4	2.8	2	50,993	71,390		90	567	793	
		06/05/1972	781	14.4	54.2	14.4	10.08	7.2	15,527	21,738		90	173	242	
		04/02/1974	684	14.6	46.8	14.6	10.22	7.3	13,407	18,770		90	149	209	
		04/16/1975	654	14.2	46.1	14.2	9.94	7.1	13,207	18,489		90	147	205	

TABLE B-3

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Lower Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		04/13/1976	623	3.5	178	3.5	2.45	1.75	50,993	71,390		90	567	793	
		05/03/1976	674	13.8	48.8	13.8	9.66	6.9	13,980	19,572		90	155	217	
		07/28/1977	801	16.5	48.5	16.5	11.55	8.25	13,894	19,452		90	154	216	
		08/25/1977	702	7.2	97.5	7.2	5.04	3.6	27,932	39,104		90	310	434	
		05/11/1978	**970**	**8.2**	**118.3**	**8.2**	**5.74**	**4.1**	**33,890**	**47,447**	**49,500**	**90**	**377**	**527**	**550**
		05/25/1978	835	18.4	45.4	18.4	12.88	9.2	13,006	18,209		90	145	202	
		04/01/1979	1065	13.7	77.7	13.7	9.59	6.85	22,259	31,163		90	247	346	
		09/01/1979	**1080**	**8.9**	**121.3**	**8.9**	**6.23**	**4.45**	**34,750**	**48,650**	**49,500**	**90**	**386**	**541**	**550**
		08/19/1980	**1178**	**12**	**98.2**	**12**	**8.4**	**6**	**28,132**	**39,385**	**49,500**	**90**	**313**	**438**	**550**
		08/22/1980	914	29.6	30.9	29.6	20.72	14.8	8,852	12,393		90	98	138	
		11/18/1981	919	48	19.1	48	33.6	24	5,472	7,660		90	61	85	
		12/01/1981	1277	13.4	95.3	13.4	9.38	6.7	27,301	38,222		90	303	425	
		03/14/1983	868	35	24.8	35	24.5	17.5	7,105	9,947		90	79	111	
		08/24/1983	1287	16.7	77.1	16.7	11.69	8.35	22,087	30,922		90	245	344	
		07/24/1984	832	48.1	17.3	48.1	33.67	24.05	4,956	6,939		90	55	77	
		08/02/1984	1232	14.5	85	14.5	10.15	7.25	24,351	34,091		90	271	379	
		10/22/1985	756	46.2	16.4	46.2	32.34	23.1	4,698	6,578		90	52	73	
		10/24/1985	1217	15.1	80.6	15.1	10.57	7.55	23,090	32,326		90	257	359	
		09/22/1998	904	10.2	88.6	10.2	7.14	5.1	25,382	35,535		90	282	395	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-4

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Upper Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	N. Oaks West	06/05/1972	1245	17.8	69.9	17.8	12.46	8.9	20,025	28,035		90	222	311	
		08/05/1972	1527	18.6	82.1	18.6	13.02	9.3	23,520	32,928		90	261	366	
		03/20/1974	1578	17.8	88.7	17.8	12.46	8.9	25,411	35,575		90	282	395	
		04/07/1975	1407	12.6	111.7	12.6	8.82	6.3	32,000	44,799		90	356	498	
		04/15/1976	1232	10.6	116.2	10.6	7.42	5.3	33,289	46,604		90	370	518	
		08/24/1977	578	7.2	80.3	7.2	5.04	3.6	23,004	32,206		90	256	358	
		06/07/1978	1392	12	116	12	8.4	6	33,231	46,524		90	369	517	
		04/01/1979	1298	10.8	120.2	10.8	7.56	5.4	34,435	48,209		90	383	536	
		09/01/1979	1185	9.7	122.2	9.7	6.79	4.85	35,008	49,011		90	389	545	
		08/02/1980	1317	11.4	115.5	11.4	7.98	5.7	33,088	46,324		90	368	515	
		12/01/1981	1598	13.4	119.3	13.4	9.38	6.7	34,177	47,848		90	380	532	
		03/07/1983	**1598**	**12.5**	**127.8**	**12.5**	**8.75**	**6.25**	**36,612**	**51,257**	**49,500**	**90**	**407**	**570**	**550**
		07/31/1984	**1558**	**12**	**129.8**	**12**	**8.4**	**6**	**37,185**	**52,059**	**49,500**	**90**	**413**	**578**	**550**
		10/23/1985	**1538**	**11.4**	**134.9**	**11.4**	**7.98**	**5.7**	**38,646**	**54,104**	**49,500**	**90**	**429**	**601**	**550**
		09/17/1998	1405	11.7	120.1	11.7	8.19	5.85	34,406	48,168		90	382	535	
SCWC	N. Oaks Central	03/26/1974	989	3.8	260.3	3.8	2.66	1.9	74,570	104,398		90	829	1,160	
		04/07/1975	823	3	274.3	3	2.1	1.5	78,581	110,013		90	873	1,222	
		04/13/1976	861	3.3	260.9	3.3	2.31	1.65	74,742	104,639		90	830	1,163	
		07/14/1977	759	4.5	168.7	4.5	3.15	2.25	48,329	67,660		90	537	752	
		05/18/1978	1023	3.6	284.2	3.6	2.52	1.8	81,417	113,984		90	905	1,266	
		04/01/1979	953	3.7	257.6	3.7	2.59	1.85	73,797	103,316		90	820	1,148	
		09/01/1979	930	1.3	715.4	1.3	0.91	0.65	204,947	286,925		90	2,277	3,188	
		08/27/1980	1021	3.5	291.7	3.5	2.45	1.75	83,566	116,992		90	929	1,300	
		11/19/1981	1078	3.8	283.7	3.8	2.66	1.9	81,274	113,783		90	903	1,264	
		03/07/1983	1139	3.4	335	3.4	2.38	1.7	95,970	134,358		90	1,066	1,493	
		07/26/1984	1164	3.5	332.6	3.5	2.45	1.75	95,283	133,396		90	1,059	1,482	
		10/23/1985	1087	3	362.3	3	2.1	1.5	103,791	145,307		90	1,153	1,615	
		09/17/1998	**1450**	**4.8**	**302.1**	**4.8**	**3.36**	**2.4**	**86,545**	**121,163**	**49,500**	**90**	**962**	**1,346**	**550**
SCWC	N. Oaks East	11/27/1963	1099	8.9	123.5	8.9	6.23	4.45	35,380	49,532		90	393	550	
		08/24/1965	707	42.1	16.8	42.1	29.47	21.05	4,813	6,738		90	53	75	
		06/02/1972	1169	8.5	137.5	8.5	5.95	4.25	39,391	55,147		90	438	613	
		03/20/1974	1016	6.5	156.3	6.5	4.55	3.25	44,777	62,687		90	498	697	
		04/15/1975	842	4.8	175.4	4.8	3.36	2.4	50,248	70,348		90	558	782	
		04/13/1976	873	5.3	164.7	5.3	3.71	2.65	47,183	66,056		90	524	734	
		07/14/1977	699	6.3	111	6.3	4.41	3.15	31,799	44,519		90	353	495	
		06/07/1978	750	4.4	170.5	4.4	3.08	2.2	48,845	68,382		90	543	760	
		04/01/1979	578	3.1	186.5	3.1	2.17	1.55	53,428	74,799		90	594	831	
		09/01/1979	510	2.2	231.8	2.2	1.54	1.1	66,406	92,968		90	738	1,033	
		08/25/1980	531	3.2	165.9	3.2	2.24	1.6	47,527	66,537		90	528	739	
		11/19/1981	1312	10.6	123.8	10.6	7.42	5.3	35,466	49,652		90	394	552	
		03/23/1983	**1312**	**7.6**	**172.6**	**7.6**	**5.32**	**3.8**	**49,446**	**69,225**	**49,500**	**90**	**549**	**769**	**550**
		07/30/1984	1261	8	157.6	8	5.6	4	45,149	63,209		90	502	702	
		11/18/1985	1143	7.3	156.6	7.3	5.11	3.65	44,862	62,807		90	498	698	
		09/17/1998	1091	18.4	59.3	18.4	12.88	9.2	16,988	23,783		90	189	264	

TABLE B-4

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Upper Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	Sierra	**03/20/1974**	**1679**	**5.7**	**294.6**	**5.7**	**3.99**	**2.85**	**84,396**	**118,155**	**49,500**	**90**	**938**	**1,313**	**550**
		04/08/1975	1425	5.3	268.9	5.3	3.71	2.65	77,034	107,848		90	856	1,198	
		04/14/1976	1418	5.8	244.5	5.8	4.06	2.9	70,044	98,061		90	778	1,090	
		07/12/1977	1291	8.9	145.1	8.9	6.23	4.45	41,568	58,195		90	462	647	
		05/16/1978	**1574**	**5.4**	**291.5**	**5.4**	**3.78**	**2.7**	**83,508**	**116,912**	**49,500**	**90**	**928**	**1,299**	**550**
		04/01/1979	1538	4.9	313.9	4.9	3.43	2.45	89,926	125,896		90	999	1,399	
		09/01/1979	1507	5.5	274	5.5	3.85	2.75	78,495	109,893		90	872	1,221	
		08/25/1980	1558	4.6	338.7	4.6	3.22	2.3	97,030	135,842		90	1,078	1,509	
		11/30/1981	1448	4.2	344.8	4.2	2.94	2.1	98,778	138,289		90	1,098	1,537	
		03/15/1983	**1950**	**5.5**	**354.5**	**5.5**	**3.85**	**2.75**	**101,557**	**142,179**	**49,500**	**90**	**1,128**	**1,580**	**550**
		07/26/1984	1860	16.8	110.7	16.8	11.76	8.4	31,713	44,398		90	352	493	
		10/29/1985	**1840**	**6.4**	**287.5**	**6.4**	**4.48**	**3.2**	**82,362**	**115,307**	**49,500**	**90**	**915**	**1,281**	**550**
		09/16/1998	851	3.3	257.9	3.3	2.31	1.65	73,883	103,436		90	821	1,149	
SCWC	Mitchell	07/19/1965	536	11.4	47	11.4	7.98	5.7	13,464	18,850		90	150	209	
		08/07/1972	1250	6.5	192.3	6.5	4.55	3.25	55,090	77,126		90	612	857	
		03/26/1974	627	2.8	223.9	2.8	1.96	1.4	64,142	89,799		90	713	998	
		04/08/1975	529	2.6	203.5	2.6	1.82	1.3	58,298	81,618		90	648	907	
		08/25/1977	**709**	**5**	**141.8**	**5**	**3.5**	**2.5**	**40,623**	**56,872**	**49,500**	**90**	**451**	**632**	**550**
		07/25/1978	613	7.7	79.6	7.7	5.39	3.85	22,804	31,925		90	253	355	
		04/01/1979	653	8.7	75.1	8.7	6.09	4.35	21,515	30,120		90	239	335	
		09/01/1979	660	9	73.3	9	6.3	4.5	20,999	29,398		90	233	327	
		08/25/1980	602	9.8	61.4	9.8	6.86	4.9	17,590	24,626		90	195	274	
		11/23/1981	664	11	60.4	11	7.7	5.5	17,303	24,225		90	192	269	
		05/23/1983	674	12.3	54.8	12.3	8.61	6.15	15,699	21,979		90	174	244	
		08/02/1984	689	25.8	26.7	25.8	18.06	12.9	7,649	10,709		90	85	119	
		10/24/1985	694	39	17.8	39	27.3	19.5	5,099	7,139		90	57	79	
		09/22/1998	593	14.3	41.5	14.3	10.01	7.15	11,889	16,644		90	132	185	
SCWC	Lost Canyon 2	04/01/1979	743	17.3	42.9	17.3	12.11	8.65	12,290	17,206	36,000	90	137	191	400
		09/01/1979	885	28	31.6	28	19.6	14	9,053	12,674		90	101	141	
		09/16/1998	799	22.1	36.2	22.1	15.47	11.05	10,371	14,519		90	115	161	
SCWC	Lost Canyon 2A	10/29/1997	834	12.4	67.3	12.4	8.68	6.2	19,280	26,992	36,000	90	214	300	400
SCWC	Sand Canyon	07/02/1975	648	2.7	240	2.7	1.89	1.35	68,755	96,257		90	764	1,070	
		04/01/1979	540	2.5	216	2.5	1.75	1.25	61,879	86,631		90	688	963	
		09/01/1979	**825**	**2.6**	**317.3**	**2.6**	**1.82**	**1.3**	**90,900**	**127,259**	**36,000**	**90**	**1,010**	**1,414**	**400**
		08/22/1980	709	3.2	221.6	3.2	2.24	1.6	63,484	88,877		90	705	988	
		11/18/1981	684	3.4	201.2	3.4	2.38	1.7	57,639	80,695		90	640	897	
		05/23/1983	714	3.2	223.1	3.2	2.24	1.6	63,913	89,479		90	710	994	
		07/24/1984	**774**	**4.2**	**184.3**	**4.2**	**2.94**	**2.1**	**52,798**	**73,917**	**36,000**	**90**	**587**	**821**	**400**
		10/22/1985	658	3.3	199.4	3.3	2.31	1.65	57,124	79,973		90	635	889	
		09/16/1998	**1147**	**9.3**	**123.3**	**9.3**	**6.51**	**4.65**	**35,323**	**49,452**	**36,000**	**90**	**392**	**549**	**400**
NCWD	Pinetree1	04/02/1999	297	13.7	21.7	13.7	9.59	6.85	6,217	8,703	31,500	90	69	97	350
NCWD	Pinetree3	**04/02/1999**	**554**	**4.7**	**117.9**	**4.7**	**3.29**	**2.35**	**33,776**	**47,286**	**31,500**	**90**	**375**	**525**	**350**
NCWD	Pinetree4	**04/02/1999**	**497**	**4.8**	**103.5**	**4.8**	**3.36**	**2.4**	**29,650**	**41,511**	**31,500**	**90**	**329**	**461**	**350**

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	D	05/29/1984	503	6	83.8	6	4.2	3	24,007	33,610		100	240	336	
		04/27/1988	**1171**	**10.1**	**115.9**	**10.1**	**7.07**	**5.05**	**33,203**	**46,484**	**35,000**	**100**	**332**	**465**	**350**
		05/29/1990	990	9.5	104.2	9.5	6.65	4.75	29,851	41,791		100	299	418	
		07/06/1994	**1119**	**9.6**	**116.6**	**9.6**	**6.72**	**4.8**	**33,403**	**46,765**	**35,000**	**100**	**334**	**468**	**350**
		04/29/1996	1105	9.8	112.8	9.8	6.86	4.9	32,315	45,241		100	323	452	
		09/15/1997	1135	9.7	117	9.7	6.79	4.85	33,518	46,925		100	335	469	
		11/03/1998	**1086**	**9.6**	**113.1**	**9.6**	**6.72**	**4.8**	**32,401**	**45,361**	**35,000**	**100**	**324**	**454**	**350**
		11/13/1998	1086	9.6	113.1	9.6	6.72	4.8	32,401	45,361		100	324	454	
NLF	E	**04/10/1984**	**1726**	**7.8**	**221.3**	**7.8**	**5.46**	**3.9**	**63,398**	**88,757**	**35,000**	**100**	**634**	**888**	**350**
		05/21/1986	1613	7.1	227.2	7.1	4.97	3.55	65,088	91,123		100	651	911	
		10/14/1987	1151	15.6	73.8	15.6	10.92	7.8	21,142	29,599		100	211	296	
		10/05/1988	766	11	69.6	11	7.7	5.5	19,939	27,914		100	199	279	
		07/11/1989	877	8.2	107	8.2	5.74	4.1	30,653	42,914		100	307	429	
		05/30/1990	1291	13.9	92.9	13.9	9.73	6.95	26,614	37,259		100	266	373	
		04/17/1991	1187	15.8	75.1	15.8	11.06	7.9	21,515	30,120		100	215	301	
		06/03/1992	**1732**	**7.9**	**219.2**	**7.9**	**5.53**	**3.95**	**62,796**	**87,914**	**35,000**	**100**	**628**	**879**	**350**
		07/20/1993	1613	7.4	218	7.4	5.18	3.7	62,452	87,433		100	625	874	
		07/20/1994	1603	7.6	210.9	7.6	5.32	3.8	60,418	84,586		100	604	846	
		07/12/1995	1644	7.4	222.2	7.4	5.18	3.7	63,655	89,118		100	637	891	
		05/14/1996	1613	7.9	204.2	7.9	5.53	3.95	58,499	81,898		100	585	819	
		04/23/1997	1583	9.9	159.9	9.9	6.93	4.95	45,808	64,131		100	458	641	
		05/06/1998	1501	6.8	220.7	6.8	4.76	3.4	63,226	88,516		100	632	885	
		05/04/1999	1501	6.9	217.5	6.9	4.83	3.45	62,309	87,233		100	623	872	
		05/21/1999	1501	6.9	217.5	6.9	4.83	3.45	62,309	87,233		100	623	872	
		04/21/2000	1378	11.4	120.9	11.4	7.98	5.7	34,635	48,489		100	346	485	
NLF	E2	07/29/1938	1921	20.7	92.8	20.7	14.49	10.35	26,585	37,219		100	266	372	
		08/05/1938	1625	18.5	87.8	18.5	12.95	9.25	25,153	35,214		100	252	352	
		08/11/1938	1630	18.2	89.6	18.2	12.74	9.1	25,668	35,936		100	257	359	
		07/25/1939	1530	15.7	97.5	15.7	10.99	7.85	27,932	39,104		100	279	391	
		08/01/1939	1846	19.1	96.6	19.1	13.37	9.55	27,674	38,743		100	277	387	
		06/13/1941	1905	13.2	144.3	13.2	9.24	6.6	41,339	57,874		100	413	579	
		07/16/1945	**1635**	**9.9**	**165.2**	**9.9**	**6.93**	**4.95**	**47,326**	**66,257**	**35,000**	**100**	**473**	**663**	**350**
		12/18/1946	**1819**	**10**	**181.9**	**10**	**7**	**5**	**52,110**	**72,955**	**35,000**	**100**	**521**	**730**	**350**
		10/28/1947	1760	16.2	108.6	16.2	11.34	8.1	31,112	43,556		100	311	436	
		06/23/1949	1225	12.5	98	12.5	8.75	6.25	28,075	39,305		100	281	393	
		06/07/1950	1070	11	97.3	11	7.7	5.5	27,874	39,024		100	279	390	
		04/11/1951	1095	37.7	29	37.7	26.39	18.85	8,308	11,631		100	83	116	
		08/07/1953	1103	22.4	49.2	22.4	15.68	11.2	14,095	19,733		100	141	197	
		02/10/1955	1481	14.9	99.4	14.9	10.43	7.45	28,476	39,866		100	285	399	
		08/12/1955	1103	22.4	49.2	22.4	15.68	11.2	14,095	19,733		100	141	197	
		09/20/1956	998	28.2	35.4	28.2	19.74	14.1	10,141	14,198		100	101	142	
		07/16/1957	938	29.2	32.1	29.2	20.44	14.6	9,196	12,874		100	92	129	
		10/09/1957	828	11	75.3	11	7.7	5.5	21,572	30,201		100	216	302	
		07/25/1958	1582	12.5	126.6	12.5	8.75	6.25	36,268	50,775		100	363	508	
		10/24/1958	1532	16.6	92.3	16.6	11.62	8.3	26,442	37,019		100	264	370	
		09/03/1959	1329	24.8	53.6	24.8	17.36	12.4	15,355	21,497		100	154	215	
		07/29/1960	1084	39.2	27.7	39.2	27.44	19.6	7,935	11,110		100	79	111	
		08/03/1961	888	20.2	44	20.2	14.14	10.1	12,605	17,647		100	126	176	
		07/17/1962	1503	18.5	81.2	18.5	12.95	9.25	23,262	32,567		100	233	326	
		05/07/1963	1487	16.2	91.8	16.2	11.34	8.1	26,299	36,818		100	263	368	

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		07/16/1964	759	47.8	15.9	47.8	33.46	23.9	4,555	6,377		100	46	64	
		08/05/1965	652	34.2	19.1	34.2	23.94	17.1	5,472	7,660		100	55	77	
		11/01/1966	536	60.1	8.9	60.1	42.07	30.05	2,550	3,570		100	25	36	
		08/10/1967	842	9.6	87.7	9.6	6.72	4.8	25,124	35,174		100	251	352	
		09/26/1968	1161	62.5	18.6	62.5	43.75	31.25	5,328	7,460		100	53	75	
		06/23/1972	1345	12.8	105.1	12.8	8.96	6.4	30,109	42,152		100	301	422	
		07/08/1974	1287	17.3	74.4	17.3	12.11	8.65	21,314	29,840		100	213	298	
		05/06/1976	1065	25.5	41.8	25.5	17.85	12.75	11,975	16,765		100	120	168	
		03/14/1977	1056	43.7	24.2	43.7	30.59	21.85	6,933	9,706		100	69	97	
		08/10/1978	725	4.8	151	4.8	3.36	2.4	43,258	60,561		100	433	606	
		12/21/1989	1086	34.6	31.4	34.6	24.22	17.3	8,995	12,594		100	90	126	
		05/30/1990	1205	36.1	33.4	36.1	25.27	18.05	9,568	13,396		100	96	134	
		04/17/1991	1056	48.5	21.8	48.5	33.95	24.25	6,245	8,743		100	62	87	
		06/03/1992	1235	22.9	53.9	22.9	16.03	11.45	15,441	21,618		100	154	216	
		07/20/1993	**1312**	**8.3**	**158.1**	**8.3**	**5.81**	**4.15**	**45,292**	**63,409**	**35,000**	**100**	**453**	**634**	**350**
		07/21/1994	**1305**	**6.3**	**207.1**	**6.3**	**4.41**	**3.15**	**59,330**	**83,061**	**35,000**	**100**	**593**	**831**	**350**
		07/12/1995	**1395**	**6.2**	**225**	**6.2**	**4.34**	**3.1**	**64,458**	**90,241**	**35,000**	**100**	**645**	**902**	**350**
		06/05/1996	**1473**	**5.8**	**254**	**5.8**	**4.06**	**2.9**	**72,765**	**101,872**	**35,000**	**100**	**728**	**1,019**	**350**
		04/23/1997	1087	6.4	169.8	6.4	4.48	3.2	48,644	68,102		100	486	681	
		06/26/1998	1055	8.3	127.1	8.3	5.81	4.15	36,411	50,976		100	364	510	
		05/04/1999	1079	6.6	163.5	6.6	4.62	3.3	46,839	65,575		100	468	656	
		05/21/1999	1079	6.6	163.5	6.6	4.62	3.3	46,839	65,575		100	468	656	
		04/21/2000	1052	6.7	157	6.7	4.69	3.35	44,977	62,968		100	450	630	
WHR	8	04/10/1969	849	5.8	146.4	5.8	4.06	2.9	41,940	58,717	35,000	100	419	587	350
WHR	16	10/06/1955	1205	8.3	145.2	8.3	5.81	4.15	41,597	58,235		100	416	582	
		11/13/1957	1052	7.6	138.4	7.6	5.32	3.8	39,649	55,508		100	396	555	
		05/28/1959	810	6.3	128.6	6.3	4.41	3.15	36,841	51,578		100	368	516	
		06/19/1959	**1436**	**9.9**	**145.1**	**9.9**	**6.93**	**4.95**	**41,568**	**58,195**	**35,000**	**100**	**416**	**582**	**350**
		06/26/1962	**1150**	**7**	**164.3**	**7**	**4.9**	**3.5**	**47,068**	**65,896**	**35,000**	**100**	**471**	**659**	**350**
		12/04/1963	1073	6.9	155.5	6.9	4.83	3.45	44,547	62,366		100	445	624	
WHR	11	11/10/1954	1401	10.9	128.5	10.9	7.63	5.45	36,812	51,537		100	368	515	
		10/06/1955	**1444**	**10.4**	**138.8**	**10.4**	**7.28**	**5.2**	**39,763**	**55,668**	**35,000**	**100**	**398**	**557**	**350**
		03/07/1962	1125	8.5	132.4	8.5	5.95	4.25	37,930	53,102		100	379	531	
		10/31/1962	1288	10.6	121.5	10.6	7.42	5.3	34,807	48,730		100	348	487	
		12/04/1963	1172	8.2	142.9	8.2	5.74	4.1	40,938	57,313		100	409	573	
WHR	18	01/27/1959	1244	9	138.2	9	6.3	4.5	39,591	55,428		100	396	554	
		05/28/1959	**1369**	**9.3**	**147.2**	**9.3**	**6.51**	**4.65**	**42,170**	**59,037**	**35,000**	**100**	**422**	**590**	**350**
		06/26/1962	1262	8	157.8	8	5.6	4	45,206	63,289		100	452	633	
		12/04/1963	940	6	156.7	6	4.2	3	44,891	62,848		100	449	628	
WHR	17	**10/06/1955**	**576**	**3.2**	**180**	**3.2**	**2.24**	**1.6**	**51,566**	**72,193**	**35,000**	**100**	**516**	**722**	**350**
		03/06/1962	539	3.3	163.3	3.3	2.31	1.65	46,782	65,495		100	468	655	
		10/31/1962	536	3.2	167.5	3.2	2.24	1.6	47,985	67,179		100	480	672	
		12/04/1963	**595**	**3.3**	**180.3**	**3.3**	**2.31**	**1.65**	**51,652**	**72,313**	**35,000**	**100**	**517**	**723**	**350**
WHR	10	10/06/1955	442	18.5	23.9	18.5	12.95	9.25	6,847	9,586	35,000	100	68	96	350
		03/06/1962	452	11.1	40.7	11.1	7.77	5.55	11,660	16,324		100	117	163	
		10/31/1962	480	15	32	15	10.5	7.5	9,167	12,834		100	92	128	
		12/03/1963	508	23.6	21.5	23.6	16.52	11.8	6,159	8,623		100	62	86	
		11/13/1964	467	27.1	17.2	27.1	18.97	13.55	4,927	6,898		100	49	69	

TABLE B-5
Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
WHR	15	10/06/1955	815	3.6	226.4	3.6	2.52	1.8	64,859	90,802		100	649	908	
		11/13/1957	1231	6.6	186.5	6.6	4.62	3.3	53,428	74,799		100	534	748	
		06/18/1958	1353	6.8	199	6.8	4.76	3.4	57,009	79,813		100	570	798	
		05/28/1959	**1655**	**9.6**	**172.4**	**9.6**	**6.72**	**4.8**	**49,389**	**69,144**	**35,000**	**100**	**494**	**691**	**350**
		06/18/1959	1353	6.8	199	6.8	4.76	3.4	57,009	79,813		100	570	798	
		06/26/1962	1260	6	210	6	4.2	3	60,160	84,225		100	602	842	
		12/05/1963	1180	7.6	155.3	7.6	5.32	3.8	44,490	62,286		100	445	623	
WHR	5	03/06/1962	684	9.7	70.5	9.7	6.79	4.85	20,197	28,275	35,000	100	202	283	350
		12/03/1963	693	8.8	78.8	8.8	6.16	4.4	22,574	31,604		100	226	316	
NCWD	Castaic1	03/31/1986	580	51.6	11.2	51.6	36.12	25.8	3,209	4,492	25,200	100	32	45	315
		04/23/1999	644	55.2	11.7	55.2	38.64	27.6	3,352	4,693		100	34	47	
NCWD	Castaic4	04/23/1999	271	87.6	3.1	87.6	61.32	43.8	888	1,243	25,200	100	9	12	315
NCWD	Castaic3	04/23/1999	470	41.3	11.4	41.3	28.91	20.65	3,266	4,572	25,200	100	33	46	315
NCWD	Castaic2	04/01/1986	428	37.9	11.3	37.9	26.53	18.95	3,237	4,532	25,200	100	32	45	315

Notes:
Kh = horizontal hydraulic conductivity
T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-6

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer In Tributary Canyons, Santa Clarita Valley, CA

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	W4	02/05/1992	592	9.4	63	9.4	6.58	4.7	18,048	25,267		100	180	253	
		08/12/1994	**957**	**10.8**	**88.6**	**10.8**	**7.56**	**5.4**	**25,382**	**35,535**	**10,500**	**100**	**254**	**355**	**105**
VWC	W6	11/22/1991	720	36	20	36	25.2	18	5,730	8,021		100	57	80	
		01/27/1992	636	40.5	15.7	40.5	28.35	20.25	4,498	6,297		100	45	63	
		05/11/1994	504	75	6.7	75	52.5	37.5	1,919	2,687		100	19	27	
		04/23/1996	531	71.3	7.4	71.3	49.91	35.65	2,120	2,968		100	21	30	
		07/15/1997	539	69.5	7.8	69.5	48.65	34.75	2,235	3,128		100	22	31	
		12/28/1998	468	83.2	5.6	83.2	58.24	41.6	1,604	2,246		100	16	22	
VWC	W9	04/23/1996	946	10.1	93.7	10.1	7.07	5.05	26,843	37,580		100	268	376	
		07/15/1997	958	10.5	91.2	10.5	7.35	5.25	26,127	36,578		100	261	366	
		12/28/1998	**990**	**10.2**	**97.1**	**10.2**	**7.14**	**5.1**	**27,817**	**38,944**	**10,500**	**100**	**278**	**389**	**105**
SCWC	Guida	**03/18/1974**	**1016**	**6.4**	**158.8**	**6.4**	**4.48**	**3.2**	**45,493**	**63,690**	**12,600**	**90**	**505**	**708**	**140**
		04/17/1975	990	6.2	159.7	6.2	4.34	3.1	45,751	64,051		90	508	712	
		04/19/1976	940	5.6	167.9	5.6	3.92	2.8	48,100	67,340		90	534	748	
		07/06/1977	890.7	5.2	171.3	5.2	3.64	2.6	49,074	68,703		90	545	763	
		05/09/1978	915	5.5	166.4	5.5	3.85	2.75	47,670	66,738		90	530	742	
		04/01/1979	990	6.5	152.3	6.5	4.55	3.25	43,631	61,083		90	485	679	
		09/01/1979	990	3.6	275	3.6	2.52	1.8	78,782	110,294		90	875	1,225	
		08/20/1980	1000	7	142.9	7	4.9	3.5	40,938	57,313		90	455	637	
		11/24/1981	1009	7.2	140.1	7.2	5.04	3.6	40,136	56,190		90	446	624	
		03/15/1983	1024	6.9	148.4	6.9	4.83	3.45	42,513	59,519		90	472	661	
		07/25/1984	**1014**	**6.4**	**158.4**	**6.4**	**4.48**	**3.2**	**45,378**	**63,529**	**12,600**	**90**	**504**	**706**	**140**
		10/28/1985	1044	7.8	133.8	7.8	5.46	3.9	38,331	53,663		90	426	596	
		09/23/1998	1066	9.4	113.4	9.4	6.58	4.7	32,487	45,481		90	361	505	
SCWC	Clark	**06/06/1972**	**814**	**4**	**203.5**	**4**	**2.8**	**2**	**58,298**	**81,618**	**22,050**	**90**	**648**	**907**	**245**
		03/18/1974	587	3.8	154.5	3.8	2.66	1.9	44,261	61,965		90	492	689	
		05/27/1975	541	3.7	146.2	3.7	2.59	1.85	41,883	58,636		90	465	652	
		04/12/1976	490	3.3	148.5	3.3	2.31	1.65	42,542	59,559		90	473	662	
		07/06/1977	500.3	3	166.8	3	2.1	1.5	47,785	66,898		90	531	743	
		05/08/1978	488	3.1	157.4	3.1	2.17	1.55	45,092	63,128		90	501	701	
		04/01/1979	600	3	200	3	2.1	1.5	57,296	80,214		90	637	891	
		09/01/1979	600	2.6	230.8	2.6	1.82	1.3	66,119	92,567		90	735	1,029	
		08/20/1980	573	2.9	197.6	2.9	2.03	1.45	56,608	79,251		90	629	881	
		11/24/1981	602	2.7	223	2.7	1.89	1.35	63,885	89,439		90	710	994	
		03/08/1983	608	2.6	233.8	2.6	1.82	1.3	66,979	93,770		90	744	1,042	
		07/25/1984	608	2.3	264.3	2.3	1.61	1.15	75,716	106,003		90	841	1,178	
		09/23/1998	677	4.4	153.9	4.4	3.08	2.2	44,089	61,725		90	490	686	

Notes:
Kh = horizontal hydraulic conductivity
T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

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APPENDIX C

Surface Water Routing Model

A Surface Water Routing Model (SWRM) was developed to support groundwater flow modeling efforts in the Santa Clarita Valley of Southern California. The SWRM was developed as a pre- and post-processor for the Santa Clarita Valley Groundwater Model (hereafter called the Regional Model), which was constructed by the Upper Basin Water Purveyors. The Regional Model will be briefly described in this appendix; however, the reader should refer to the main body of this report for a more detailed description of the Regional Model.

C.1 Introduction

The Regional Model simulates monthly groundwater conditions from 1980 through 1999 over a 120 square mile (mi^2) area within a portion of the Santa Clara River Valley East Groundwater Subbasin. This subbasin lies within the Upper Santa Clara River Hydrologic Area, which is a watershed of approximately 460 mi^2 that lies in northwest Los Angeles County and a small portion of eastern Ventura County (Figure C-1).

The outer limits of the Regional Model correspond to the outer limits of the Santa Clarita Valley's groundwater systems, which consist of the Alluvial Aquifer and the Saugus Formation. These aquifers lie in the south-central portion of the hydrologic area, and the watershed extends upstream beyond the outer limits of the groundwater systems. Geologic formations located within the watershed, but outside of the Regional Model area, consist of bedrock and do not transmit significant quantities of groundwater flow due to their low permeability. However, an understanding of the availability of surface water runoff and infiltration within and upstream of the Regional Model area is critical to accurately simulate the water budget through time within the Regional Model area. Therefore, a surface water routing tool was developed to estimate, on a monthly basis, the location, magnitude, and timing of surface water infiltration to groundwater within the Regional Model boundary.

The SWRM was written in the Visual Basic Editor within Microsoft® Excel 97. The remainder of this appendix is organized as follows:

a. A list of the sources of recharge that are evaluated by the SWRM

b. The design of the SWRM

c. Detailed discussions of the calculations of magnitudes of each surface water source and its associated infiltration rate to groundwater

C.2 Sources of Recharge

The sources of recharge to the groundwater system in the Santa Clarita Valley are:

a. Infiltration of applied water for urban and industrial outdoor uses and for irrigating golf courses. Sources of urban and golf course irrigation water are groundwater pumping from the Alluvial Aquifer and the Saugus Formation, and import of water from the State Water Project (SWP).

b. Infiltration of water that is used for agricultural irrigation within the Regional Model area. This source of water consists exclusively of groundwater pumping from the Alluvial Aquifer.

c. Infiltration of direct precipitation within the Regional Model area, which is derived from precipitation data.

d. Infiltration of stormwater and anthropogenic streamflows. These sources include the following:

    1. Surface water runoff and infiltration from portions of the Upper Santa Clara River Hydrologic Area located outside of the Regional Model boundary
    2. Santa Clara River flows that enter the valley from the east
    3. Water released from Castaic Lagoon into Castaic Creek by the California Department of Water Resources
    4. Treated water discharged into the Santa Clara River from two Los Angeles County Sanitation District (LACSD) water reclamation plants (WRP)

C.3 SWRM Design

At every node in the grid that forms the Regional Model domain, the SWRM estimates groundwater recharge terms using the following three basic steps:

1. Calculate the monthly volume of surface water from each water source within and upstream of the Regional Model area.
2. Calculate the monthly volume of water in a stream that leaks through the streambed and collects on the water table, based on an assigned streambed leakage rate at each Regional Model stream node.
3. Calculate the monthly volume of water in a stream that does not infiltrate because of gaining stream conditions (i.e., rejected stream leakage). Rejected stream leakage remains as surface water as it passes the mouth of the stream and flows into the next stream system. For the Santa Clara River, rejected stream leakage eventually exits the Regional Model area at the west end of the valley, at the County Line stream gage.

Flow volumes in streams and rates of infiltration to groundwater from all water sources vary both geographically and over time based on sets of rules programmed into the SWRM. One of the most significant rules in the SWRM is that the infiltration rates to groundwater are not allowed to exceed the total amount of water generated by all surface water sources in a given month. The magnitude of each potential source of groundwater recharge is based on local hydrologic measurements that have been recorded over time.

Following are discussions of the data and methods that were used to estimate the source water volumes and the amount of infiltration from each of these sources.

C.4 Infiltration of Applied Water (Urban Use, Excluding Golf Courses)

A significant portion of water that is used outdoors goes to plant uptake and direct evaporation, and a smaller portion infiltrates to the underlying aquifer system. The magnitude of infiltration was estimated using recent water use and land use data (Figure C-2) for developed areas within the Santa Clarita Valley.

The average annual water demand provided by the Upper Basin Water Purveyors was approximately 49,000 acre-feet per year (AF/yr) from 1994 through 1998. On a long-term basis, outdoor water use in urbanized areas is approximately 66 percent of the total annual water demand, as indicated by records of total water demands and WRP flows (see Table C-1). Within urbanized areas that are industrial and retail land uses, the outdoor water use is estimated to be approximately 30 percent of the total water use. For all urbanized areas excluding golf courses, it was assumed that 10 percent of the applied water in areas of urban development could potentially recharge groundwater. This assumption means that a total of 90 percent of the applied water goes to evapotranspiration (ET) demands, surface runoff, and return flow to surface water.

Aerial photographs of the valley taken in 1999 were used to identify land uses in developed areas, and a geographic information system (GIS) was used to determine the acreage of each land use type. Table C-2 summarizes the derivation of estimated values of infiltration for urban irrigation water from land use and water use data. The table shows the average annual water use volumes, the land use acreage, and the calculated depths of annual infiltration to groundwater. As shown in the table, infiltration of urban irrigation water is estimated to be approximately 1 inch per year (in/yr) for retail and industrial land uses, and 2.2 in/yr for suburban residential land use and recreational land use (parks). These values were used as direct specified input to the SWRM and were not varied during calibration of the Regional Model.

An attempt was made to vary over time, the locations at which urban applied water was specified in the Regional Model. However, electronic records of historical land use data were unavailable. Consequently, to ensure that the total infiltration volume in urbanized areas reflected the increase in development and water use that occurred throughout the 1980s and 1990s, this infiltration was applied to the 1999 urbanized area, but at rates that were adjusted upward or downward in a given year according to the difference between water uses in that year and in 1999. Tables C-3 and C-4 show the actual rates that were applied to the 1999 urbanized area to account for the gradual increase in water use from 1980 through 1999.

C.5 Infiltration of Applied Water (Golf Course Irrigation)

From 1994 through 1998, the average annual water use for golf course irrigation was approximately 500 AF/yr. The majority of this water use was for irrigation and was specified in the SWRM as 100 percent of the total water use for the golf course.

The amount of return flow to groundwater resulting from golf course irrigation was estimated to be 30 percent of applied water, which is three times higher than the assumed rate for other urbanized areas. This estimate was based on information suggesting that golf courses irrigate beyond the water demand requirements of grassy areas to maintain the quality of the greens. As shown in Table C-2, this resulted in an estimated annual average infiltration rate of 4.6 in/yr. As with urban irrigation, the golf course irrigation was increased gradually from 1980 through 1999 to account for the increased population growth and urban water use in the urbanized Santa Clarita Valley (see Table C-5).

C.6 Infiltration of Applied Water (Agricultural)

Aerial photographs of the valley taken in 1999 indicate that approximately 877 acres are currently irrigated for agricultural uses in the model study area. Approximately 90 percent of these irrigated lands are underlain by the Alluvial Aquifer, while the remaining 10 percent lie on the terrace deposits or in areas where the Saugus Formation is exposed at the ground surface. The total area of irrigated agriculture has diminished substantially since the 1960s as a result of development in the area.

Agricultural land in the Santa Clarita Valley is used primarily to grow row crops. A review was performed of detailed records of agricultural pumping, crop types, the acreage of each crop type, and the water use requirements for each crop type (as listed in the California Irrigation Management Information System). This review was performed for the period 1996 through 2000 to estimate the amount of applied irrigation water that infiltrates to groundwater beneath irrigated agricultural lands. Figure C-3 shows the analysis, which compares crop water use requirements with applied water volumes and identifies the difference as being equal to the infiltration volume to groundwater. For the period 1996 through 2000, Figure C-3 shows the following:

a. The average applied water volume was 7,038 AF/yr

b. The average amount of water that was not consumptively used (and which therefore infiltrated to groundwater) was 2,583 AF/yr, which is approximately 37 percent of the applied water volume

c. The equivalent average infiltration rate over the 877-acre area was 2.9 AF/acre/yr (which is equivalent to 2.9 ft/yr)

The infiltration rate of 2.9 ft/yr corresponds to the 7,038 AF/yr average water use during 1996 through 2000. A higher infiltration rate would be expected during years of higher water use and lower rate during years of reduced water use. Table C-6 shows the corresponding infiltration rates for each year, based on the water use each year. The 500-foot spacing of the Regional Model grid resulted in slight over-estimation of the acreage within the model (1,205 acres) compared with the actual irrigated acreage (877 acres). This adjustment is also shown in Table C-6.

C.7 Infiltration of Direct Precipitation

As water falls onto the land surface or onto a body of water, it follows the three following natural pathways:

1. **Evapotranspiration.** This is the process by which water passes from a liquid to a vapor state via direct evaporation and through transpiration by plants (crops, urban landscaping, and native vegetation).
2. **Surface water runoff.** This represents water occurring as overland flow or water flowing in a stream.
3. **Infiltration.** This is the process by which water moves from the land surface downward through the upper soil layers. The process of infiltration increases the soil moisture content. If the soil moisture content reaches its field capacity, then any additional infiltration that takes place displaces water in the vadose zone and collects on the water table as groundwater recharge (deep percolation of precipitation). For the sake of clarity, references to infiltration in the rest of Appendix C will be synonymous with deep percolation of precipitation.

To estimate the infiltration rate, an understanding of the spatial pattern of precipitation must first be developed. To estimate the total volume of precipitation that falls onto the watershed, one would ideally like to have long-term precipitation data from several active rain gages located on a fairly consistent spacing throughout the watershed. However, due to the expense and maintenance required to operate a rain gage, such an extensive network of rain gages within a single watershed is typically not available for an extended period in most watersheds, as is the case for the Santa Clarita Valley.

C.7.1 Precipitation Data

The SWRM used precipitation data from the rain gage at the Newhall County Water District (NCWD) office, which is located south of Newhall Creek, approximately 1.3 miles south of the Newhall-Soledad rain gage (Figure C-4). Table C-7 lists the monthly precipitation at the NCWD gage from 1980 through 1999.

Because data from a single rain gage is not ideal for estimating the total volume of precipitation that falls within the entire watershed area, an isohyet map of California was also used. Figure C-4 shows contours of long-term average annual rainfall (isohyets) based on data compiled by the U.S. Geological Survey (USGS), the California Department of Water Resources, the California Geologic Survey (formerly the California Division of Mines and Geology), and where available, county and/or other local agencies. The source maps that were used to create the isohyet map are based primarily on U.S. Weather Service data from approximately 800 precipitation stations statewide. The U.S. Weather Service data were supplemented with county and local agency precipitation data in the Los Angeles area. The precipitation data were collected by these agencies over a sixty-year period from 1900 to

1960. Further information on the source of the isohyet data is available at the California Spatial Information Library.[1]

Because these isohyet data represent long-term hydrologic conditions from 1900 to 1960, a methodology was developed to estimate monthly precipitation throughout the Upper Santa Clara River Hydrologic Area using the NCWD gage data and the isohyets. For each month during the 1980 through 1999 Regional Model calibration period, this was done both within the Regional Model area and in the portions of the watershed lying outside the Regional Model area. The long-term average annual precipitation distribution shown in Figure C-4 was electronically draped over the nodes that comprise the Regional Model grid using the ESRI® ArcMap™/ArcInfo™ 8.3 GIS software. The annual precipitation rates at the NCWD rain gage from 1980 through 1999 were computed and compared with the value presented on the 1900 to 1960 isohyet map at that same location. The percent difference between the annual precipitation value and the isohyet value was computed for the NCWD rain gage location and applied to all isohyet values assigned to the Regional Model nodes, to estimate the average spatial distribution of precipitation for that particular calendar year. For example, the 1900-1960 isohyet value at the NCWD rain gage was 20.50 inches, but the 1980 annual precipitation data indicate 31.95 inches fell that year. Therefore, the adjustment factor for the isohyet values at all Regional Model nodes for 1980 was 31.95 divided by 20.50 or 1.559. This adjustment factor was then multiplied by the isohyet values at all Regional Model node locations to estimate the spatial distribution of annual precipitation during 1980.

The derivation of infiltration rates from direct precipitation within the Regional Model boundary is described in Section C.7.2. The derivation of streamflow rates from precipitation occurring outside the regional model boundary is discussed in Section C.8.1.

C.7.2 Infiltration Within the Regional Model Area

Because the Regional Model is a groundwater flow model, it does not directly input precipitation data. Instead, the monthly component of infiltration is estimated by the SWRM and used as input for the Regional Model. The infiltration rate is computed by the SWRM, within the Regional Model area, as described in the following paragraphs.

Annual precipitation infiltration volumes within the Regional Model domain were estimated from annual precipitation data using a variation of the Turner (1986) method. Turner empirically derived a power-function equation that described the relationship between annual rainfall and ET rates, based on the measured yields from 68 different watersheds located throughout California. Rainfall that does not go to ET is available for surface water runoff and infiltration to groundwater. During the largest storm events, some of this water leaves the basin before it has a chance to infiltrate to groundwater. However, during all but the largest storm events, precipitation that is not consumed by ET eventually infiltrates to groundwater, as defined by the following equation (Turner, 1986):

$$\text{Infiltration} + \text{Runoff} = \text{Precipitation} - 2.32(\text{Precipitation})^{0.66} \qquad \text{(C-1)}$$

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[1] http://gis.ca.gov/meta.epl?oid=286

Equation C-1 is plotted on Figure C-5 for a range of annual precipitation values expressed in units of inches. Because this expression was empirically derived based on a best-fit to data from 68 watersheds throughout California, it is not necessarily representative of the conditions in an individual watershed. Therefore, the two power-function coefficients were adjusted during the process of calibrating the Regional Model. A final set of power-function coefficients for the Regional Model produced the following relationship for the Santa Clarita Valley:

$$\text{Infiltration} + \text{Runoff} = \text{Precipitation} - 6.20(\text{Precipitation})^{0.33} \qquad \text{(C-2)}$$

Equation C-2 (Figure C-5) was then applied to the annual precipitation-adjusted isohyet values to estimate the annual rate of infiltration from 1980 through 1999. Finally, based on the percentage of annual precipitation that fell each month during that calendar year at the NCWD rain gage, the annual infiltration rates were converted into monthly rates for every node in the Regional Model.

C.8 Infiltration From Streams

The natural sources of water to streams within the Santa Clarita Valley are surface water runoff from portions of the Upper Santa Clara River Hydrologic Area watershed that lie outside of the Regional Model boundary, and flow in the Santa Clara River where it enters the valley. Additionally, DWR releases water into Castaic Creek from Castaic Lagoon in some years, and treated water is discharged into the river from two WRPs on a continual basis. Following are discussions of the volumes of these water sources and the method used to determine infiltration rates in stream beds, based on the magnitude of flow in each stream.

C.8.1 Surface Water Runoff Volume Outside the Regional Model Area

For the Regional Model to honor the water budget for the entire watershed, a method was developed to estimate the monthly availability of surface water runoff and subsurface inflow from areas that are tributary to the Regional Model boundary. To do this, GIS software was used to provide specific input data to the SWRM as follows:

a. First, GIS software was used to delineate the extents of selected subwatersheds within the Upper Santa Clara River Hydrologic Area, using 30-meter digital elevation model data obtained from the USGS. Figure C-6 depicts the extents of these subwatersheds. The extents of the subwatersheds were important to delineate because precipitation rates vary spatially (see Figure C-4); therefore, at any given time, each sub-watershed receives different magnitudes of precipitation, and yields different quantities of surface water runoff and subsurface inflow into the Regional Model area.

b. Once the selected subwatersheds were delineated, the spatial areas were computed by GIS software for the entire subwatershed and for the portion of the subwatershed lying outside the Regional Model boundary. The GIS software also computed the mean of the 1900 to 1960 precipitation (isohyet) distribution within each subwatershed. The areas and the 1900 to 1960 mean precipitation values for each subwatershed are listed in Table C-8. The means of the 1900-1960 precipitation data were then multiplied by the precipitation adjustment factor (discussed in Section C.7.1) for each calendar year to estimate the average magnitude of precipitation that fell within each sub-watershed during that calendar year.

c. Equation C-2 was then applied to the adjusted annual precipitation values for each sub-watershed to estimate the annual rate of surface water runoff from 1980 through 1999. This provided an estimate of the annual volume of water from subwatersheds that is then available as potential groundwater recharge within the stream reach that lies within the Regional Model domain. These annual estimates were then converted to monthly estimates by multiplying by the monthly percentage of precipitation that fell at the Newhall County Water District rain gage.

C.8.2 Santa Clara River Streamflow at Eastern Regional Model Boundary

The eastern point of the Regional Model, the location at which the Santa Clara River enters the model area, marks the approximate location of the Lang gage (Figure C-6). Streamflow was measured at this gage by the USGS and Los Angeles County for a discontinuous period of 36 years starting in 1949. The gaging station was removed from service in October 1989. Because the Santa Clara River flow into the model domain is a critical boundary condition for the Regional Model, it was necessary to estimate this streamflow beginning in October 1989.

The following paragraphs describe the method used to estimate the monthly streamflow at the Lang gage. This process used the Lang gage data through September 1989 and monthly precipitation data from a rain gage in the Acton groundwater basin, which is immediately east and upgradient of the Regional Model area. Using a multiple linear regression method described below, a good correlation between monthly precipitation data from the U.S Forest Service's Acton rain gage and the Lang stream gage was achieved. The resulting regression equation was used to generate estimates of streamflow during the period that streamflow data were unavailable (October 1989 through December 1999).

C.8.2.1 Data Sources

Monthly precipitation data for 1949 to 2001 were obtained for the Acton, California rain gage maintained by the U.S. Forest Service from the Western Regional Climate Data Center. This gage was determined to be the closest rain gage to the center of the Acton watershed with a long enough period of record to complete the regression analysis. Average rainfall at the Acton rain gage was 10.3 inches during the period of record, which is approximately 58 percent of the 17.83-inch average measured from 1883 through 2000 at the Newhall-Soledad gage.

C.8.2.2 Streamflow Estimation Method

The streamflow estimation procedure for the Lang gage site assumed that a predictable relationship exists between streamflows at the Lang gage and precipitation at the Acton rain gage. This assumption was used to develop a multiple linear regression relationship and to test the quality of that relationship using historical data. A simple mathematical model was established in which the streamflow at the Lang gage during a given month was estimated from the precipitation during the prior month. A Microsoft® Excel spreadsheet was used to perform the multiple linear regression calculations and to determine the regression coefficients for each monthly rainfall value.

The regression model was calibrated using monthly streamflow data for the Lang gage during water years 1949 to 1956. The calibration was verified using streamflow and precipitation data for water years 1957 to 1989. Numerous iterations using different rainfall periods and durations were attempted before achieving a good correlation. The final regression model bases the streamflow estimates on the previous six monthly rainfall values to predict each monthly streamflow value at the Lang gage.

The final regression equation was of the form:

$$\text{Streamflow at the Lang gage} = C1*\text{Rain}_{\text{month1}} + C2*\text{Rain}_{\text{month2}} + \ldots + C6*\text{Rain}_{\text{month6}} \quad \text{(C-3)}$$

where C1, C2, ...C6 are the regression constants.

C.8.2.3 Accuracy of Streamflow Estimates

Once a regression equation is developed and its predictions are verified, streamflows are commonly estimated by applying the equation to any set of precipitation data that are similar in magnitude to those which were used to develop the regression relationship (in this case, the historic values at the Acton rain gage). To verify that the regression equations produced accurate streamflow predictions, streamflow rates calculated from the regression equations were plotted and compared against measured streamflow rates for the period of record at the Lang gage. Figure C-7 shows a comparison plot using the results of this analysis, along with the final regression equation. The plotted data indicate that the regression equation produced streamflow estimates that closely matched measured streamflows. Where differences are apparent between computed and measured streamflows, this results from one or more of the following influences:

a. **System Operation.** The effects of streamflow diversions, pump stations, and wet weather bypasses are not consistent from storm to storm, and can result in irregular streamflows under similar precipitation events.

b. **Rainfall Distribution.** The regression equations were generated from the rain gage that was thought to best represent the precipitation distributed over the entire Acton basin. However, variability of rainfall volume and intensity is normal across basins, resulting in differences in streamflow volume and timing.

c. **Gage Data.** It is common to have intermittent problems with streamflow measurement devices, particularly because of changes in the depth-versus-streamflow relationship at the gaging station over time. The regression equation was produced from storm events during periods where the Acton precipitation data appeared to be the most reliable. These data are reasonable and appropriate for the uses of this study.

d. **Antecedent Conditions.** Streamflow predicted by the regression equation will be most accurate when applied to periods when storm intensity, duration, and antecedent conditions are similar to those used to generate the regression equations. If the antecedent conditions differ significantly from those present in the historical record, then the ability to forecast streamflow characteristics may be hindered.

As Figure C-7 shows, the relationship between monthly precipitation at the Acton rain gage and streamflow at the Lang gage is fairly predictable and has been consistent over time. This mathematical relationship would be expected to remain consistent unless significant changes occur within the basin to affect streamflows, such as major land use changes.

The Acton rain gage was removed from service at the end of August 2000, therefore streamflow predictions cannot be made beyond this date using the calibrated regression model parameters described above. Table C-9 lists the combined set of measured and computed monthly streamflow values for the Lang gage from 1980 through 1999.

The monthly availability of streamflows at the Lang gage were input into the SWRM and allowed to infiltrate based on the specified maximum stream leakage rate, as Section C.8.5 of this appendix will discuss.

C.8.3 Releases from Castaic Lake

As described in Section 2.6.3.4 in the main body of this report, Castaic Creek occasionally receives surface water releases from Castaic Lagoon (i.e., Castaic Lake). The SWRM treats this surface water as it would any other available surface water in a stream. Based on the volume of available water during each monthly stress period, that water is allowed to infiltrate the Castaic Creek streambed and recharge the underlying groundwater system at a rate equal to or less than the streambed infiltration capacity (see Section C.8.5). Table C-10 lists the monthly releases of state surface water into Castaic Creek.

C.8.4 Treated Wastewater

Another anthropogenic source of recharge to the groundwater system is treated wastewater from the two LACSD WRPs in the valley, Plant No. 32 near Valencia, known as the Valencia WRP, and Plant No. 26 near Bouquet Canyon known, as the Saugus WRP. Tables C-11 and C-12 list the monthly volumes of treated wastewater that are discharged to the Santa Clara River from the Valencia WRP and the Saugus WRP, respectively.

The SWRM treats this surface water component as it would any other available surface water in a simulated stream. The volume of available treated wastewater during each monthly stress period is simulated to infiltrate the Santa Clara River streambed and recharge the groundwater system at a rate equal to or less than the streambed infiltration capacity (see Section C.8.5).

C.8.5 Assignment of Stream Leakage

Once the monthly streamflows were established for the Santa Clara River and each of its selected tributaries, a method had to be developed to determine the rates and locations of surface water infiltration to the underlying Alluvial Aquifer system. The following paragraphs describe this method.

C.8.5.1 Stream Connectivity and Ranking System

For the SWRM to assign stream leakage rates accurately, a stream ranking convention was adopted (Figure C-8) as follows:

1. Santa Clara River
2. All modeled streams that merge with the Santa Clara River (2nd order streams)

3. All modeled streams that merge with the 2nd order streams (3rd order streams)
4. All modeled streams that merge with the 3rd order streams (4th order streams)
5. All modeled streams that merge with the 4th order streams (5th order streams)

For the entire model domain, the SWRM processes the assignment of stream leakage beginning with the highest ranking stream nodes and progressing sequentially downstream to the lowest ranking stream nodes for each subwatershed. This ensures a correct accounting of available stream leakage throughout the stream network in the Regional Model domain. Within a given stream, the connectivity relationships between each Regional Model grid node in that stream were established by ordering the Regional Model stream node number from upgradient nodes to downgradient nodes (Figure C-8). Additionally, the last stream node of a given stream was assigned a "next node number," which indicated the nearest node for the next downstream (lower ranking) stream that could receive any surface flows that remained in the higher ranking stream. This "next node number" attribute allowed the SWRM to simulate continued surface water infiltration in the lower ranking streams as long as the total volume of available recharge water was not consumed in upstream reaches of the simulated stream.

C.8.5.2 Stream Geometry at Each Node

Another necessary input for specifying infiltration rates from streams was the geometry of each individual stream node, specifically, the length, width, and area of each stream node (Figure C-8). This was required because the groundwater recharge module that was used within the Regional Model requires input in units of feet per day, then internally computes the volumetric groundwater recharge rate (in cubic feet per day) using the nodal area (in square feet). Thus, the SWRM requires input of simulated stream geometry assumptions to ensure that the correct volume of water is being recharged through the simulated streambeds.

C.8.5.3 Streambed Infiltration Capacity at Each Node

The streambed infiltration capacity was specified at each stream node in the SWRM. The streambed infiltration capacity is the maximum volume of water that can infiltrate through streambed sediments, assuming a sufficient volume of water in the stream. The streambed infiltration capacity is measured in cubic feet per second per stream mile and is a function of streambed sediment permeability and wetted width of the stream at any given time.

The wetted width of a stream at any given time will vary as a function of the amount of flow in the stream and will be less than the nodal width for all but the highest streamflows. Additionally, permeability of the streambed sediments will vary spatially and can even vary over time at any given location because of the scouring and deposition that occur during high flow events. Consequently, the streambed infiltration capacity of a stream at any given location can vary over time. For this reason, and because stream widths can vary in the field but not in the Regional Model, streambed infiltration capacity was allowed to vary over time in the SWRM.

A post-processor was written into the SWRM code to aid in the selection of time-varying streambed infiltration rates. The post-processor became a part of the calibration process of the Regional Model, in that differences between measured and simulated groundwater elevations were used to help determine whether the streambed infiltration capacity of a given stream reach needed to be raised or lowered during any given month. Because this process required groundwater elevation data in the underlying groundwater system (in this case, the Alluvial Aquifer), the post-processor could only be applied along the Santa Clara River and Castaic Creek. Few, if any, records of groundwater elevations exist for the Alluvial Aquifer along the other streams, so streambed infiltration capacities were not varied over time along those streams. A complete description of the Regional Model calibration process and results can be found in Sections 4 and 5 in the main body of this report.

The monthly adjustment of the assumed streambed infiltration capacities during calibration of the Regional Model was performed in an iterative manner, using the following steps (which are also shown in Figure C-9):

1. Initial estimates of the maximum stream leakage rate were specified in the SWRM, which then generated monthly sets of groundwater recharge rates at each Regional Model node along the Santa Clara River and Castaic Creek during the 20-year simulation period.

2. The Regional Model was then run, and simulated groundwater elevations were recorded over time at selected calibration well locations along the Santa Clara River and Castaic Creek.

3. Simulated groundwater elevations were compared with measured elevations at each calibration well, and the differences (head residuals) were used to compute the surplus or deficit of water calculated by the Regional Model. For example, if a set of calibration wells in a particular area along the Santa Clara River indicated that simulated groundwater levels were 10 feet too high during a monthly stress period, then the computation would proceed as follows:

    a. Multiply the head residuals by the specific yield and the adjacent stream node area in the stream reach where the calibration well is located, to obtain the volume of surplus recharge water in the model.

    b. Reduce the assumed maximum stream leakage rate so that the calculated surplus recharge volume of water would not infiltrate in the stream reach associated with the calibration well during that particular monthly stress period. In other words, at a location where the model simulates too much stream leakage, the post-processor computes the volume of surplus recharge that, if eliminated, would allow the simulated groundwater elevations to better match the measured groundwater elevations. In this example, streamflow would be infiltrating the simulated streambed at a slower rate, thereby persisting as streamflow for a longer downstream reach of the stream channel.

4. Using the new values of streambed infiltration capacity, the SWRM was then run again to provide new groundwater recharge rates each month at the nodes where the post-processor was applied. The Regional Model was then run again with the new groundwater recharge rates, and this entire process was repeated until the assumed maximum stream leakage rate and/or the simulated groundwater elevations showed little to no change from one simulation to the next.

The streambed infiltration capacity that is assigned by the SWRM for each month is not necessarily the rate that surface water leaks into the Regional Model at any given location. The specified infiltration capacity simply allows stream leakage to occur as long as streamflows are available. For example, if the selected calibration wells are simulating groundwater elevations too low in comparison with measured groundwater elevations during a drought period, then the post-processor function within the SWRM would try to increase the assumed maximum stream leakage rate. However, during a drought, the availability of surface water is diminished. Therefore, even though the SWRM might increase the streambed infiltration capacity, there would be reaches where streamflows would be too low to allow water to infiltrate at a rate as high as the streambed infiltration capacity. The SWRM can only infiltrate the surface water if it is available, based on the complete water balance within the watershed. This rule allows the SWRM and the Regional Model to honor the watershed water budget.

C.9 Rejected Stream Leakage

As previously mentioned, the SWRM also tracks the volume of surface water in each simulated stream that does not infiltrate during each monthly stress period because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage remains as surface water in the Santa Clara River and eventually exits the Regional Model at the west end of the valley at the County Line stream gage. The monthly volumes of rejected stream leakage (calculated by the SWRM) and groundwater discharges to the river (calculated by the Regional Model) were used during the calibration process to compare these combined flow rates with streamflows measured at the County Line stream gage. This is discussed in detail in Sections 4.4.2 and 5.2.3 of the report.

Table C-13 lists the monthly streamflow measured from 1980 through 1999 at the County Line gage, which is located on the Santa Clara River at the western (downstream) end of the Santa Clarita Valley. Until October 1996, this gage was located just downstream of the Los Angeles-Ventura County line and just upstream of Blue Cut.[2] This gage continued operation through October 21, 1996, at which time it was permanently taken out of service. A new gage (USGS Gage No. 11109000) was put into service beginning on October 1, 1996 approximately 2.5 miles downstream, near Piru Junction, at the Las Brisas Bridge.

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[2] Blue Cut is an area where the valley becomes substantially narrower in width and the river begins to bend toward the southern side of the valley. See Figure C-1 for this location.

C.10 References

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Tables

Table C-1
Comparison of WRP Discharges with Urban Water Demands
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	WRP Discharges to the Santa Clara River (AF/yr)	Urban Water Demands (AF/yr)	Percentage of Urban Demand Used Indoors (Routed to WRPs)	Percentage of Urban Demand Used Outdoors
1980	7,374	22,319	33.0	67.0
1981	7,950	24,822	32.0	68.0
1982	8,438	21,912	38.5	61.5
1983	9,422	21,386	44.1	55.9
1984	9,514	27,386	34.7	65.3
1985	9,616	28,482	33.8	66.2
1986	6,020	31,152	19.3	80.7
1987	11,843	33,877	35.0	65.0
1988	12,363	37,634	32.9	67.1
1989	13,560	42,813	31.7	68.3
1990	14,006	43,066	32.5	67.5
1991	14,108	39,793	35.5	64.5
1992	15,702	41,266	38.1	61.9
1993	17,178	43,352	39.6	60.4
1994	16,946	45,988	36.8	63.2
1995	17,823	45,673	39.0	61.0
1996	16,827	50,147	33.6	66.4
1997	15,775	54,173	29.1	70.9
1998	17,691	48,858	36.2	63.8
1999	17,847	57,250	31.2	68.8
1999	17,847	57,250	31.2	68.8
Statistics for 1980 through 1999				
Minimum	**6,020**	**21,386**	**19.3**	**55.9**
Maximum	**17,847**	**57,250**	**44.1**	**80.7**
Average	**13,231**	**38,981**	**34.2**	**65.8**
Median	**14,006**	**41,266**	**33.8**	**66.2**
Statistics for 1980 through 1999, Excluding 1986				
Minimum	**7,374**	**21,386**	**29.1**	**55.9**
Maximum	**17,847**	**57,250**	**44.1**	**70.9**
Average	**13,592**	**39,372**	**34.9**	**65.1**
Median	**14,057**	**42,040**	**34.3**	**65.7**

TABLE C-2
Calculation of Outdoor Irrigation Infiltration Rates to Groundwater for Non-Agricultural Water Uses
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Term	Value	Units	Reference or Calculation Method	Comment
NCWD Annual Water Use, 5-Year Average 1994 through 1998	8,150	AF/yr	Table III-6 in *1999 Annual Basin Report* (Luhdorff and Scalmanini Consulting Engineers, 2000)	16 percent of retailer-supplied water.
SCWD Annual Water Use, 5-Year Average 1994 through 1998	20,920	AF/yr		42 percent of retailer-supplied water.
VWC Total Annual Use, 5-Year Average 1994 through 1998	19,330	AF/yr		40 percent of retailer-supplied water.
LA County 36 Annual Water Use, 5-Year Average 1994 through 1998	570	AF/yr		1 percent of retailer-supplied water.
Valencia Country Club (VCC) Annual Water Use, 5-Year Average 1994 through 1998	490	AF/yr		1 percent of retailer-supplied water.
Annual Water Use, 5-Year Average 1994 through 1998	**49,460**	**AF/yr**		
Area of Water Use (excluding agriculture and undeveloped)	17,691	acres	Aerial photography (1999).	Area where retailer-supplied water is used.
Alluvial Aquifer Area of Water Use (excluding agriculture and undeveloped)	8,000	acres		Alluvial area where retailer-supplied water is used.
Saugus Area of Water Use (excluding agriculture and undeveloped)	9,691	acres		Saugus area where retailer-supplied water is used.
Alluvial Aquifer Lands – Suburban Residential Area	4,765	acres	Aerial photography (1999) and geologic mapping.	60 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Retail – Office – Industrial Area	2,900	acres		36 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Recreational Area	0	acres		No recreational areas were identified as overlying alluvium.
Alluvial Aquifer Lands – Golf Course Area	335	acres		4 percent of alluvium area receiving applied water.
Saugus Lands – Suburban Residential Area	8,192	acres		85 percent of Saugus area receiving applied water.
Saugus Lands – Retail - Office – Industrial Area	1,411	acres		15 percent of Saugus area receiving applied water.
Saugus Lands – Recreational Area	46	acres		Less than 1 percent of Saugus area receiving applied water.
Saugus Lands -- Golf Course Area	42	acres		Less than 1 percent of Saugus area receiving applied water.
Percent Annual Water Consumption for Outdoor Use -- Suburban Residential	65		Comparison of historical water use records and WRP flow records. See Table C-1.	
Percent Annual Water Consumption for Outdoor Use -- Retail/Office/Industrial	30			
Percent Annual Water Consumption for Outdoor Use -- Recreational	65			
Percent Annual Water Consumption for Outdoor Use -- Golf Course	100			
Percent Applied Water Going to Deep Percolation -- Suburban Residential	10		Assumed irrigation efficiency is 10 percent for all urban land uses where irrigation occurs.	
Percent Applied Water Going to Deep Percolation -- Retail/Office/Industrial	10			
Percent Applied Water Going to Deep Percolation -- Recreational	10			
Percent Applied Water Going to Deep Percolation -- Golf Course	30			
Percent Total Water Use Going to Deep Percolation -- Suburban Residential	6.5		Calculated.	Equals 65 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation -- Retail/Office/Industrial	3.0			Equals 30 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation -- Recreational	6.5			Equals 65 percent times 10 percent
Percent Total Water Use Going to Deep Percolation -- Golf Course	30.0			Equals 100 percent times 30 percent.
Alluvial Aquifer Annual Deep Percolation – Suburban Residential	866	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the alluvium for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (4765 acres / 17691 acres) * 6.5 percent.
Alluvial Aquifer Annual Deep Percolation -- Retail/Office/Industrial	243	AF/yr		Equals 49,460 AF/yr * (2900 acres / 17691 acres) * 3.0 percent.
Alluvial Aquifer Annual Deep Percolation – Recreational	0	AF/yr		No recreational areas overlie alluvium.
Alluvium Annual Deep Percolation -- Golf Course	130	AF/yr		Equals 490 AF/yr * (335 acres / (335+42 acres)) * 30.0 percent.
Alluvial Aquifer Annual Deep Percolation	**1,239**	**AF/yr**		
Alluvial Aquifer 5-Year Deep Percolation (1994 through 1998)	**6,195**	**AF**		
Saugus Annual Deep Percolation – Suburban Residential	1,489	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the Saugus for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (8192 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Retail/Office/Industrial	118	AF/yr		Equals 49,460 AF/yr * (1411 acres / 17691 acres) * 3.0 percent.
Saugus Annual Deep Percolation – Recreational	8	AF/yr		Equals 49,460 AF/yr * (46 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation -- Golf Course	16	AF/yr		Equals 490 AF/yr * (42 acres / (335+42 acres) * 30.0 percent.
Saugus Annual Deep Percolation	**1,631**	**AF/yr**		
Saugus 5-Year Deep Percolation (1994 through 1998)	**8,155**	**AF**		
Average Area-Wide Deep Percolation -- Suburban Residential	2.2	in/yr	Calculated from applied water volumes in Alluvial and Saugus samples, as well as combined area in alluvium and Saugus occupied by each land use category.	Equals (12 in/ft)* (866+1,489 AF/yr) / (4,765+8,192 acres).
Average Area-Wide Deep Percolation -- Retail/Office/Industrial	1.0	in/yr		Equals (12 in/ft)* (243+118 AF/yr) / (2,900+1411 acres).
Average Area-Wide Deep Percolation -- Recreational	2.2	in/yr		Equals (12 in/ft)* (0+8 AF/yr) / (0+46 acres).
Average Area-Wide Deep Percolation -- Golf Course	4.6	in/yr		Equals (12 in/ft)* (130+16 AF/yr) / (335+42 acres).

Notes:

Applied water recharge to Saugus includes areas where terrace deposits are present at the ground surface.
in/ft = inches per foot

Table C-3
Irrigation Infiltration Rates over 1999 Suburban Residential Area
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Suburban Residential Area (in/yr)	Ratio Compared with 1999
1980	22,319	0.86	0.391
1981	24,822	0.95	0.432
1982	21,912	0.84	0.382
1983	21,386	0.82	0.373
1984	27,386	1.05	0.477
1985	28,482	1.09	0.495
1986	31,152	1.2	0.545
1987	33,877	1.3	0.591
1988	37,634	1.45	0.659
1989	42,813	1.65	0.75
1990	43,066	1.65	0.75
1991	39,793	1.53	0.695
1992	41,266	1.59	0.723
1993	43,352	1.67	0.759
1994	45,988	1.77	0.805
1995	45,673	1.76	0.8
1996	50,147	1.93	0.877
1997	54,173	2.08	0.945
1998	48,858	1.88	0.855
1999	57,250	2.2	1
2000	60,988	2.34	1.064

Note:

Eq. = equivalent

Table C-4
Irrigation Infiltration Rates over 1999 Retail and Industrial Area
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Retail/Industrial Area (in/yr)	Ratio Compared with 1999
1980	22,319	0.39	0.39
1981	24,822	0.43	0.43
1982	21,912	0.38	0.38
1983	21,386	0.37	0.37
1984	27,386	0.48	0.48
1985	28,482	0.5	0.5
1986	31,152	0.54	0.54
1987	33,877	0.59	0.59
1988	37,634	0.66	0.66
1989	42,813	0.75	0.75
1990	43,066	0.75	0.75
1991	39,793	0.7	0.7
1992	41,266	0.72	0.72
1993	43,352	0.76	0.76
1994	45,988	0.8	0.8
1995	45,673	0.8	0.8
1996	50,147	0.88	0.88
1997	54,173	0.95	0.95
1998	48,858	0.85	0.85
1999	57,250	1	1

Table C-5
Irrigation Infiltration Rates over 1999 Golf Course Areas
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Golf Courses Area (in/yr)	Ratio Compared with 1999
1980	22,319	1.79	0.389
1981	24,822	1.99	0.433
1982	21,912	1.76	0.383
1983	21,386	1.72	0.374
1984	27,386	2.2	0.478
1985	28,482	2.29	0.498
1986	31,152	2.5	0.543
1987	33,877	2.72	0.591
1988	37,634	3.02	0.657
1989	42,813	3.44	0.748
1990	43,066	3.46	0.752
1991	39,793	3.2	0.696
1992	41,266	3.32	0.722
1993	43,352	3.48	0.757
1994	45,988	3.7	0.804
1995	45,673	3.67	0.798
1996	50,147	4.03	0.876
1997	54,173	4.35	0.946
1998	48,858	3.93	0.854
1999	57,250	4.6	1

Table C-6

Irrigation Infiltration Rates for Agricultural Lands

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Agricultural Applied Water Volume (AF/yr)	Infiltration Rate (ft/yr)	Infiltration Rate for Modeled Acreage (ft/yr)	Percentage of 1996 through 2000 Average
1980	6,364	2.7	1.9	90
1981	7,433	3.1	2.2	106
1982	5,441	2.3	1.6	77
1983	4,487	1.9	1.3	64
1984	6,311	2.6	1.9	90
1985	5,241	2.2	1.5	74
1986	4,657	1.9	1.4	66
1987	3,662	1.5	1.1	52
1988	3,348	1.4	1.0	48
1989	3,511	1.5	1.0	50
1990	4,623	1.9	1.4	66
1991	3,958	1.7	1.2	56
1992	5,022	2.1	1.5	71
1993	4,508	1.9	1.3	64
1994	5,958	2.5	1.8	85
1995	6,276	2.6	1.8	89
1996	6,728	3.2	2.2	108
1997	7,528	3.0	2.1	102
1998	5,980	2.7	1.9	93
1999	7,479	2.9	2.1	99
2000	7,476	2.9	2.0	98
Average (1996 through 2000)	**7,038**	**2.9**	**2.1**	100

Note:
Actual acreage is 877 acres; modeled acreage is 1,205 acres.

TABLE C-7
Monthly Precipitation Measured at the Newhall County Water District Rain Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
1981	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
1982	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
1983	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
1984	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
1985	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
1986	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
1987	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
1988	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
1989	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
1990	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
1991	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
1992	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
1993	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
1994	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
1995	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
1996	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
1997	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
1998	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
1999	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05

Note:

All precipitation values are measured in inches.

TABLE C-8
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
Bee Canyon	1,163.38	970.06	11.41
Bouquet Canyon	11,995.90	9,100.66	14.09
Bouquet Canyon Tributary 1	409.84	291.36	12.81
Bouquet Canyon Tributary 2	683.75	577.67	13.25
Bouquet Canyon Tributary 3	459.20	393.53	13.18
Lower Castaic Creek	13,109.20	4,205.12	14.73
Upper Castaic Creek	98,417.60	98,417.60	19.62
Charlie Canyon	6,323.41	5,418.33	15.55
Dry Canyon	4,883.13	2,900.08	14.20
Gavin Canyon	3,608.62	2,913.39	21.32
Haskell Canyon	7,608.26	5,976.49	14.01
Hasley Canyon	5,609.59	385.96	14.25
Iron Canyon	1,734.63	1,401.94	18.92
Marple Canyon	6,031.13	4,980.94	17.09
Mint Canyon	5,711.30	4,155.07	12.45
Mint Canyon Tributary 1	615.56	367.82	12.14
Mint Canyon Tributary 2	1,697.89	1,438.90	12.22
Mint Canyon Tributary 3	304.45	296.87	12.61
Mint Canyon Tributary 4	234.88	231.90	12.93
Mint Canyon Tributary 5	118.01	114.80	13.01
Newhall Canyon	3,191.67	1,625.11	18.98
Oak Spring Canyon	3,628.60	2,721.91	16.21
Pico Canyon	4,404.42	2,853.93	19.47
Placerita Canyon	6,117.92	2,490.47	18.20
Plum Canyon	2,085.00	753.09	13.25
Pole Canyon	1,744.04	1,614.78	15.95
Potrero Canyon	2,865.18	1,074.76	15.88
Railroad Aqueduct Canyon	865.82	198.83	20.27

TABLE C-8
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
San Francisquito Canyon	31,388.60	26,878.10	16.51
San Martinez Canyon	2,117.60	1,384.49	13.67
Sand Canyon	5,489.51	4,191.58	19.39
Sand Canyon Road Tributary	554.03	508.56	13.12
Sand Canyon Tributary 1	644.26	251.41	15.97
Sand Canyon Tributary 2	338.66	221.79	16.99
Santa Clara River East	12,696.90	2,562.57	14.16
Santa Clara River West	17,105.90	3,169.86	13.76
Santa Clara River Tributary 1	1,278.18	927.13	16.97
Santa Clara River Tributary 2	277.82	264.96	13.64
Santa Clara River Tributary 3	219.50	189.19	13.65
Santa Clara River Tributary 4	101.25	91.84	13.54
Santa Clara River Tributary 5	114.80	106.31	13.44
South Fork Santa Clara River	5,491.11	655.74	17.62
Tapie Canyon	1,260.27	1,235.25	11.39
Texas Canyon	6,956.88	6,659.55	13.59
Tick Canyon	3,662.58	3,428.16	11.57
Tick Canyon Tributary	175.19	154.75	12.09
Towsley Canyon	3,681.64	3,606.56	21.43
Vasquer Canyon	2,743.26	2,151.81	12.66
Whitney Canyon	1,321.58	1,104.38	18.95
Area Totals	**293,241.89**	**217,615.36**	

TABLE C-9

Monthly Streamflows Measured in the Santa Clara River at the Lang Gage

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
1981	594	98	339	240	107	18	18	12	338	321	258	394	2,739
1982	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
1983	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
1984	0	596	405	240	143	166	228	411	154	220	904	578	4,044
1985	483	461	274	215	77	0	0	0	12	179	221	301	2,224
1986	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
1987	117	117	65	31	12	0	0	0	0	0	258	516	1,116
1988	222	209	506	117	77	68	0	0	0	0	12	25	1,236
1989	50	111	60	25	6	0	0	0	102	94	34	18	499
1990	212	276	230	46	46	5	0	0	0	27	36	147	1,025
1991	162	775	879	736	145	142	14	0	45	69	62	263	3,291
1992	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
1993	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
1994	388	493	497	319	163	80	20	7	37	102	193	941	3,239
1995	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
1996	666	896	730	315	151	46	7	0	54	154	307	510	3,836
1997	517	346	140	85	33	5	4	50	66	240	566	809	2,859
1998	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
1999	92	85	204	224	197	107	80	46	52	54	31	80	1,252

Note:

All monthly streamflows are measured in acre-feet.

TABLE C-10
Monthly Releases of Water from Castaic Lagoon to Castaic Creek
Regional Groundwater Flow Model Report for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
1981	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1982	0	0	0	0	0	667	842	735	0	0	0	0	2,244
1983	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1987	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
1988	0	0	809	341	900	0	0	0	0	0	0	0	2,050
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	66	66
1992	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
1993	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
1994	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
1995	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
1996	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
1997	0	0	8701	873	0	0	0	0	0	0	0	310	9,884
1998	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
1999	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830

Note:

All monthly releases are measured in acre-feet.

TABLE C-11
Monthly Treated Wastewater Discharge Measured at the Valencia Water Reclamation Plant
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	266	258	257	239	247	212	219	219	212	228	239	247	2,844
1981	248	220	249	235	244	237	253	255	248	263	285	270	3,006
1982	275	247	284	271	277	269	275	268	254	266	271	284	3,241
1983	286	261	301	288	296	277	287	296	282	286	276	295	3,432
1984	303	281	304	294	321	315	320	317	314	322	315	319	3,723
1985	309	283	316	316	333	331	354	359	348	361	357	341	4,006
1986	350	341	374	359	377	380	415	454	446	440	421	445	4,801
1987	455	415	472	489	550	567	603	594	579	633	600	624	6,582
1988	622	557	588	587	603	537	575	606	587	608	600	602	7,072
1989	622	593	695	666	671	708	714	731	668	678	673	676	8,095
1990	698	644	725	695	666	693	725	714	692	700	658	680	8,290
1991	715	662	702	627	668	646	647	691	709	743	717	748	8,276
1992	777	777	819	813	824	800	853	869	818	828	811	786	9,775
1993	778	733	863	858	869	925	910	846	816	834	818	858	10,107
1994	722	729	809	776	802	761	771	764	739	763	735	760	9,132
1995	889	777	935	887	884	848	853	814	826	834	823	855	10,225
1996	893	838	935	890	902	876	903	891	886	817	810	816	10,456
1997	815	713	866	829	852	879	860	851	824	826	778	775	9,867
1998	778	787	955	955	984	965	1,136	1,139	1,020	993	911	906	11,529
1999	930	868	962	953	985	968	1,003	1,018	961	1,020	1,040	987	11,695

Note:

All monthly releases are measured in acre-feet.

TABLE C-12

Monthly Treated Wastewater Discharge Measured at the Saugus Water Reclamation Plant

Regional Groundwater Flow Model Report for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	362	365	419	414	419	387	362	362	350	362	359	371	4,529
1981	382	337	390	398	444	412	417	429	431	434	412	460	4,945
1982	445	399	456	444	446	434	434	421	415	434	431	438	5,196
1983	460	421	514	541	562	545	520	477	458	481	477	534	5,990
1984	558	505	499	485	476	443	458	456	451	467	474	519	5,791
1985	503	461	505	458	448	444	452	459	452	470	460	498	5,610
1986	498	475	528	501	499	483	481	476	500	511	518	552	6,023
1987	524	475	542	487	425	383	391	403	395	397	411	430	5,264
1988	443	411	439	434	440	430	445	457	435	464	436	460	5,294
1989	462	410	441	450	464	436	476	479	462	471	451	466	5,468
1990	463	403	432	426	483	492	513	504	489	493	508	512	5,718
1991	495	423	479	427	491	516	557	525	486	474	470	493	5,835
1992	488	507	530	472	489	476	493	521	492	498	452	514	5,931
1993	595	534	616	581	615	587	622	604	578	609	567	567	7,075
1994	601	606	694	677	687	644	642	645	619	663	655	685	7,817
1995	657	578	676	705	699	631	641	635	617	613	568	581	7,602
1996	532	504	525	501	517	506	511	525	532	579	558	583	6,375
1997	564	516	515	461	469	417	442	474	475	503	521	553	5,911
1998	529	541	544	511	617	587	426	399	457	501	521	533	6,166
1999	542	485	551	391	544	512	547	532	521	527	487	514	6,153

Note:

All monthly discharges are measured in acre-feet.

TABLE C-13
Monthly Streamflows Measured in the Santa Clara River at the County Line Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	8,428	43,565	18,125	8,551	3,792	3,963	1,202	1,111	1,668	1,470	1,452	1,884	95,211
1981	3,376	1,533	5,415	1,815	1,662	1,279	942	906	1,139	1,488	2,138	2,539	24,232
1982	2,826	2,358	5,572	7,091	3,909	1,749	1,694	1,392	1,597	1,621	3,449	3,229	36,488
1983	7,787	9,122	67,712	11,240	10,320	3,828	2,102	2,678	2,053	3,443	5,040	5,911	131,236
1984	5,691	3,931	4,084	4,530	2,309	1,607	1,224	1,511	1,464	1,624	3,237	8,067	39,279
1985	3,116	2,561	2,852	1,974	1,694	1,365	1,178	1,365	1,551	1,880	2,102	2,828	24,466
1986	3,955	13,991	10,616	3,328	2,612	1,622	1,454	1,482	1,870	1,896	2,606	2,590	48,024
1987	2,485	2,325	2,575	1,841	1,908	1,710	1,650	1,470	1,412	2,309	2,057	4,457	26,198
1988	3,421	2,981	3,025	3,172	2,636	2,231	1,734	1,494	1,605	1,904	2,027	10,381	36,611
1989	2,644	3,340	2,584	2,055	1,740	1,920	1,732	1,345	1,535	2,146	1,964	1,795	24,799
1990	2,709	3,247	2,269	1,898	1,730	1,545	1,478	1,751	1,668	1,660	1,924	1,593	23,472
1991	2,051	3,219	15,981	1,837	1,519	1,113	1,144	831	912	948	1,014	4,332	34,901
1992	3,737	37,636	9,576	4,439	1,964	1,533	1,377	1,085	1,129	1,329	1,496	3,277	68,577
1993	47,199	44,749	25,738	9,459	4,860	3,324	2,797	2,771	2,949	3,005	2,686	3,247	152,783
1994	3,281	3,437	3,501	3,533	3,519	2,200	1,640	1,400	1,192	1,855	2,263	4,219	32,039
1995	31,125	3,828	19,662	8,452	3,901	2,527	1,843	2,192	1,855	1,716	2,075	3,235	82,409
1996	3,604	10,669	7,678	6,073	3,584	1,678	1,640	1,579	1,509	2,625	1,590	5,701	47,930
1997	5,375	3,913	7,884	3,370	1,680	1,240	1,571	1,371	1,230	1,662	2,636	4,848	36,780
1998	5,875	104,388	25,377	9,378	34,992	5,312	3,935	3,537	2,579	2,450	2,890	4,427	205,139
1999	4,328	4,128	4,322	6,526	4,760	3,590	1,125	1,439	2,164	1,888	2,243	2,434	32,382

Note:

All monthly streamflows are measured in acre-feet.

Figures

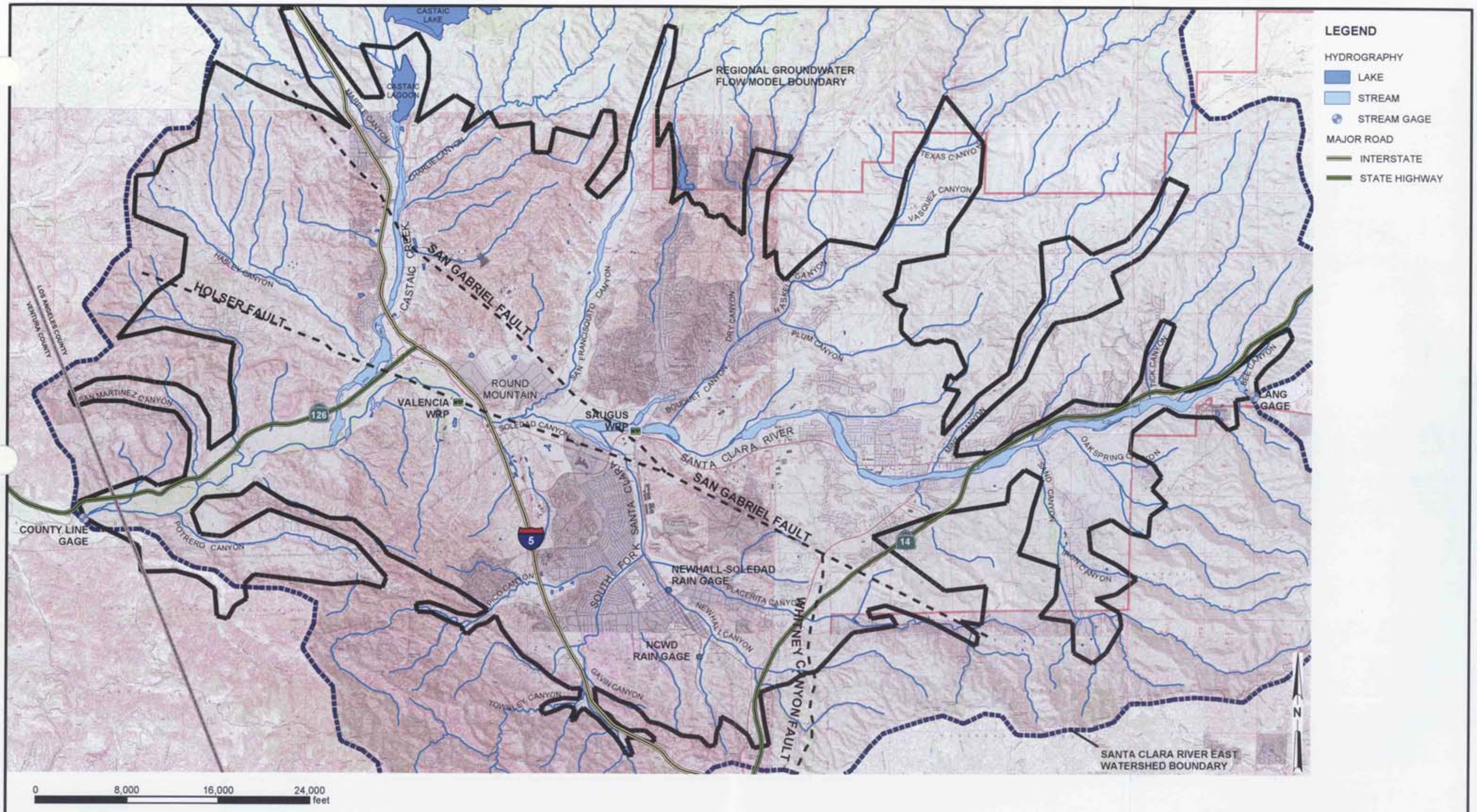

FIGURE C-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-01.MXD FIGC-01.PDF

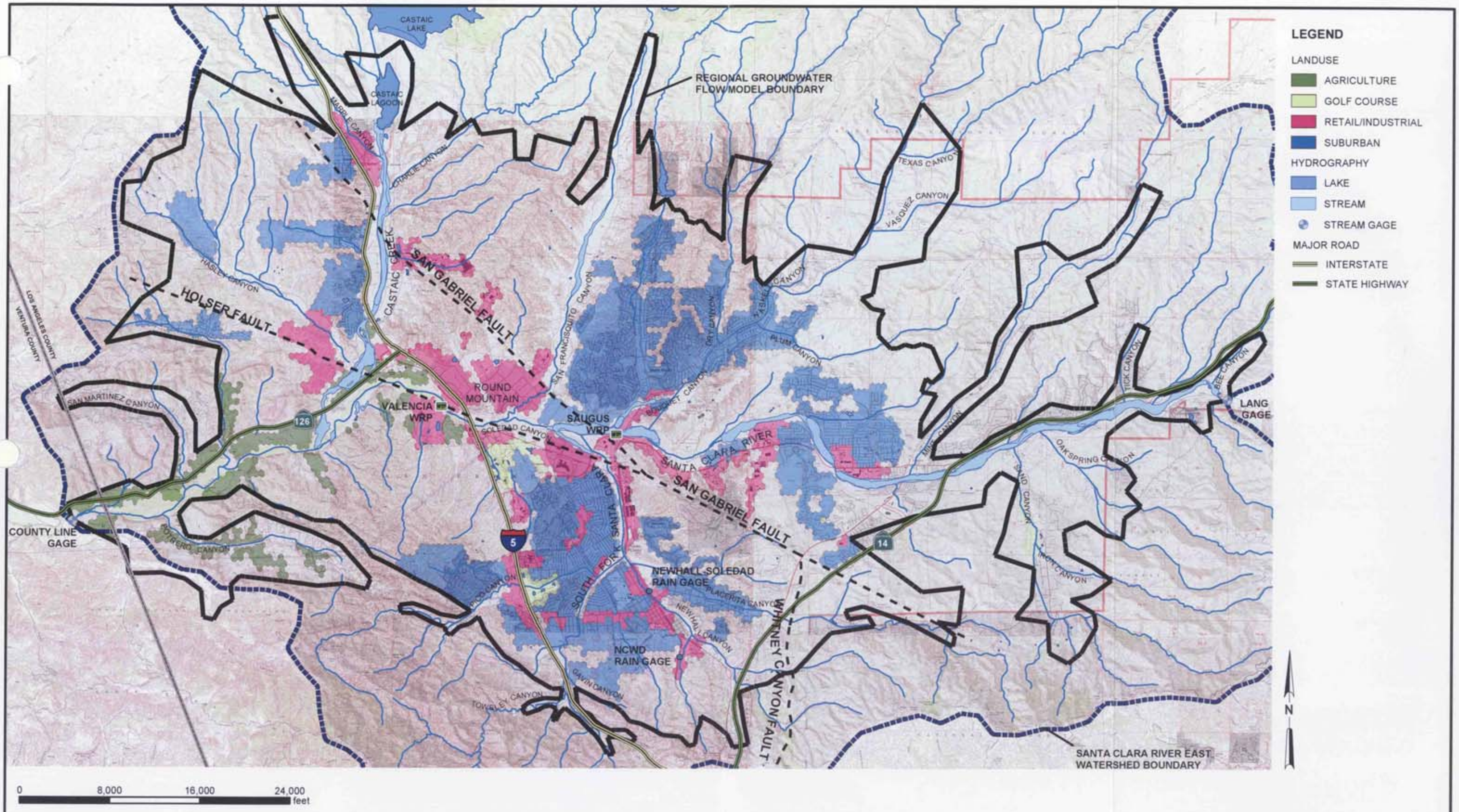

FIGURE C-2
LAND USE MAP
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-06.MXD FIGC-02.PDF 02/03/2004 09:36:51

Year	Acres				Acreage %		
	Alfalfa	Sudan	Vegetables	Total	Alfalfa	Sudan	Vegetables
1996	105	170	537	812	12.9%	20.9%	66.1%
1997	160	103	663	926	17.3%	11.1%	71.6%
1998	115	100	590	805	14.3%	12.4%	73.3%
1999	55	150	709	914	6.0%	16.4%	77.6%
2000	55	150	722	927	5.9%	16.2%	77.9%
Average	**98**	**134.6**	**644.2**	**876.8**	**11.3%**	**15.4%**	**73.3%**

Year	CIMIS AF/yr		
	Alfalfa	Sudan	Vegetables
1996	10.21	10.21	7.3
1997	10.22	10.22	7.3
1998	9.4	9.4	6.71
1999	10.51	10.51	7.51
2000	10.37	10.37	7.41
Average	**10.142**	**10.142**	**7.246**

Year	Water Use (AF/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	1,072	1,736	3,920	6,728
1997	1,635	1,053	4,840	7,528
1998	1,081	940	3,959	5,980
1999	578	1,577	5,325	7,479
2000	570	1,556	5,350	7,476
Average	**987**	**1,372**	**4,679**	**7,038**

Data Source: Appendix 2.5(m) of
Draft Additional Analysis to the
Newhall Ranch Specific Plan and
Water Reclamation Plant, Final
Environmental Impact Report
Impact Sciences, Inc., April 2001)

Crop Efficiency		
Alfalfa	Sudan	Vegetables
50%	**50%**	**70%**

Year	Estimated Infiltration (AF/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	536	868	1,176	2,580
1997	818	526	1,452	2,796
1998	541	470	1,188	2,198
1999	289	788	1,597	2,675
2000	285	778	1,605	2,668
Average	**494**	**686**	**1,404**	**2,583**

Year	Estimated Infiltration (AF/acre/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	5.1	5.1	2.2	3.2
1997	5.1	5.1	2.2	3.0
1998	4.7	4.7	2.0	2.7
1999	5.3	5.3	2.3	2.9
2000	5.2	5.2	2.2	2.9
Average	**5.1**	**5.1**	**2.2**	**2.9**

This represents the average deep percolation on irrigated acreage during the past 5 years, consistent with the water application of an average 7,038 AF/yr during this period. Values are in AF/acre/year, which is equivalent to feet/year.

FIGURE C-3
ANALYSIS OF AGRICULTURAL WATER USE AND ASSOCIATED INFILTRATION TO GROUNDWATER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-409.xls\FigureC-3

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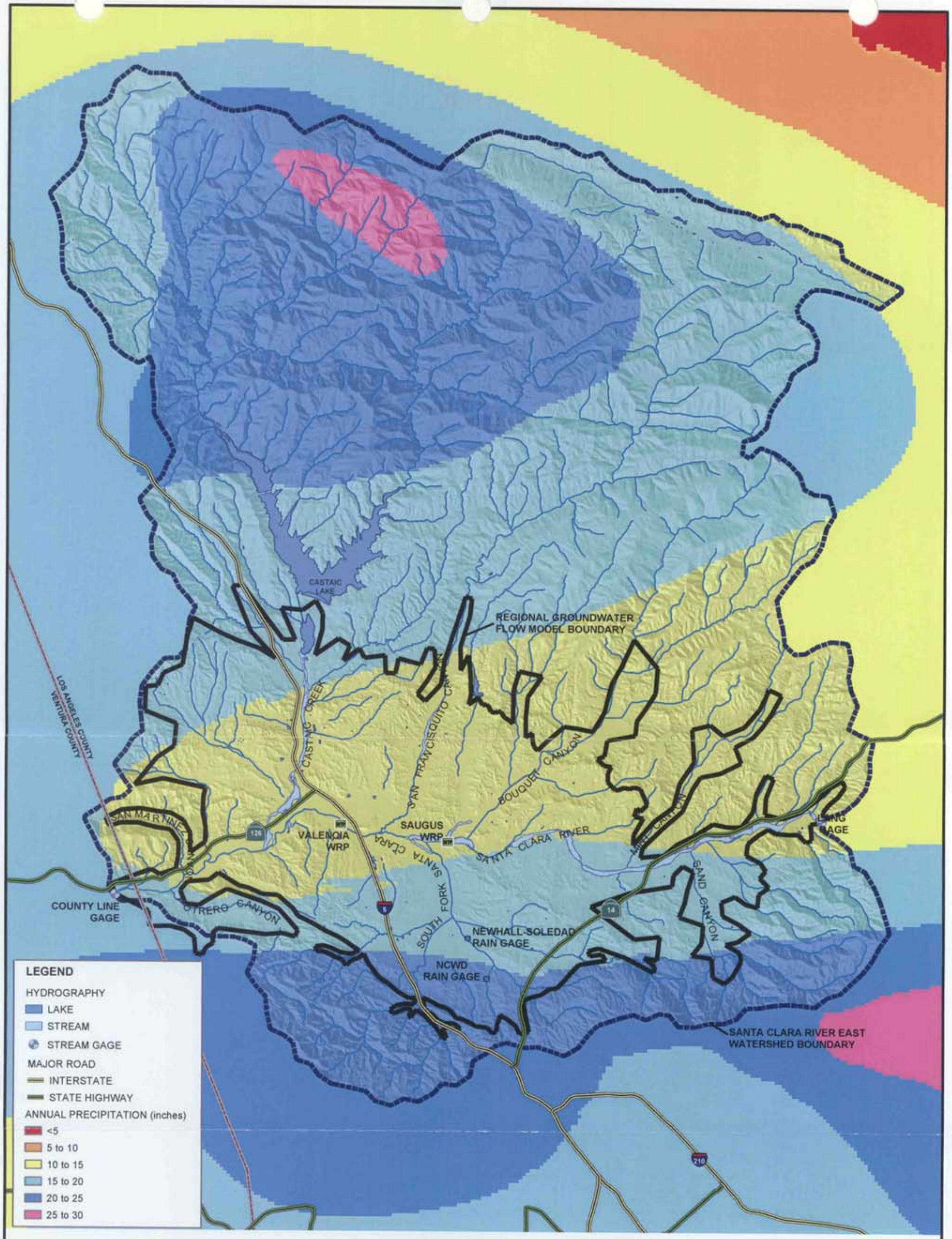
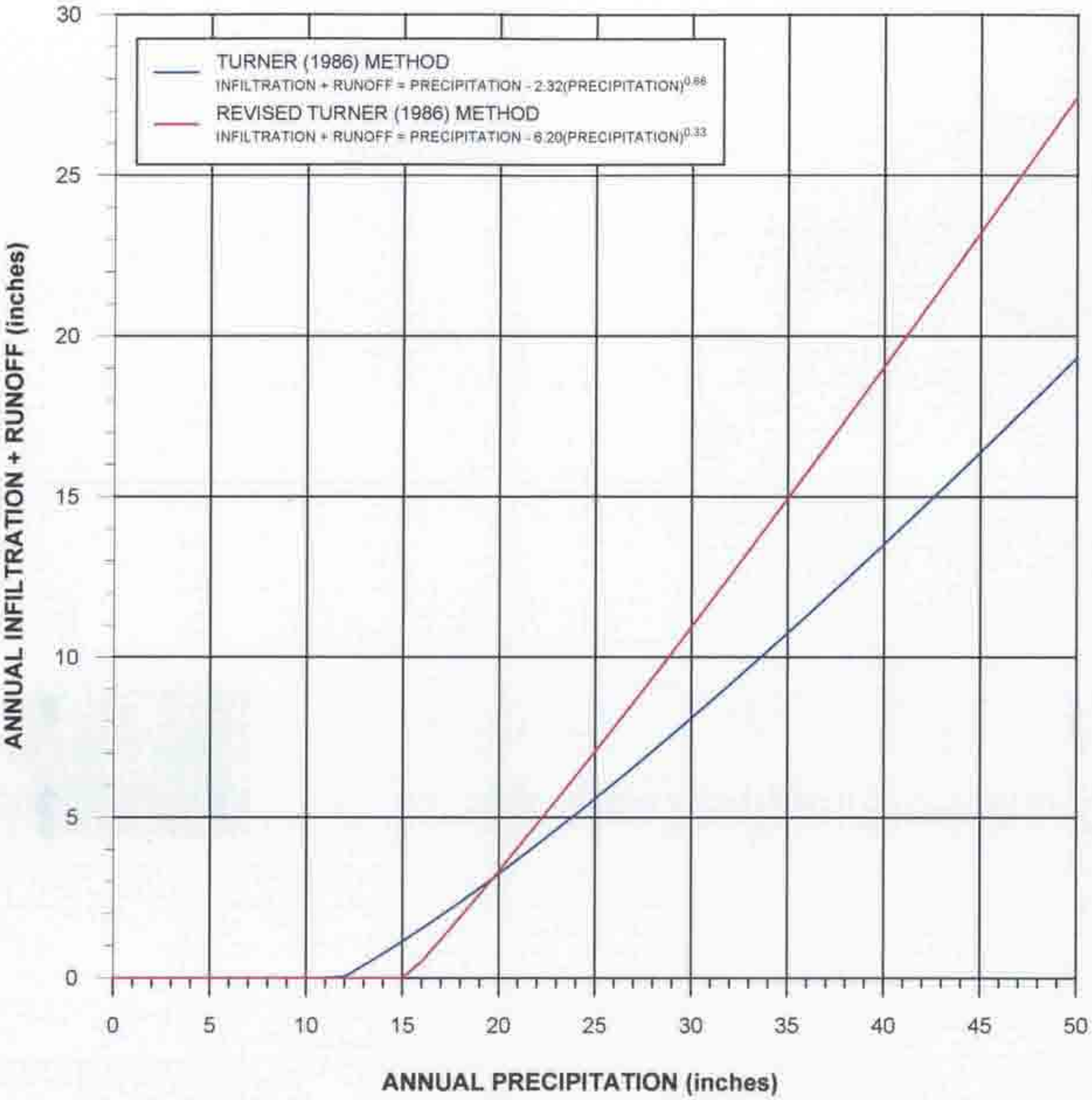


SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

FIGURE C-4
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA



SOURCE:

TURNER, K.M. 1986. WATER LOSS FROM FOREST AND RANGE LANDS IN CALIFORNIA. *IN* PROCEEDINGS OF THE CHAPPARRAL ECOSYSTEMS CONFERENCE, SANTA BARBARA, CALIFORNIA, MAY 16-17, 1986, J. DEVRIES (EDITOR). WATER RESOURCES CENTER, REPORT 62, UNIVERSITY OF CALIFORNIA-DAVIS, CALIFORNIA, PP. 63-66.

FIGURE C-5
INFILTRATION AND RUNOFF
AS A FUNCTION OF PRECIPITATION
REGIONAL GROUNDWATER MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

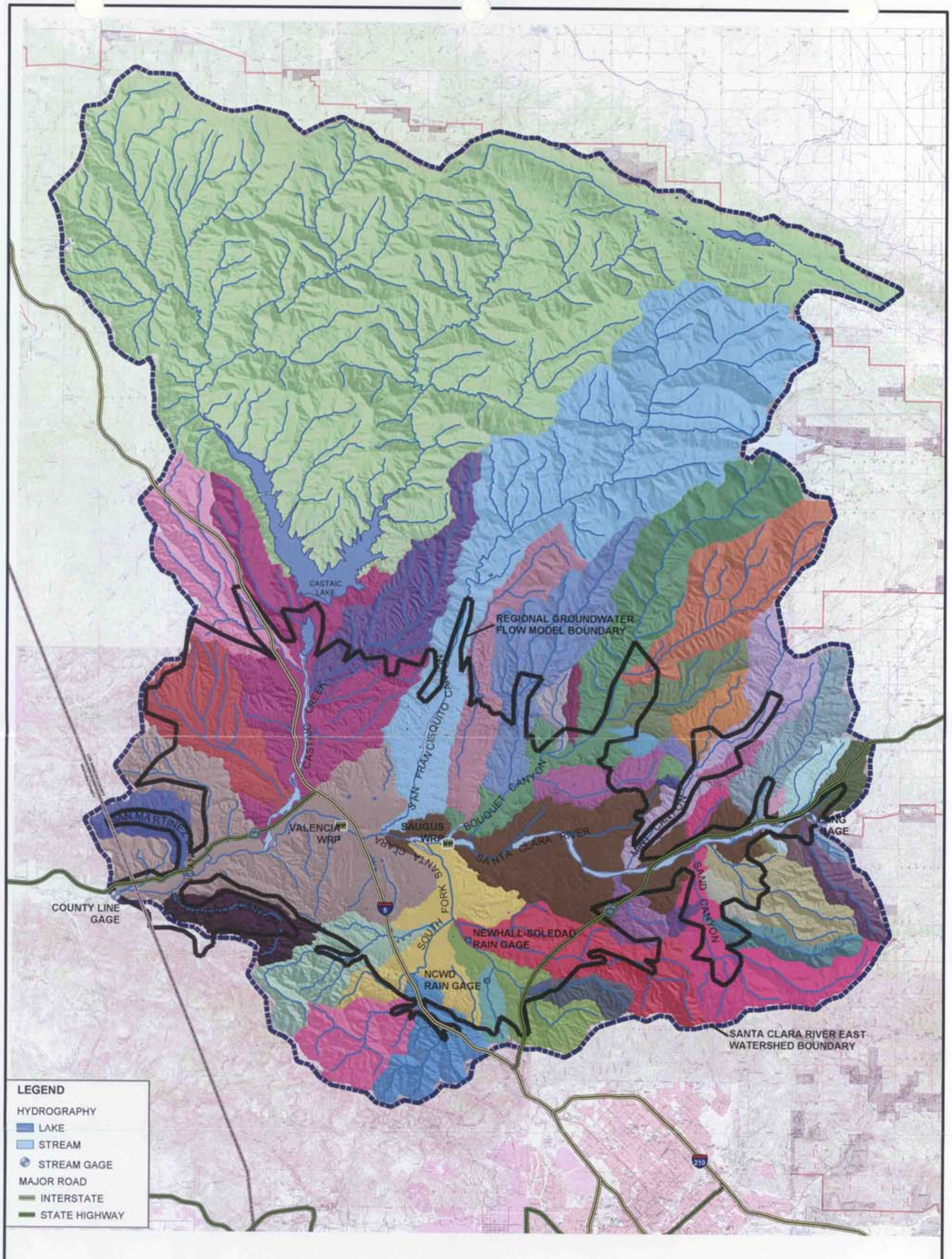


FIGURE C-6
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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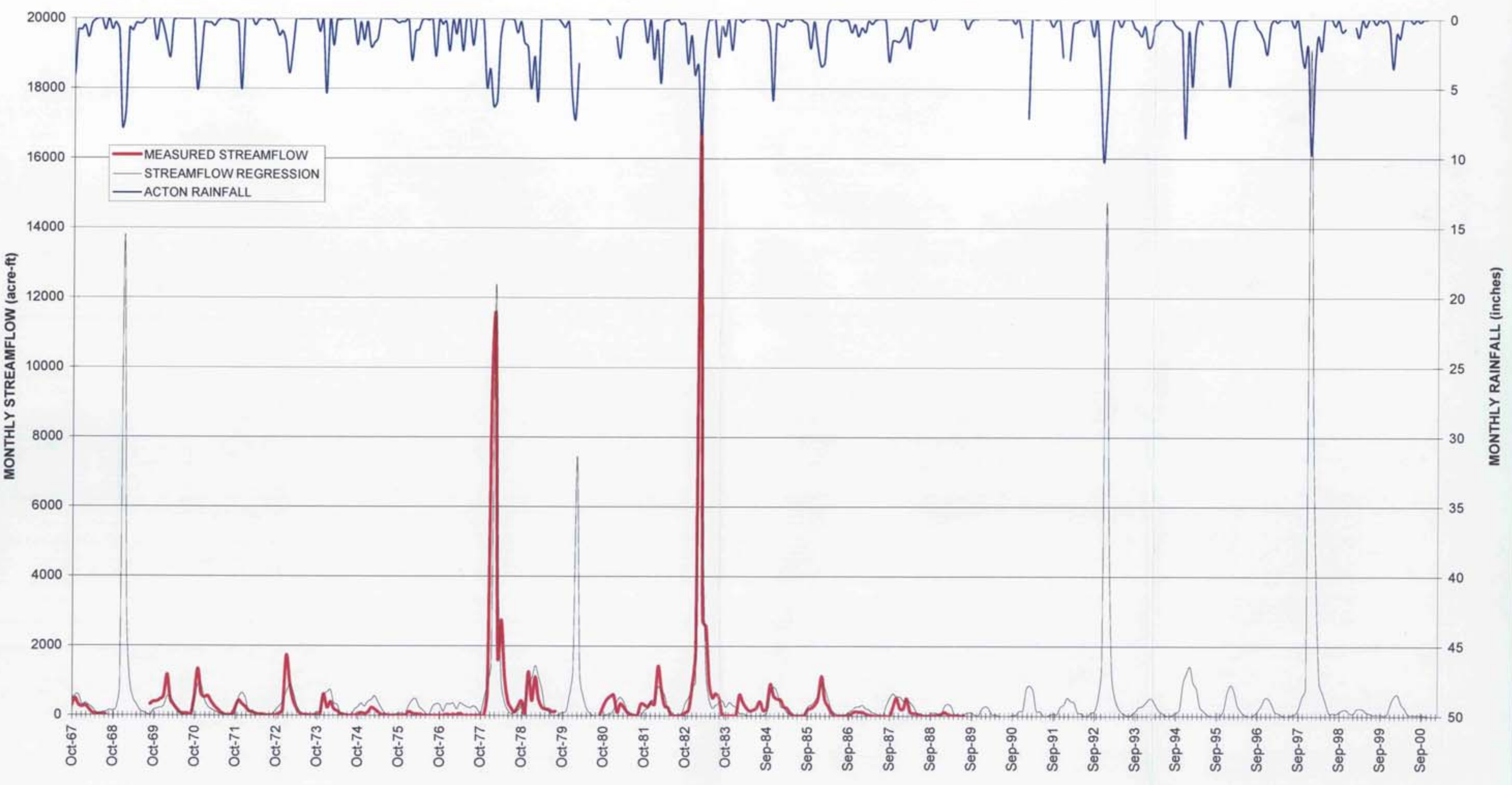
RDD \\RDD31002540555SANTACLARITA_MOU\FIGURES\MXD\FIGC-06.MXD FIGC-06.PDF 01/22/2004 08:19:58

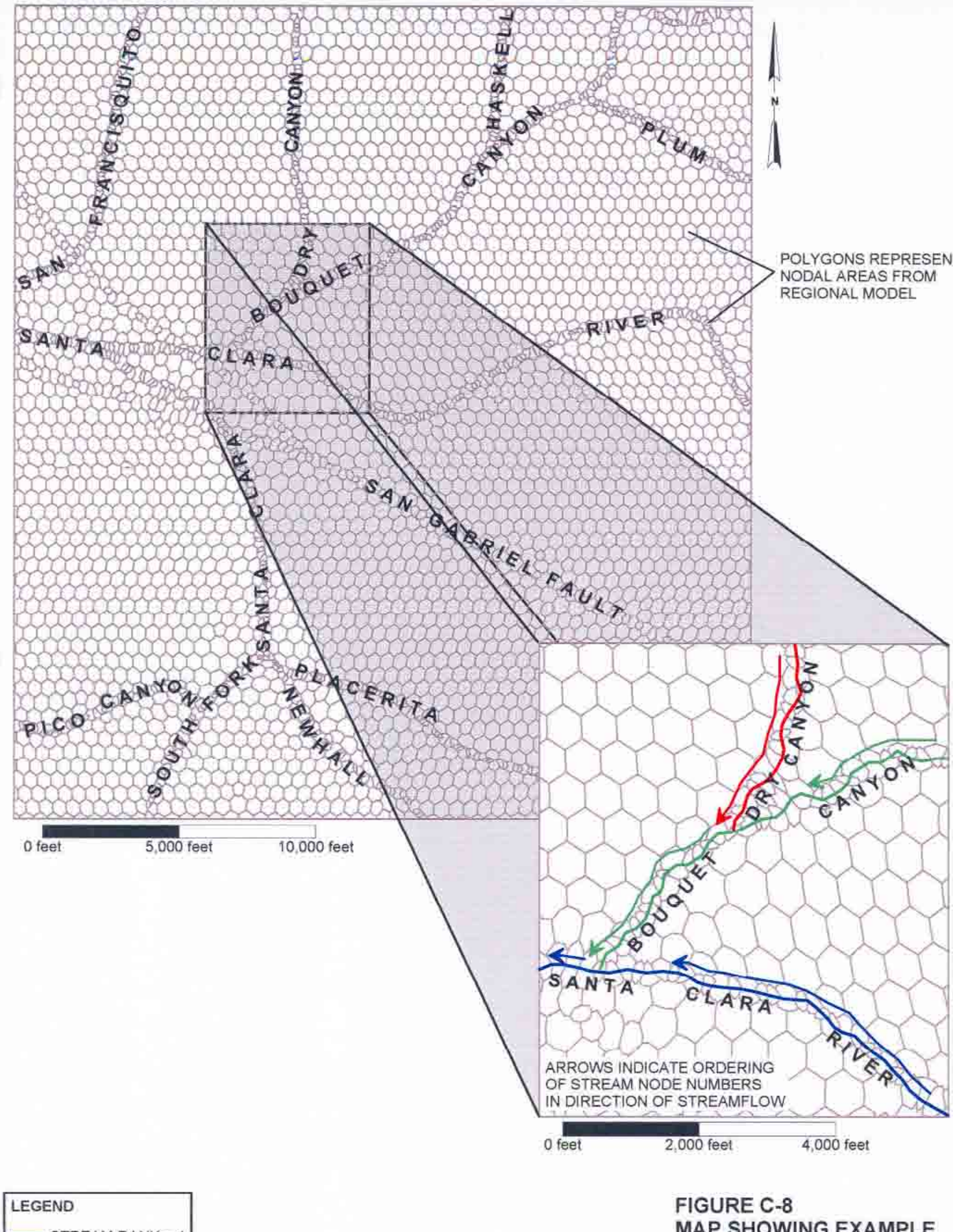


REGRESSION EQUATION:
MONTHLY STREAMFLOW AT LANG = 90.00*1 mo + 120.00*2 mo + 100.00*3 mo + 20.00*4 mo + 20.00*5 mo + 2.00*6 mo

FIGURE C-7
SANTA CLARA RIVER STREAMFLOW REGRESSION

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



ARROWS INDICATE ORDERING OF STREAM NODE NUMBERS IN DIRECTION OF STREAMFLOW

LEGEND

🟦	STREAM RANK = 1
🟩	STREAM RANK = 2
🟥	STREAM RANK = 3

FIGURE C-8
MAP SHOWING EXAMPLE OF STREAM RANKING

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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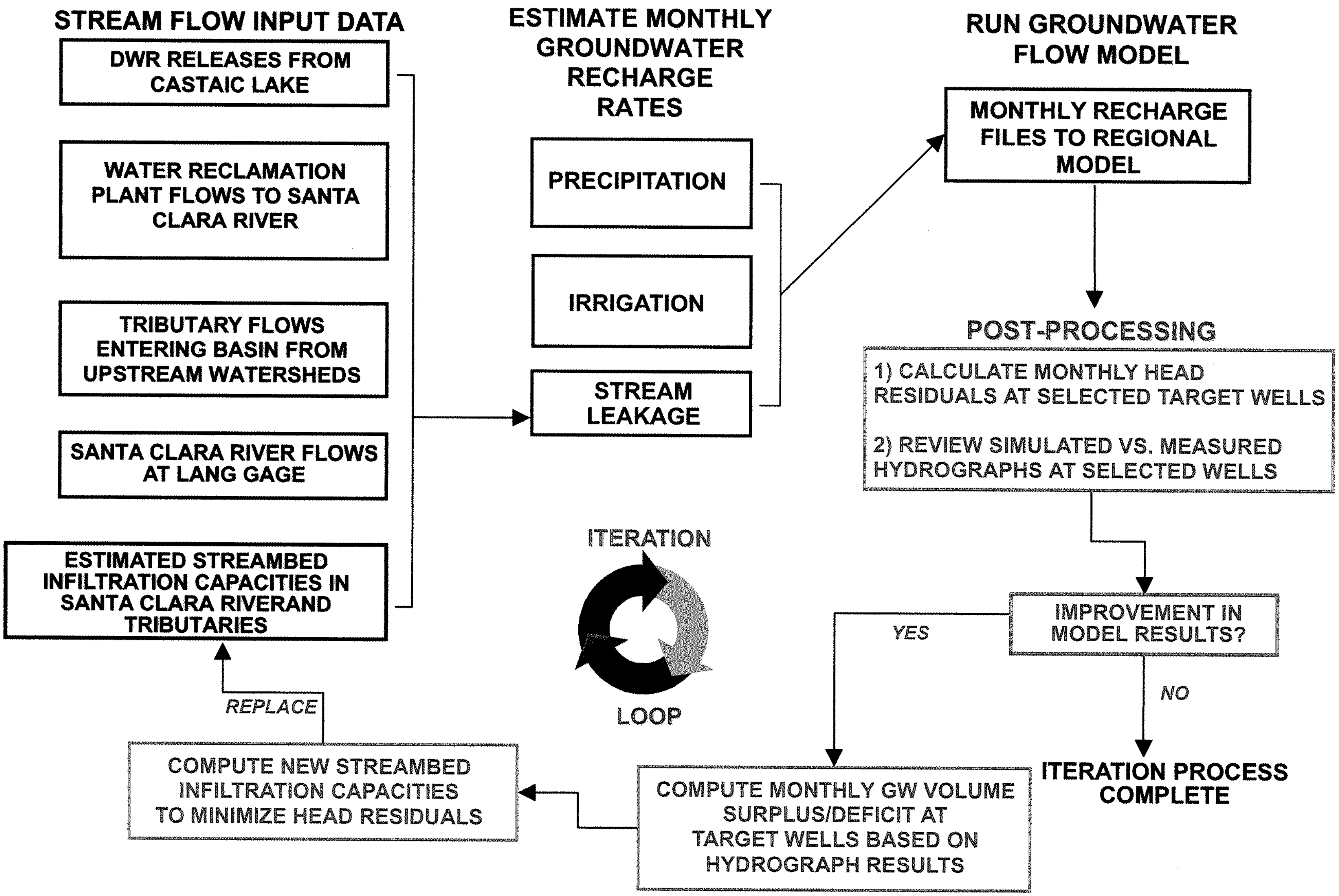

FIGURE C-9
FLOW CHART SHOWING ITERATIVE PROCESS USED TO VARY STREAMBED INFILTRATION CAPACITIES DURING MODEL CALIBRATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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