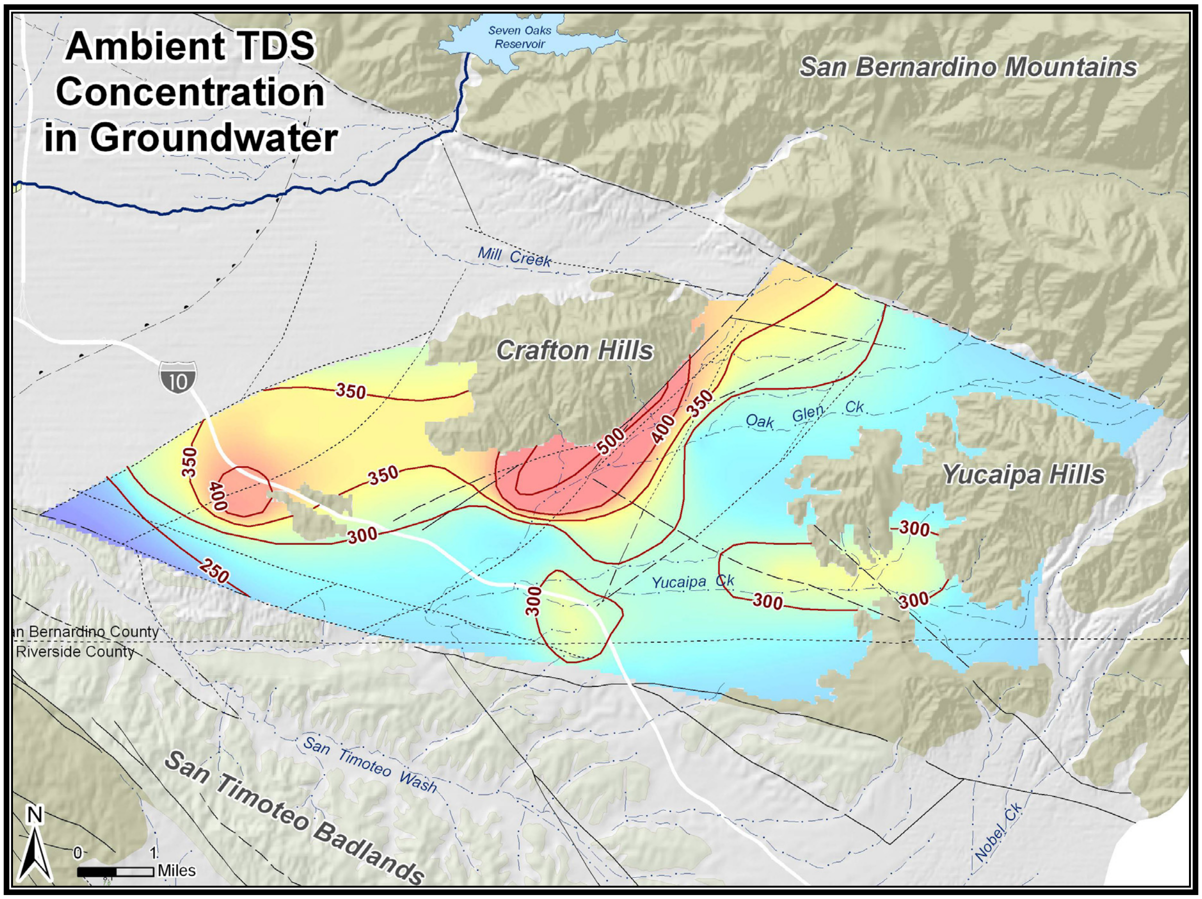
BASIN PLAN AMENDMENT
REQUIRED MONITORING AND ANALYSES

Recomputation of Ambient Water Quality in the Santa Ana River Watershed for the Period 1984 to 2003

Final Technical Memorandum



Prepared for

Basin Monitoring Program Task Force

Prepared by

Wildermuth Environmental, Inc.

November 2005

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ACRONYM AND ABBREVIATIONS LIST

BMPTF	Basin Monitoring Program Task Force
CBWCD	Chino Basin Water Conservation District
CBWM	Chino Basin Watermaster
CDFM	cumulative departure from the mean
DB	database
DHS	California Department of Health Services
EC	electrolytic conductivity
EDD	electronic data deliverable
EMWD	Eastern Municipal Water District
EPA	US Environmental Protection Agency
EVMWD	Elsinore Valley Municipal Water District
FORTRAN	FORmula TRANslator
GIS	Geographic Information System
IEUA	Inland Empire Utilities Agency
JCSD	Jurupa Community Services District
meq/L	milliequivalents per liter
MS	Microsoft
MSL	mean sea level
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
POTW	Publicly-Owned Treatment Works
QA	quality assurance
QA/QC	quality assurance/quality control
QC	Quality Control
RDBMS	Relational Database Management System
RWQCB	Regional Water Quality Control Board
SAWPA	Santa Ana Watershed Project Authority
SBVMWD	San Bernardino Valley Municipal Water District
SBVWCD	San Bernardino Valley Water Conservation District
STWMA	San Timoteo Watershed Management Authority
TDS	total dissolved solids
TIN	total inorganic nitrogen
TIN/TDS	total inorganic nitrogen/total dissolved solids

ACRONYM AND ABBREVIATIONS LIST

US	United States of America
US EPA	US Environmental Protection Agency
USGS	US Geological Survey
WEI	Wildermuth Environmental Inc
WMWD	Western Municipal Water District
WQ/WL	water quality/water level
YVWD	Yucaipa Valley Water District

1. Introduction

In 1995, a Task Force was formed to provide oversight, supervision, and approval of a study to evaluate the impact of Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) on water resources in the Santa Ana Watershed. Members of the TIN/TDS Task Force included:

- Chino Basin Water Conservation District (CBWCD)
- Chino Basin Watermaster (CBWM)
- City of Colton
- City of Corona
- City of Redlands
- City of Rialto
- City of Riverside
- City of San Bernardino
- Eastern Municipal Water District (EMWD)
- Elsinore Valley Municipal Water District (EVMWD)
- Inland Empire Utilities Agency (IEUA)
- Jurupa Community Services District (JCSD)
- Orange County Sanitation District (OCSD)
- Orange County Water District (OCWD)
- Regional Water Quality Control Board, Santa Ana Region (RWQCB) – Advisory Member
- Riverside-Highland Water Company
- San Bernardino Valley Municipal Water District (SBVMWD)
- San Bernardino Valley Water Conservation District (SBVWCD)
- San Timoteo Watershed Management Authority (STWMA)
- Santa Ana Watershed Project Authority (SAWPA) – Task Force Administrator
- US Geological Survey (USGS) – Advisory Member
- West San Bernardino County Water District
- Yucaipa Valley Water District (YVWD)

Wildermuth Environmental, Inc. (WEI) was retained by the TIN/TDS Task Force, through a contract administered by SAWPA, to conduct Phase 2A of the TIN/TDS Study (Task Order 1998-W020-1616-03). Phase 2A was comprised of the following tasks:

- Task 1: Develop Surface Water Translator for Meeting Groundwater Objectives that Accounts for Nitrogen Losses During Percolation
- Task 2: Develop New Compliance Metric and Monitoring Plan to Replace Current August-Only Below Prado Metric
- Task 3: Develop Updated Boundary Maps for Groundwater Subbasins and New Management Zones
- Task 4: Estimate Regional TDS and Nitrogen Concentrations in Groundwater

- Task 5: Compute TDS and Nitrogen Objectives for New Groundwater Basins and Management Areas

These tasks were completed in July of 2000, and were documented in the TIN/TDS Study – Phase 2A Final Technical Memorandum (WEI, 2000a). The groundwater management zones delineated in this study, with subsequent revisions, were adopted in the January 22, 2004 Basin Plan amendment (see Figures 1-1, 1-2, 1-3b, 1-4 and 1-5), and replaced the groundwater sub-basins of the 1995 Basin Plan.

Table 1-1 and 1-2 display the ambient water quality estimates (for TDS and nitrate-nitrogen) for groundwater management zones that were generated during the Phase 2A study for the periods 1954-1973 and 1978-1997. The ambient water quality estimates from the "historical" period (1954-1973) were used as the basis for the new water quality objectives in the 2004 Basin Plan amendment. The ambient water quality estimates from the "current" period (1978-1997) were used to assess compliance with the new water quality objectives, and to determine the magnitude of assimilative capacity, if it exists, within individual management zones.

If the current quality of a management zone is the same as or poorer than the water quality objectives, then that management zone does not have assimilative capacity. If the current quality is better than the water quality objectives, then that management zone has assimilative capacity. In the later case, the difference between the objective and current quality is the amount of assimilative capacity available.

Note in Tables 1-1 and 1-2 that a number of the water quality objectives have been raised to create assimilative capacity and, thus, encourage reclamation and the maximum beneficial use of State waters. These so-called "maximum benefit" water quality objectives for management zones are contingent on the implementation of certain projects and programs by specific dischargers as part of their maximum benefit demonstrations. Also note that the Chino Basin management zones, as delineated in the TIN/TDS Study – Phase 2A Final Technical Memorandum (with revisions), have been revised again to accompany the maximum benefit water quality objectives (see Figure 1-3a).

As part of the agreement to adopt the 2004 Basin Plan amendment, the affected parties have agreed to recompute ambient water quality for individual management zones every three years. The determination of current ambient quality shall be accomplished using methodology consistent with that employed by the TIN/TDS Task Force (20-year running averages) to develop the TDS and nitrate water quality objectives included in the 2004 Basin Plan.

Specifically, the 2004 Basin Plan states:

> No later than (*6 months from effective date of this Basin Plan amendment*), Orange County Water District, Irvine Ranch Water District, Inland Empire Utilities Agency, Chino Basin Watermaster, City of Riverside, City of Corona, Elsinore Valley Municipal Water District, Eastern Municipal Water District, City of Colton, City of San Bernardino Municipal Water Department, City of Redlands, Jurupa Community Services District, Western Riverside County Regional Wastewater Authority , Lee Lake Water District, Yucaipa Valley Water District, City of Beaumont, the San Timoteo Watershed Management Authority and the City of Rialto shall submit to the Regional Board for approval, a proposed watershed-wide TDS and nitrogen monitoring program that will provide data necessary to review and update the TDS/nitrogen management plan. Data to be collected and analyzed shall address, at a minimum: (1) determination of current ambient quality in groundwater management zones; (2) determination of compliance with TDS and nitrate-nitrogen objectives for the management zones; (3) evaluation of assimilative capacity findings for groundwater management zones; and (4) assessment of the effects of recharge of surface water POTW discharges on the quality of affected groundwater management zones. The determination of current ambient quality shall be accomplished using methodology consistent with that employed by the Nitrogen/TDS Task Force (20-year running averages) to develop the TDS and nitrogen water

> quality objectives included in this Basin Plan. [Ref. 1] The determination of current ambient groundwater quality throughout the watershed must be reported by July 1, 2005, and, at a minimum, every three years thereafter.

The agencies reference in the Basin Plan (above) formed the Basin Monitoring Program Task Force (BMPTF) to supervise and oversee the recomputation of ambient water quality, among other related tasks. The first episode of recomputation of ambient water quality is for the period 1984-2003 (to be reported by July 1, 2005). WEI was retained by the BMPTF to perform the recomputation beginning on July 1, 2004.

In August 2005, a draft technical memorandum was submitted to the BMPTF, the RWQCB, other affected public agencies and interested parties for comment. These comments were addressed with text revisions where appropriate, and responses to the comments were composed and compiled as an appendix.

This final technical memorandum describes in detail the specific tasks involved, and the results derived from, the recomputation of ambient water quality for all groundwater management zones listed in Tables 1-1 and 1-2 for the period 1984 to 2003.

Table 1-1
TIN/TDS Phase 2A Results for TDS

Groundwater Basin	Management Zone	TDS			
		Water Quality Objective *(mg/L)*	**Historical Ambient[1]** *(mg/L)*	**Current Ambient[2]** *(mg/L)*	**Assimilative Capacity** *(mg/L)*
San Bernardino Valley & Yucaipa/Beaumont Plains					
	Beaumont -- "max benefit"[3]	330	233	290	40
	Beaumont -- "antideg"	230	233	290	
	Bunker Hill-A	310	313	350	
	Bunker Hill-B	330	332	260	70
	Lytle	260	264	240	20
	San Timoteo -- "max benefit"	400	303	300	100
	San Timoteo -- "antideg"	300	303	300	
	Yucaipa -- "max benefit"	370	319	330	40
	Yucaipa -- "antideg"	320	319	330	
San Jacinto Basins					
	Canyon	230	234	220	10
	Hemet-South	730	732	1030	
	Lakeview/Hemet-North	520	519	830	
	Menifee	1020	1021	3360	
	Perris-North	570	568	750	
	Perris-South	1260	1258	3190	
	San Jacinto-Lower	520	520	730	
	San Jacinto-Upper	320	321	370	
Chino, Rialto/Colton, & Riverside Basins					
	Chino-North -- "max benefit"	420	260	300	120
	Chino 1 -- "antideg"	280	280	310	
	Chino 2 -- "antideg"	250	250	300	
	Chino 3 -- "antideg"	260	260	280	
	Chino-East	730	733	760	
	Chino-South	680	676	720	
	Colton	410	407	430	
	Cucamonga -- "max benefit"	380	212	260	120
	Cucamonga -- "antideg"	210	212	260	
	Rialto	230	230	230	
	Riverside-A	560	560	440	120
	Riverside-B	290	289	320	
	Riverside-C	680	684	760	
	Riverside-D	810	812	?	
	Riverside-E	720	721	720	
	Riverside-F	660	665	580	80
	Prado Basin	surface water objective applies	618	819	surface water objective applies
Elsinore/Temescal Valleys					
	Arlington	980	983	?	
	Bedford	?	?	?	
	Coldwater	380	381	380	
	Elsinore	480	476	480	
	Lee Lake	?	?	?	
	Temescal	770	771	780	
	Warm Springs Valley	?	?	?	
Orange County Basins					
	Irvine	910	908	910	
	La Habra	?	?	?	
	Orange County[4]	580	585	560	
	Santiago	?	?	?	

? = Not enough data to estimate TDS concentrations; management zone is presumed to have no assimilative capacity. If assimilative capacity is demonstrated by an existing or proposed discharger, that discharge would be regulated accordingly.

[1] Data sampling period was 20 years (1954-1973) for historical ambient water quality computations.

[2] Data sampling period was 20 years (1978-1997) for current ambient water quality computations.

[3] Assimilative capacity created by "maximum benefit" objectives is allocated solely to agency(ies) responsible for "maximum benefit" implementation.

[4] For the purposes of regulating discharges other than those associated with projects implemented within the Orange County Management Zone to facilitate remediation projects and/or to address legacy contamination, no assimilative capacity is assumed to exist.

For detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (July, 2000).

This table reflects all revisions requested and approved by the TIN/TDS Task Force since original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).

Table 1-2
TIN/TDS Phase 2A Results for Nitrate-N

Groundwater Basin	Management Zone	Nitrate-Nitrogen (NO_3-N) Water Quality Objective *(mg/L)*	Historical Ambient[1] *(mg/L)*	Current Ambient[2] *(mg/L)*	Assimilative Capacity *(mg/L)*
San Bernardino Valley & Yucaipa/Beaumont Plains					
	Beaumont -- "max benefit"[3]	5.0	1.5	2.6	2.4
	Beaumont -- "antideg"	1.5	1.5	2.6	
	Bunker Hill-A	2.7	2.7	4.5	
	Bunker Hill-B	7.3	7.3	5.5	1.8
	Lytle	1.5	1.5	2.8	
	San Timoteo -- "max benefit"	5.0	2.7	2.9	2.1
	San Timoteo -- "antideg"	2.7	2.7	2.9	
	Yucaipa -- "max benefit"	5.0	4.2	5.2	
	Yucaipa -- "antideg"	4.2	4.2	5.2	
San Jacinto Basins					
	Canyon	2.5	2.5	1.6	0.9
	Hemet-South	4.1	4.1	5.2	
	Lakeview/Hemet-North	1.8	1.8	2.7	
	Menifee	2.8	2.8	5.4	
	Perris-North	5.2	5.2	4.7	0.5
	Perris-South	2.5	2.5	4.9	
	San Jacinto-Lower	1.0	1.0	1.9	
	San Jacinto-Upper	1.4	1.4	1.9	
Chino, Rialto/Colton, & Riverside Basins					
	Chino-North -- "max benefit"	5.0	3.7	7.4	
	Chino 1 -- "antideg"	5.0	5.0	8.4	
	Chino 2 -- "antideg"	2.9	2.9	7.2	
	Chino 3 -- "antideg"	3.5	3.5	6.3	
	Chino-East	10.0	13.3	29.1	
	Chino-South	4.2	4.2	8.8	
	Colton	2.7	2.7	2.9	
	Cucamonga -- "max benefit"	5.0	2.4	4.4	0.6
	Cucamonga -- "antideg"	2.4	2.4	4.4	
	Rialto	2.0	2.0	2.7	
	Riverside-A	6.2	6.2	4.4	1.8
	Riverside-B	7.6	7.6	8.0	
	Riverside-C	8.3	8.3	15.5	
	Riverside-D	10.0	19.5	?	
	Riverside-E	10.0	13.3	14.8	
	Riverside-F	9.5	12.1	9.5	
	Prado Basin	surface water objective applies	4.3	22.0	surface water objective applies
Elsinore/Temescal Valleys					
	Arlington	10.0	25.5	?	
	Bedford	?	?	?	
	Coldwater	1.5	1.5	2.6	
	Elsinore	1.0	1.0	2.6	
	Lee Lake	?	?	?	
	Temescal	10.0	11.8	13.2	
	Warm Springs Valley	?	?	?	
Orange County Basins					
	Irvine	5.9	5.9	7.4	
	La Habra	?	?	?	
	Orange County	3.4	3.4	3.4	
	Santiago	?	?	?	

? = Not enough data to estimate nitrate-nitrogen concentrations; management zone is presumed to have no assimilative capacity. If assimilative capacity is demonstrated by an existing or proposed discharger, that discharge would be regulated accordingly.

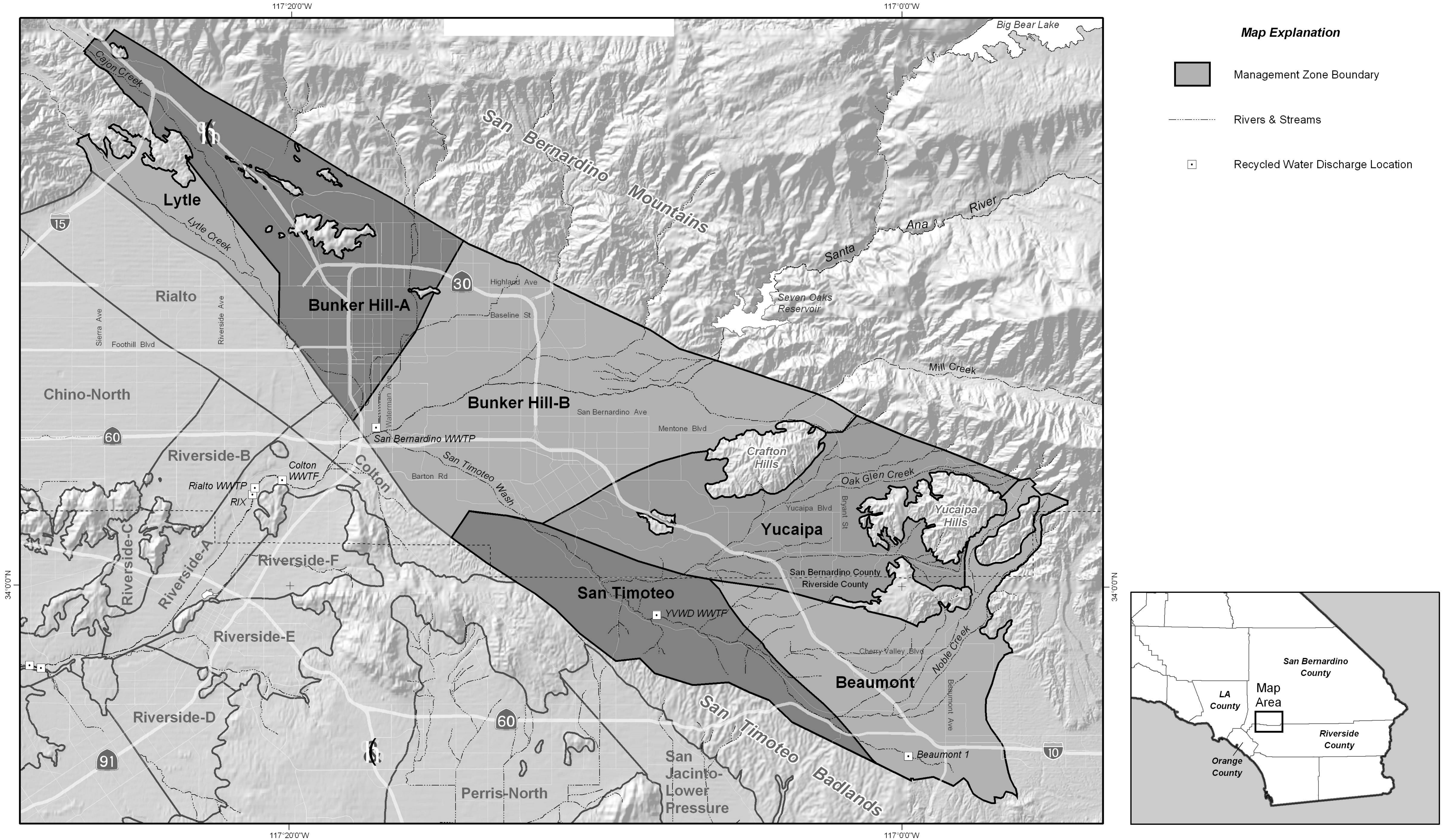
[1] Data sampling period was 20 years (1954-1973) for historical ambient water quality computations.

[2] Data sampling period was 20 years (1978-1997) for current ambient water quality computations.

[3] Assimilative capacity created by "maximum benefit" objectives is allocated solely to agency(ies) responsible for "maximum benefit" implementation.

For detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (July, 2000).

This table reflects all revisions requested and approved by the TIN/TDS Task Force since original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).



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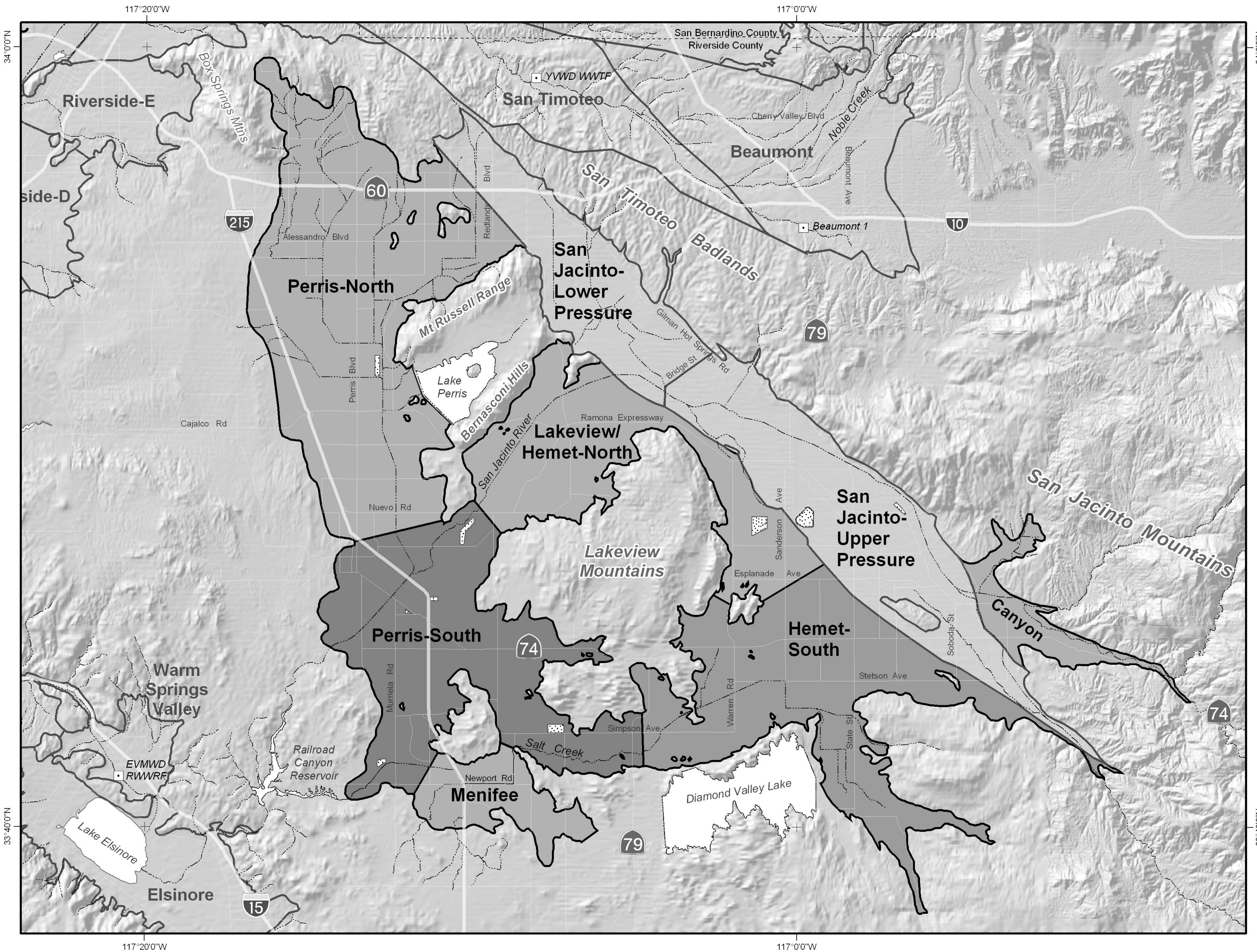
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Management Zone Boundaries

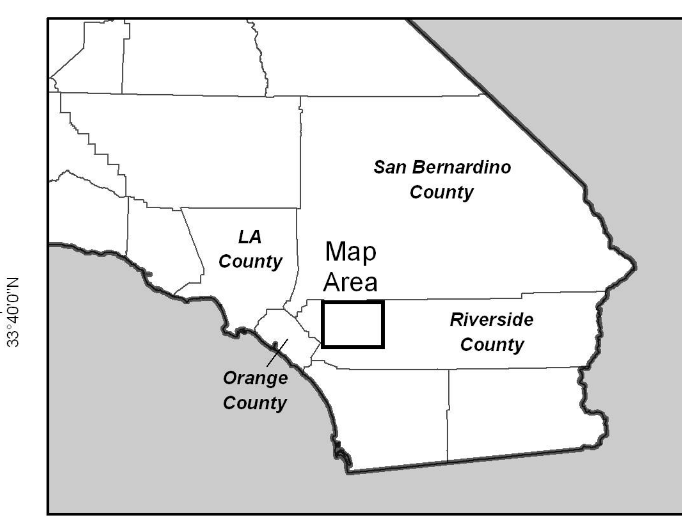
San Bernardino Valley & Yucaipa/Beaumont Plains

Figure 1-1



Map Explanation

- Management Zone Boundary
- Rivers & Streams
- Recycled Water Discharge Location
- Recycled Water Pond



0 1 2 3 4 5 6 Miles

0 2 4 6 8 10 KM

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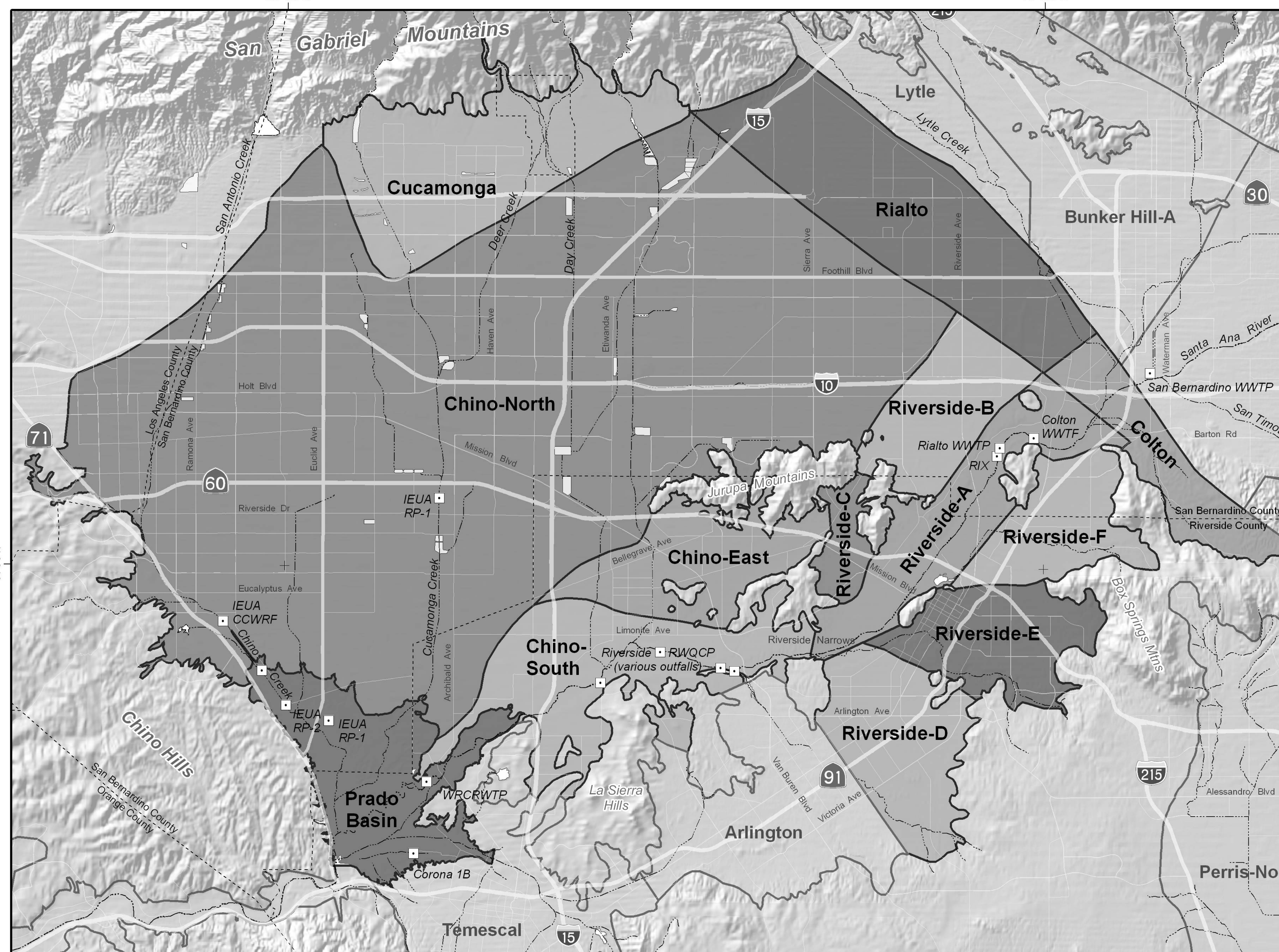
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Management Zone Boundaries

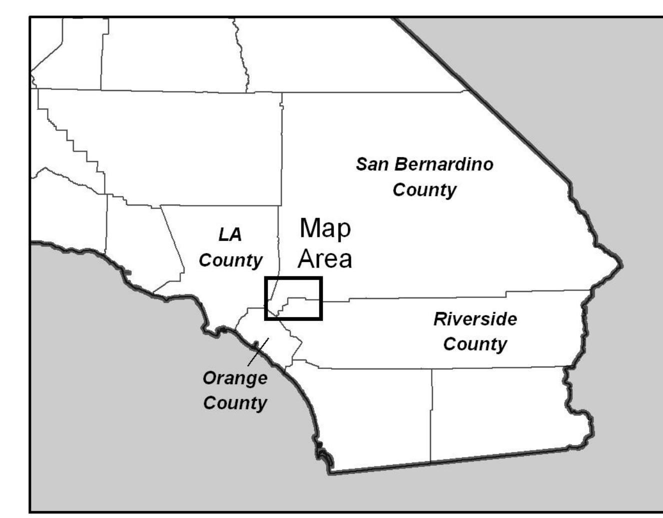
San Jacinto Basins

Figure 1-2



Map Explanation

- Management Zone Boundary
- Rivers & Streams
- Recycled Water Discharge Location



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0 1 2 3 4 5 6 *Miles*
0 2 4 6 8 10 *KM*

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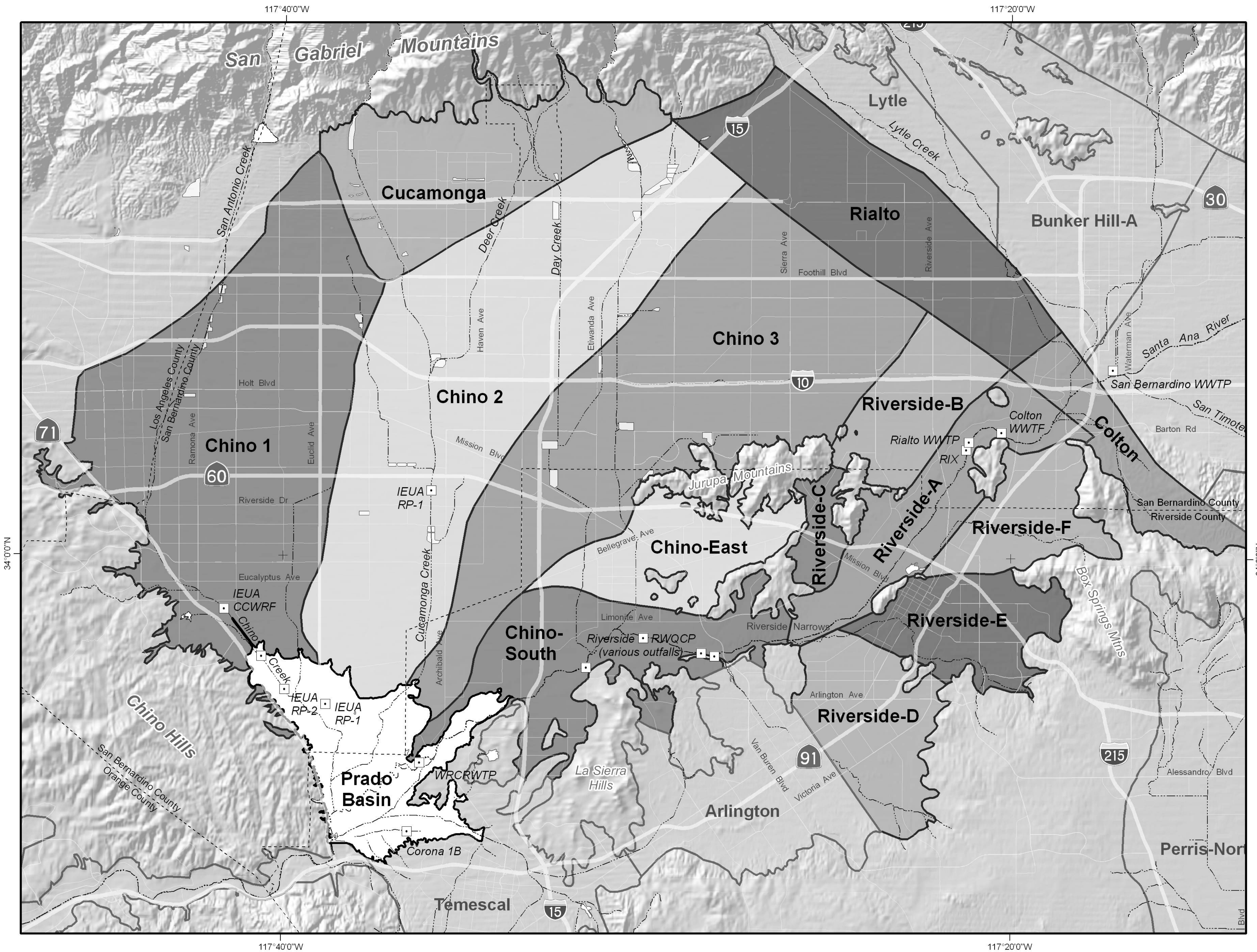
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Management Zone Boundaries
Chino (Maximum Benefit), Rialto-Colton, & Riverside Basins

Figure 1-3a

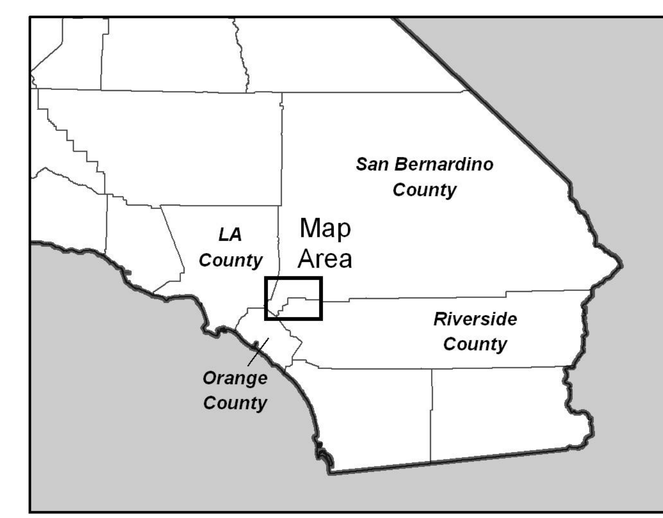


Map Explanation

Management Zone Boundary

Rivers & Streams

Recycled Water Discharge Location



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0 1 2 3 4 5 6 Miles
0 2 4 6 8 10 KM

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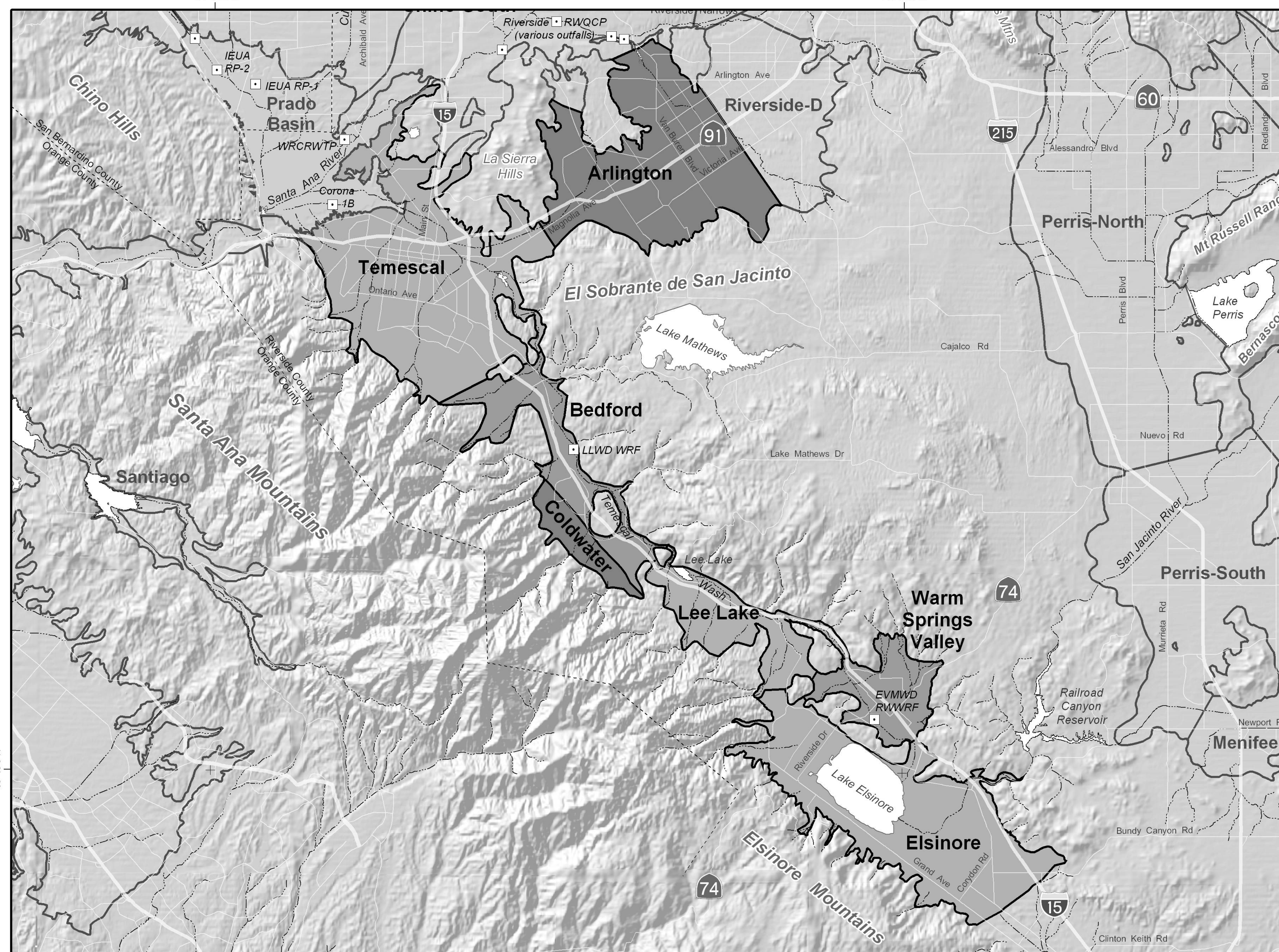
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Management Zone Boundaries

Chino (Anti-degradation), Rialto-Colton, & Riverside Basins

Figure 1-3b

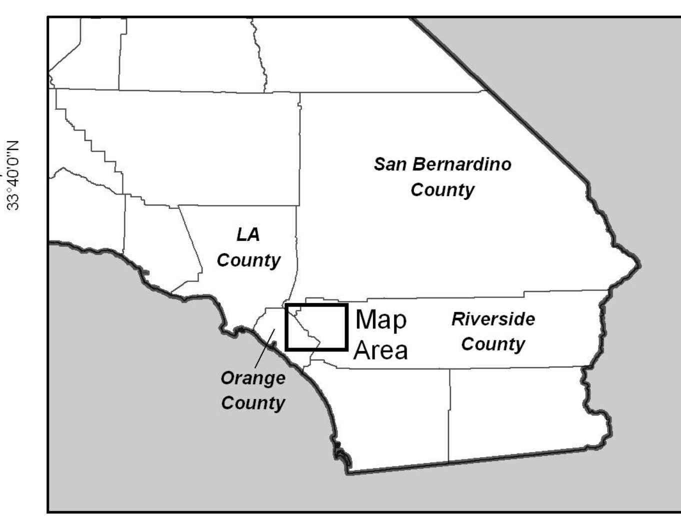


Map Explanation

Management Zone Boundary

Rivers & Streams

Recycled Water Discharge Location



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0 1 2 3 4 5 6 Miles
0 2 4 6 8 10 KM

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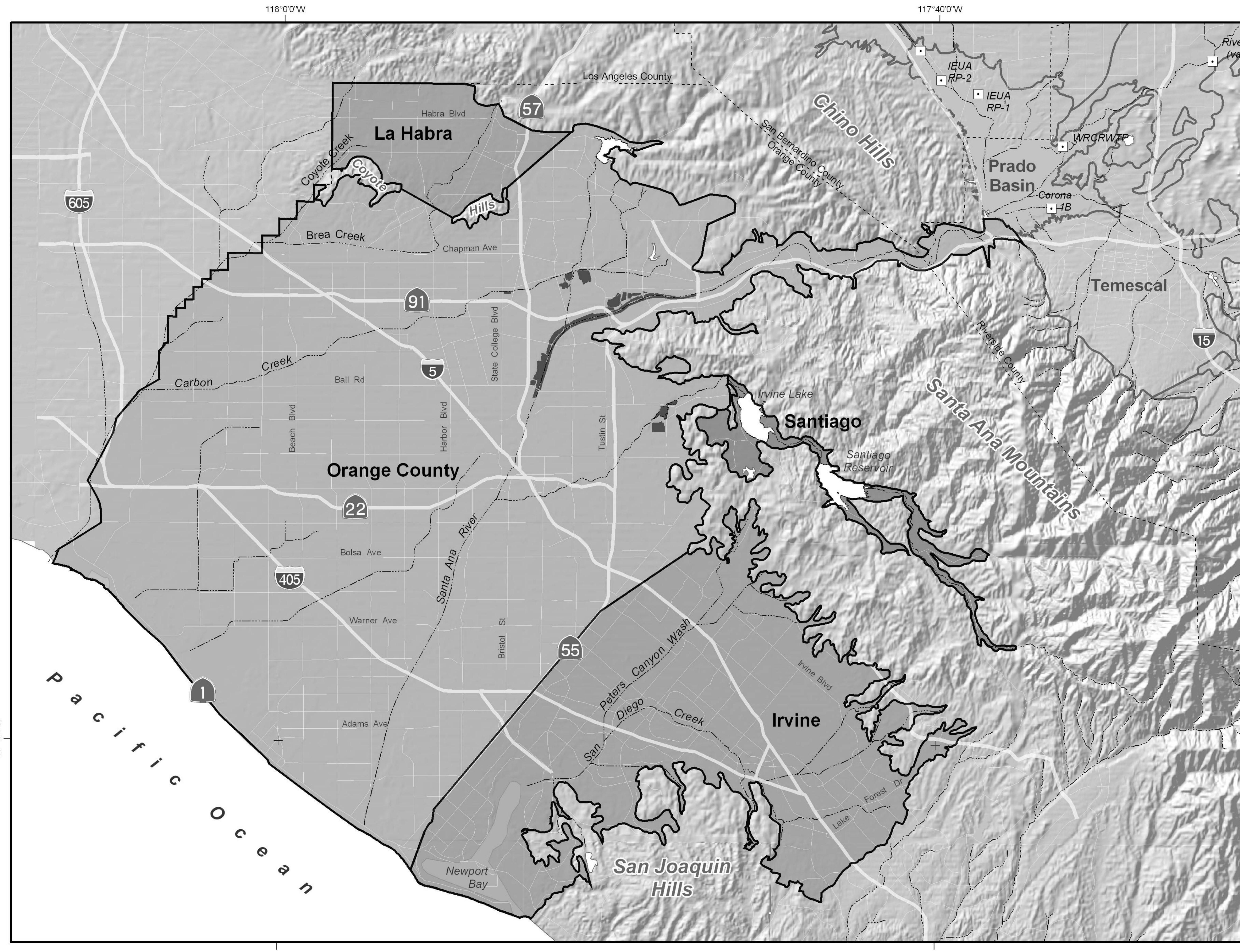
Recomputation of Ambient Water Quality for the Period 1984 to 2003

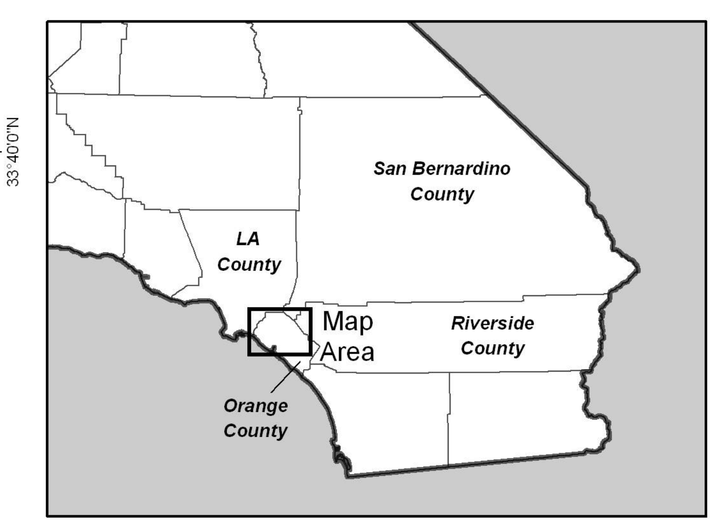
Management Zone Boundaries
Elsinore/Temescal Valleys

Figure 1-4



Map Explanation

- Management Zone Boundary
- Rivers & Streams
- Recycled Water Discharge Location
- Orange County Water District Forebay Recharge Facilities



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Scale: 0 1 2 3 4 5 6 Miles; 0 2 4 6 8 10 KM

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Recomputation of Ambient Water Quality for the Period 1984 to 2003

Management Zone Boundaries

Orange County Basins

Figure 1-5

2. METHODS TO RECOMPUTE AMBIENT WATER QUALITY

The database developed for the Phase 2A study (WEI, 2000b) contains all historical data through 1997. The most efficient way to process the data required to recompute ambient water quality for the period 1984-2003 was to load data from 1998 through 2003 into the existing Phase 2A database. First, well information, water quality data, and water level data were collected from each SAWPA agency and/or sub-agency that collects and stores such data. Once the data were processed, checked, and uploaded to the Phase 2A database, then the technical process of re-calculating ambient water quality across the watershed commenced. This process included:

- The development of water quality point statistics for TDS and nitrate at wells
- The estimation (mapping) of regional TDS and nitrate in groundwater across the watershed
- The computation of ambient TDS and nitrate-nitrogen for each management zone in the watershed

The following tasks describe in detail the process of recomputing ambient water quality for all management zones listed in Tables 1-1 and 1-2 for the period 1984 to 2003:

Task 1. Meet with Agencies/Develop Specific Protocols

In August 2004, the RWQCB sent request letters to the SAWPA agencies and sub-agencies (data providers) throughout the watershed asking for cooperation and participation in the recomputation of ambient water quality in the Santa Ana River watershed as required by the Basin Plan. Following the RWQCB letter, WEI staff contacted each of the notified agencies. A checklist of items was discussed and resolved with each agency's database (DB) manager or other water quality staff. This included, but was not limited to, the matching of agency wells to the wells in the Phase 2A database, and the matching of agency chemical parameter data to the chemical parameters in the Phase 2A database.

Initially, a simple map of all well sites for each agency was constructed, and the agency was asked to check the physical location of each well and to add those wells that were not shown on the map (those constructed after 1997). As new or revised information was received, the STATIONS table in the Phase 2A database was updated.

As to the water quality and water level data, a concerted effort was made to assure the collection of a complete data set from each agency. This requires elaboration: a data set is a collection of data about a specific topic. Data sets are organized in a database in tabular format with columns (called *fields*) and rows (called *records*). Each field contains the same type of information for all records. For example, in a data set of residential addresses, the *fields* would be street number, street name, city, state, and zip code. All the *fields* together form the residential address *record*. However, if only the street number and state *fields* were supplied, then the residential address record is meaningless. Because of this, data sets require a minimum number of *fields* to make a *record* meaningful. For the data collected during this effort, this set of *fields* is known as the "Minimum Required Data Fields" (US EPA, 1992), and these fields are shown in Table 2-1. The specific set of water quality analytes that was required and requested for this effort is listed in Table 2-2.

Task 2. Collect Historical Data (1998 to 2003)

Water quality data for the Phase 2A study were only collected through 1997. To complete the recomputation, data had to be collected from each agency through 2003. As site information was confirmed with each agency, water quality and water level data for the period 1998-2003 were also requested and/or collected. Where available, copies of each agency's database or electronic archives were collected (provided the minimum requirements were met).

For those agencies that did not have these data available digitally, hard copies of archived water quality lab reports were collected. In cases where data were unavailable from a particular agency, the data were collected from the State of California, Department of Health Services (DHS) database.

Table 2-3 summarizes the agencies contacted, the extent to which data were received, and the format in which the data were received.

Task 3. Process and Upload Historical Data

As stated in Task 2, the data received from the participating agencies in the watershed came in a variety of formats (hardcopy, custom spreadsheets, and database tables).

When data were received from an agency, the first task was to update the well site information in the database. The next step was to process the water quality and water level data into a normalized format for upload to the database:

- A limited number of the agencies provided data in database format, which required little or no re-formatting and/or normalization of the data before upload.
- Many of the agencies archive data in hard copy and/or customized spreadsheet files. For hard copy data, custom data-entry tools were developed to help ensure data accuracy by providing standardized drop-down lists which enforced valid values and formats. Then, using these data-entry tools, the hard copy lab reports and water level data were keypunched into a normalized, digital format. This approach significantly minimized data entry errors. About 50% of the keypunched hard copy data were checked manually against the original source.
- Data received in custom spreadsheets or text files typically required extensive re-formatting and normalization before the data could be uploaded into the database. These datasets were processed and normalized through variety of methods. Due to extent of processing required for electronic data sets, 100% of these data sets were manually checked for quality control.

The final step of quality control was a visual check of all processed data. In-house tools were used to plot processed data to MS Excel time history charts (see Appendix). The data collected during the TIN/TDS Phase 2A study were plotted on the same chart (but with different symbology) as the data that were collected for the current effort. If data anomalies were identified visually, then WEI staff went back to the original data source and verified the reported values. This method identified any data discrepancies that were introduced during the processing steps (such as incorrect well assignment or incorrect analyte/unit assignment).

Once the data successfully passed all QA/QC protocol measures, the data were appended through queries to the existing database that was developed for the TIN/TDS Phase 2A Study in 2000 (data thru 1997).

Task 4. Develop Queries to Extract WQ/WL Data for TDS/Nitrate-N

Database queries were developed and executed to extract the necessary water quality and water level data to perform the calculations of volume-averaged ambient concentrations. These queries were often developed in concert with the work performed in Tasks 5 and 6, such as the development of time history charts, the development of water quality statistics, and the creation of water level maps.

Task 5. Develop Water Quality Point Statistics for TDS/Nitrate-N

The following steps were executed to develop ambient water quality point statistics at wells for TDS and nitrate-nitrogen, and are identical to the methods used in WEI (2000a):

- *Reviewed TDS and nitrate-nitrogen time histories*. The TDS and nitrate-nitrogen time histories were developed for all wells used in the estimate of ambient water quality. Each time history includes a cumulative departure from the mean (CDFM) curve for rainfall. The CDFM curve is useful in characterizing the occurrence and magnitude of wet and dry climatic periods. Negatively sloping segments (trending down to the right) in CDFM curves indicate dry periods; and positively sloping segments (trending up to the right) indicate wet periods.
- *Defined data sampling periods*. For historical ambient water quality, the data sampling period was January 1, 1954 to December 31, 1973 (objective setting period). For current ambient water quality, the data sampling period is a 20-year period with the latest complete set of data. For the current recomputation of ambient water quality, this period was January 1, 1984 to December 31, 2003. Current ambient water quality will always be computed as a rolling 20-year average.
- *Conducted a series of data quality tests and rejected data*. These tests were based on the results of general mineral analyses, if the data were available. Any failed data quality test resulted in the rejection of the sample from the analysis. These tests are described in Standard Methods for the Examination of Water and Wastewater (Greenberg et al., 1992): 1030 F. Checking Correctness of Analyses:

  1. Anion-Cation Balance

$$\%\ difference = 100 \cdot \frac{\sum cations - \sum anions}{\sum cations + \sum anions}$$

  with the following acceptance criteria:

Anion Sum (milliequivalents per liter [meq/L])	Acceptable % Difference
0 – 3	±0.2 meq/L
3 – 10	±2%
10 - 800	±2-5%

  2. Measured TDS = Calculated TDS

$$1.0 < \frac{measured\ TDS}{calculated\ TDS} < 1.2$$

where:

calculated TDS = 0.6 (alkalinity) + Na + K + Ca + Mg + Cl + SO_4 + SiO_3 + NO_3 + F

3. Measured EC and Ion Sums

$$0.9 \cdot EC < 100 \cdot anion\ (or\ cation)\ sum,\ meq/L < 1.1 \cdot EC$$

4. TDS to EC Ratios

$$0.55 < \frac{measured\ TDS}{EC} < 0.7$$

and

$$0.55 < \frac{calculated\ TDS}{EC} < 0.7$$

{Note: If a well had nitrate-nitrogen or TDS data but did not have all of the prerequisite data to perform the above listed data quality tests, then the well passed to the next level of statistical tests for normality and outliers.}

- *Computed statistics.* Before performing the statistical tests for normality and outliers, the following statistics for each well for both TDS and nitrate-nitrogen were computed: mean and standard deviation.
- *Annualized data.* If a well had more than one observation of TDS or nitrate-nitrogen per calendar year, the values were averaged prior to computing the ambient water quality statistics. Only one value per year – the annual average – was used in the computation of ambient water quality.
- *Applied appropriate statistical tests for normality and outliers*. The assumption of the "mean + t*standard error of the mean" approach is that the data are normally distributed or that a transformation can approximate a normal distribution. The use of the Shapiro-Wilk test for both normality and outlier testing was recommended and adopted by the TIN/TDS Task Force at the June 15, 1999 meeting. Shapiro and Wilk (1965) developed a test for normality based on normal order statistics. In the Shapiro-Wilk test, a value for the variable, W, is calculated with the formula below. The calculated value of W is then compared with a critical W found in reference tables (*e.g.*, Gibbons, 1994).

$$W = \left(\sum_{i=1}^{n} a_{i,n} \cdot x_i\right)^2 \Big/ \sum_{i=1}^{n}\left(X_i - X_{avg}\right)^2$$

where: $a_{i,n}$ = coefficients based on the order of the observation, *i*, and the number of observations, *n*. (see for example, Gibbons [1994]).

X_i = i^{th} observation

X_{avg} = mean of *n* observations

- *Computed statistics*. Statistics for both TDS and nitrate-nitrogen were computed: standard error of the mean and mean plus t*standard error of the mean. **Mean plus t*standard error of the mean** is the statistic that was plotted on maps and used to define historical and current ambient water quality.

Task 6. Estimate Regional TDS/Nitrate-N in Groundwater

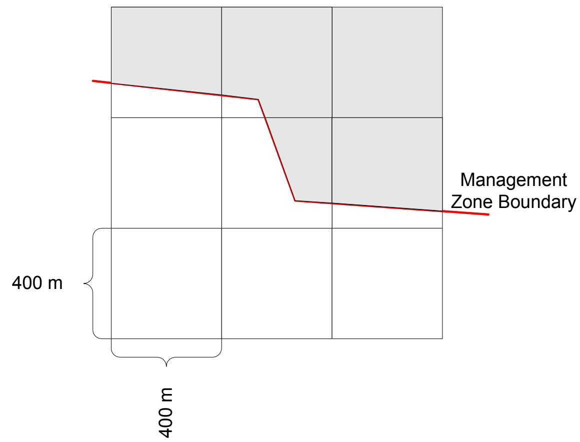
The following steps were executed to estimate regional TDS/Nitrate-N in groundwater (WEI, 2000a):

- *For both TDS and nitrate-nitrogen, mapped the location of wells where statistics were computed*. These locations were annotated with the computed statistic. In addition, wells with mean values (but where statistics could not be computed [*e.g.*, less than the required three annual data points]) also were plotted. For each management zone, the following maps were developed:
  - TDS statistic – current ambient (1984 to 2003)
  - Nitrate-Nitrogen statistic – current ambient (1984 to 2003)
- *Defined relative aquifer contributions.* For regions with multi-layered aquifers, well construction data were compared to the hydrostratigraphy developed in the Phase 2A study to identify which aquifers are tributary to each well. The water quality maps listed above were developed for each aquifer.
- *Developed and digitized contours of TDS and nitrate-nitrogen statistics*. The computed statistics for each period, each aquifer layer (if appropriate), and each water quality constituent were carefully hand-contoured and digitized, taking into account:
  - management zone boundaries;
  - ancillary water quality data (mean values). These ancillary water quality data were given less weight when contouring than wells with computed statistics. These ancillary data were mainly used to help guide contours in areas where there was a paucity of computed statistics.

Task 7. Compute Ambient TDS/Nitrate-N for Management Zones

The final steps in the development of ambient water quality determinations were to (1) develop a rectangular grid (*i.e.* GIS polygon layer) over every management zone in the watershed, (2) estimate the volume of groundwater in each grid cell and in each management zone, (3) estimate the mass of TDS and nitrate in each grid cell and in each management zone, and (4) compute the volume-weighted, ambient water quality in each management zone. If the management zone contains more than one aquifer, then the volume and mass terms were computed for each aquifer layer at each grid cell during steps (2) and (3). The specific steps are outlined below:

- *Developed fine rectangular grid*. The grid size is the same in each management zone and is fine enough so that the resulting ambient quality determinations are not significantly influenced by grid size. Numerical tests were done previously (WEI, 2000a) to determine the appropriate grid size. The grid cell size used in the Phase 2A study was 400x400 meters. This same grid cell dimension was used in this effort. Where a grid cell is split by a management zone boundary, that grid cell is assigned parameters based on the apportionment of the grid cell in each management zone (determined by area).



- *Computed volume of groundwater in storage in each grid cell*. Groundwater elevation contours for Fall 2003 were hand-drawn and digitized. The groundwater elevations for each grid cell were estimated by an automated gridding program that interpolates between contours. The volume of groundwater in a grid cell for a single-layer aquifer is operationally-defined as:

$$V_i = A_i * (WL_i - B_i) * SY$$

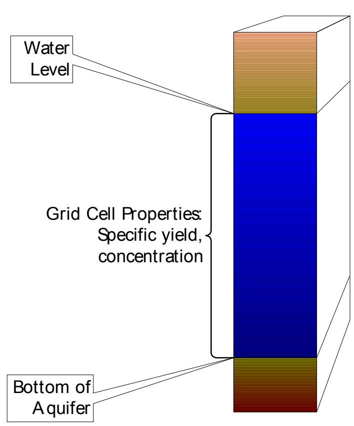
where V_i = volume of groundwater in i^{th} grid cell

A_i = grid cell area (160,000 square meters for a square grid cell)

WL_i = average elevation of groundwater in i^{th} grid cell (feet above mean sea level [MSL])

B_i = average elevation of the effective base of aquifer in i^{th} grid cell (feet above MSL)

SY = specific yield



GIS layers of specific yield were previously developed to estimate specific yield at each grid cell. The use of specific yield (as opposed to porosity) causes the computed volume of groundwater to represent the volume that can be pumped, not the actual amount of water in storage.

- *Computed volume of groundwater in storage in each layer of a multi-layer aquifer*. Groundwater in storage for each layer in a multi-layer aquifer was computed in exactly the same fashion as in a single-layer aquifer. However, the top of a confined aquifer was used to calculate the water in storage if the groundwater level was above the top of the aquifer. The volume of groundwater in storage in each grid cell was the sum of the volume in each aquifer layer.
- *Computed volume of groundwater in a management zone*. Total volume of groundwater within a management zone was calculated by summing the volume of groundwater in all grid cells within the management zone.
- *Estimated value of the water quality statistic for each grid cell*. The values of the TDS and nitrate-nitrogen statistic for each grid cell were estimated by an automated gridding program that interpolates between contours of the statistics.
- *Compute volume-weighted statistic for each aquifer in each management zone*. The ambient water quality (C_{avg}) was calculated using the following formula:

$$C_{avg} = \left(1/V_T \right) \cdot \sum C_i \cdot V_i$$

where: C_{avg} is the ambient concentration of TDS or nitrate in a management zone
V_T is the total volume of groundwater within a management zone
C_i is the concentration in grid cell i
V_i is the volume of water stored in grid cell i and with concentration C_i

The methodology described above was the template used to compute ambient concentrations of TDS and nitrate for management zones. In some instances, the methodology was modified to accommodate the available data. The following is a list of details related to the computation of ambient concentrations for management zones:

- For the Orange County groundwater basin, the shallow and principal (middle) aquifers were used in the recomputation of ambient water quality. The deep aquifer was not used because relatively few wells produce from this aquifer, water quality data are sparse and, hence, ambient water quality could not be characterized.
- For the Bunker Hill groundwater basin, the shallow and middle aquifers within the so-called Pressure Zone were used in the recomputation of ambient water quality. The deep aquifer was not used because relatively few wells produce from this aquifer, water quality data are sparse and, hence, ambient water quality could not be characterized.
- For the Chino groundwater basin, the shallow, middle, and deep aquifers were used in the recomputation of ambient water quality within Chino-1, Chino-2, and Chino-3 management zones. The confining units that separate the aquifers in Chino-1, Chino-2, and Chino-3 become thin or "pinch out" within the Chino-East and Chino-South management zones and, hence, Chino-East and Chino-South were treated as single-aquifer systems in the recomputation of ambient water quality.

- OCWD provided groundwater elevation contour maps for the principal (middle) aquifer. However, estimates of groundwater levels in the shallow aquifer were necessary to calculate regional water quality in the shallow aquifer. OCWD staff and WEI agreed to estimate water levels in the shallow aquifer by using groundwater elevation contours of the principal aquifer in the forebay areas and using the top of shallow aquifer in the pressure areas (i.e. assuming complete saturation of the shallow aquifer in the pressure area).
- For the Orange County groundwater basin, OCWD provided aquifer geometry data from its current groundwater model. In some areas, the model boundary did not extend to the management zone boundaries. As a result, some grid cells did not contain aquifer geometry data and were not used to recompute ambient water quality. In most cases, these grid cells were located at the periphery of the basin where saturated aquifer thickness was small or non-existent.
- In some instances, where data were not sufficient, ambient concentrations were not computed for those management zones, which include the Warm Springs Valley, Lee Lake, Santiago, La Habra, Riverside-D, and San Timoteo management zones.

Task 8. Prepare Technical Memorandum

A draft technical memorandum summarizing the results of the recomputation of ambient water quality for the period 1984 to 2003 was composed in August 2005. The memorandum contained the pertinent text, tables, and maps that describe the recomputation methods and results. The draft technical memorandum was submitted to the SAWPA, BMPTF participants, the RWQCB, all other affected public agencies, and other interested parties for comment. These comments from all parties were addressed, with revisions, and the comments and responses are included as an appendix to this final technical memorandum.

Table 2-1
Minimum Required Data Fields

Table: STATIONS	
Field	**Description**
Station Name	Unique station name
Station Identifier	Unique station identifier
Agency	Agency or source of information
Owner	Owner name of the station
Station Type	Type of station
Physical Description	Physical description of the station
X,Y Location	Coordinate location of the station
Location Units of Measure	Units of location coordinates
Location Datum	Datum of location coordinates
Location Projection	Projection used for location coordinates
Ground Surface Elevation (wells only)	Value of ground surface elevation (GSE)
GS Elevation Method (wells only)	Method used to measure GSE
GS Elevation Units (wells only)	Units of GSE
GS Elevation Datum (wells only)	Datum of GSE
GS Elevation Measure Date (wells only)	Date GSE measured
Ground Surface to Reference Point (wells only)	Distance from GSE to reference point
Reference Point Description (wells only)	Description related to RPE
Perforated Interval (wells only)	"From" and "To" fields (depth in feet-bgs)

Table: GW_ELEVATIONS	
Field	**Description**
Station Identifier	Unique station identifier
Agency	Agency or source of information
Date Measured	Date measurement taken
Time Measured	Time measurement taken
Well Activity	Activity of the station at time of measurement
Well Activity Comments	Activity comments related to measurement
Reference Point Description	Description related to RPD
Reference Point to Ground Water Level	Distance from RPE to groundwater level
Qualifier	Value qualifier
Units of Measure	Units of groundwater level elevation

Table: ANALYSES	
Field	**Description**
Station Identifier	Unique station identifier
Date Sampled	Date sample taken
Time Sampled	Time sample taken
Chemical Name or Code	Name or code of constituent analyzed
Qualifier	Value qualifier for result
Result	Concentration or value of analysis
Units of Measure	Units of constituent concentration

Table 2-2
Analytes of Interest

Calcium
Magnesium
Sodium
Potassium
Bicarbonate
Carbonate
Sulfate
Chloride
Fluoride
Silica
Nitrate as NO3 or N
Total Alkalinity as CaCO3
Electrical Conductivity
Total Dissolved Solids

Table 2-3
Summary of Data Collection Effort by Agency

Agency/Subagency	Data Requested	Data Received	Format of Water Quality and Water Level Data
Banning, City of	X	X	Hardcopy
Beaumont-Cherry Valley Water District	X	X	Hardcopy
Chino Basin Watermaster	X	X	Database Tables
Chino Hills, City of	X	X	Hardcopy
Chino, City of	X	X	Hardcopy
Colton, City of	X	X	Hardcopy
Corona, City of	X	X	Hardcopy
Cucamonga Valley Water District	X	X	Spreadsheet
East Valley Water District	X	X	Hardcopy
Eastern Municipal Water District	X	X	Database Tables
Elsinore Valley Municipal Water District	X	X	Spreadsheet
Elsinore Water District	X	X	Hardcopy
Fontana Water Company	X	X	Spreadsheet/DHS[a]
Home Gardens County Water District		X	DHS
Inland Empire Utilities Agency	X	X	Spreadsheet
Jurupa Community Services District	X	X	Hardcopy
Lee Lake Water District	X	no data	--
Loma Linda, City of	X	X	Hardcopy
Marigold Mutual Water Company	X	X	Hardcopy
Meeks and Daly Water Company	X	X	Spreadsheet
Monte Vista Water District	X	X	Database Tables
Muscoy Mutual Water Company	X	X	Hardcopy[b]
Norco, City of	X	X	Hardcopy
Ontario, City of	X	X	Hardcopy
Orange County Water District	X	X	Database Tables
Pomona, City of	X	X	Database Tables
Redlands, City of	X	X	Spreadsheet
Rialto, City of	X	X	Hardcopy
Riverside, City of	X	X	Database Tables
Riverside-Highland Water Company	X	X	Hardcopy
San Antonio Water Company	X	X	Hardcopy
San Bernardino, County of (Landfill Monitoring)	X	X	Spreadsheets
San Bernardino Valley Municipal Water District	X	X	Database Tables[c]
San Bernardino Water Department	X	X	Database Tables
San Gorgonio Pass Water Agency	X	X	Text Files[d]
Santa Ana River Water Company	X	X	Hardcopy
South Mesa Water Company	X	X	Hardcopy
Southern California Water Company	X	X	Hardcopy
Upland, City of	X	X	Hardcopy and Spreadsheet
West Valley Water District	X	X	Hardcopy
Western Heights Water Company	X	X	Hardcopy
Western Municipal Water District	X	no data	--
Yucaipa Valley Water District	X	X	Database Tables

[a]DHS = from database of the State of California Department of Health Services

[b]Sent annual summaries, used DHS

[c]SBVMWD database contained information for other agencies wells; used to augment information received fromeach agency directly.

[d]Received USGS data for wells in their area

3. AMBIENT WATER QUALITY RESULTS FOR THE PERIOD 1984 TO 2003

This section summarizes the results of this ambient water quality recomputation, and provides some limited interpretation of the results and some recommendations for future recomputations.

3.1 Ambient Water Quality for TDS and Nitrate-N (1984-2003)

The results of the ambient water quality recomputations for TDS and nitrate-nitrogen for each management zone for the period 1984 to 2003 are presented in Tables 3-1 (TDS) and 3-2 (nitrate-nitrogen). Figures 3-1 and 3-2 show these same results as map graphics.

3.2 Assimilative Capacity for TDS and Nitrate-N (2003)

Also shown in Tables 3-1 and 3-2 are:

- The ambient water quality concentrations for TDS and nitrate-nitrogen for each management zone for a historical period (1954-1973) and a current period (1978-1997). These concentrations were derived during the TIN/TDS Phase 2A Study (WEI, 2000a).
- The water quality objectives for TDS and nitrate-nitrogen for each management zone. These objectives were based on the historical ambient water quality concentrations.
- The assimilative capacity for TDS and nitrate-nitrogen for each management zone. Compliance with the objectives is measured by comparing the objective with the current ambient water quality. If the current quality of a management zone is the same as or poorer than the water quality objectives, then that management zone does not have assimilative capacity. If the current quality is better than the water quality objectives, then that management zone has assimilative capacity. In the later case, the difference between the objectives and current quality is the amount of assimilative capacity available. Figures 3-3 (TDS) and 3-4 (nitrate-nitrogen) show the assimilative capacity results from this study as map graphics.
- A number of the water quality objectives have been raised by the RWQCB to create assimilative capacity and, thus, encourage reclamation and the maximum beneficial use of State waters. These so-called "maximum benefit" water quality objectives for management zones are contingent on the implementation of certain projects and programs by specific dischargers as part of their maximum benefit demonstrations. The management zones with "maximum benefit" water quality objectives are Chino-North, Cucamonga, Yucaipa, San Timoteo, and Beaumont.

3.3 Change in Current Ambient Water Quality (1997-2003)

Subtracting the 1997 current ambient water quality from the 2003 current ambient water quality equals the change in current ambient water quality for all management zones from 1997 to 2003. The table below shows the magnitude of the changes in current ambient water quality by management zone. These same data are displayed in map view in Figures 3-5 and 3-6.

Management Zone	Change in Ambient Water Quality (1997-2003)	
	TDS *mg/L*	Nitrate-N *mg/L*
Arlington	--	--
Beaumont	-30	-0.6
Bedford	--	--
Bunker Hill-A	-30	-0.2
Bunker Hill-B	20	0.3
Canyon	200	0.5
Chino 1	20	0.5
Chino 2	40	2.3
Chino 3	0	0.5
Chino-East	-140	-19.5
Chino-North	20	1.3
Chino-South	70	6.5
Coldwater	20	-0.2
Colton	0	0.0
Cucamonga	-10	-0.1
Elsinore	-20	-0.2
Hemet-South	-180	0.2
Irvine	-30	-0.9
La Habra	--	--
Lakeview/Hemet-North	10	0.7
Lee Lake	--	--
Lytle	-10	-0.1
Menifee	-1140	0.6
Orange County	0	-0.3
Perris-North	30	2.0
Perris-South	-990	1.0
Prado Basin	--	--
Rialto	-10	-0.1
Riverside-A	0	0.5
Riverside-B	-10	-0.2
Riverside-C	-10	-0.2
Riverside-D	--	--
Riverside-E	-20	0.6
Riverside-F	-10	1.1
San Jacinto-Lower	220	-0.1
San Jacinto-Upper	0	-0.2
San Timoteo	--	--
Santiago	--	--
Temescal	-80	-0.4
Warm Springs Valley	--	--
Yucaipa	-20	0.2

The analysis indicates that some management zones experienced water quality improvement, while others experienced water quality degradation. Factors influencing changes in ambient water quality can include:

- the geographic distribution of gained/lost wells within management zones
- differences in the techniques employed to contour and interpolate water quality data
- the elimination of six years of data from the analysis (1978-1983)
- the addition of six years of data to the analysis (1998-2003)
- changes in water levels that affect groundwater storage in a management zone
- pumping/recharge stresses and/or groundwater flow within or between management zones that can add, remove, and/or transport TDS and nitrate constituents in groundwater

Changes in ambient water quality due to the first three factors bulleted above are not necessarily true changes in groundwater quality, but rather are changes driven by the methods and techniques employed in the recomputation (artificial factors). However, changes in ambient water quality due to the last four factors are real (true factors).

In most instances, all factors bulleted above play a role in the recomputation of ambient water quality. The relative roles of each factor for each management zone are not easily quantified, and such quantification is not within the scope of this study, but a number of general observations can be qualitatively described:

- Groundwater quality is typically slow to change – especially in the large groundwater basins of the Santa Ana River watershed. Therefore, relatively large ambient water quality changes in management zones are likely due primarily to *artificial factors*. As an example, in the Chino-East management zone, water quality improves by 19.5 mg/L in nitrate-nitrogen and by 140 mg/L TDS – both relatively large changes in ambient water quality. These changes can most likely be attributed to the fact that in the 1997 study there were nine wells with enough data to produce a statistic, while in 2003 study there were 16 wells with enough data to produce a statistic. This increase in the amount of data, as well as the evenly-spaced geographic distribution of the new data, allowed for a better characterization of the ambient water quality within the management zone. Other management zones where *artificial factors* played an obvious and significant role in calculated ambient water quality changes include Chino-South, Menifee, and San Jacinto-Lower.
- Ambient water quality changes in groundwater basins that are monitored by numerous wells of evenly-spaced geographic distribution are more likely reflective of *true factors* that influence ambient water quality. Orange County, Irvine, Yucaipa, Bunker Hill-A, Bunker Hill-B, and Chino-North are examples of these types of management zones.

3.4 Recommendations for Future Ambient Water Quality Recomputations

Even in instances where a management zone contains many wells, of even geographic distribution, with much water quality data, the contouring techniques can play a large factor in the recomputation of ambient water quality. As a result, much attention was given to 1997 contours of TDS and nitrate, especially in those areas with little data to control the shape and position of the contours.

Given (1) the influence of *artificial factors* in the recomputation of ambient water quality, and (2) that this study is only the second in an on-going series of triennial recomputations, it is premature to draw conclusions regarding the rate of change in ambient water quality in any one management zone. However, true groundwater quality trends may be revealed if the *artificial factors* that influence ambient water quality are minimized in future recomputations through:

- continued monitoring of water quality, at least annually, at all wells that were used in this recomputation
- improved monitoring efforts within management zones with little or no groundwater quality data
- continued efforts to improve the data management system on a watershed scale
- consistency in the techniques to contour and interpolate the water quality data during the recomputation process

The second bullet above is of concern to the RWQCB, particularly in those management zones with water quality objectives based on “maximum benefit,” which includes the San Timoteo management zone. Too little data existed in San Timoteo to compute an ambient water quality estimate for 1984-2003. Comprehensive groundwater monitoring efforts must be conducted in San Timoteo (by Yucaipa Valley Water District, City of Beaumont, and San Timoteo Watershed Management Authority) to estimate ambient water quality in future recomputations and meet the “maximum benefit” commitments in the 2004 Basin Plan.

Table 3-1
Water Quality Objectives, Ambient Water Quality, and Assimilative Capacity for TDS

Groundwater Basin	Management Zone	TDS Water Quality Objective (mg/L)	TDS Historical Ambient[1] (mg/L)	TDS 1997 Current Ambient[2] (mg/L)	TDS 2003 Current Ambient[3] (mg/L)	TDS Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains						
	Beaumont -- "max benefit"[4]	330	233	290	260	70
	Beaumont -- "antideg"	230	233	290	260	
	Bunker Hill-A	310	313	350	320	
	Bunker Hill-B	330	332	260	280	50
	Lytle	260	264	240	230	30
	San Timoteo -- "max benefit"	400	303	300	?	
	San Timoteo -- "antideg"	300	303	300	?	
	Yucaipa -- "max benefit"	370	319	330	310	60
	Yucaipa -- "antideg"	320	319	330	310	10
San Jacinto Basins						
	Canyon	230	234	220	420	
	Hemet-South	730	732	1030	850	
	Lakeview/Hemet-North	520	519	830	840	
	Menifee	1020	1021	3360	2220	
	Perris-North	570	568	750	780	
	Perris-South	1260	1258	3190	2200	
	San Jacinto-Lower	520	520	730	950	
	San Jacinto-Upper	320	321	370	370	
Chino, Rialto/Colton, & Riverside Basins						
	Chino-North -- "max benefit"	420	260	300	320	100
	Chino 1 -- "antideg"	280	280	310	330	
	Chino 2 -- "antideg"	250	250	300	340	
	Chino 3 -- "antideg"	260	260	280	280	
	Chino-East	730	733	760	620	110
	Chino-South	680	676	720	790	
	Colton	410	407	430	430	
	Cucamonga -- "max benefit"	380	212	260	250	130
	Cucamonga -- "antideg"	210	212	260	250	
	Rialto	230	230	230	220	10
	Riverside-A	560	560	440	440	120
	Riverside-B	290	289	320	310	
	Riverside-C	680	684	760	750	
	Riverside-D	810	812	?	?	
	Riverside-E	720	721	720	700	20
	Riverside-F	660	665	580	570	90
	Prado Basin	surface water objective applies	618	819		surface water objective applies
Elsinore/Temescal Valleys						
	Arlington	980	983	?	1020	
	Bedford	?	?	?	740	
	Coldwater	380	381	380	400	
	Elsinore	480	476	480	460	20
	Lee Lake	?	?	?	?	
	Temescal	770	771	780	700	70
	Warm Springs Valley	?	?	?	?	
Orange County Basins						
	Irvine	910	908	910	880	30
	La Habra	?	?	?	?	
	Orange County[5]	580	585	560	560	20
	Santiago	?	?	?	?	

? = Not enough data to estimate TDS concentrations; management zone is presumed to have no assimilative capacity. If assimilative capacity is demonstrated by an existing or proposed discharger, that discharge would be regulated accordingly.
[1] Data sampling period was 20 years (1954-1973) for historical ambient water quality computations.
[2] Data sampling period was 20 years (1978-1997) for current ambient water quality computations.
[3] Data sampling period was 20 years (1984-2003) for current ambient water quality computations.
[4] Assimilative capacity created by "maximum benefit" objectives is allocated solely to agency(ies) responsible for "maximum benefit" implementation.
[5] For the purposes of regulating discharges other than those associated with projects implemented within the Orange County Management Zone to facilitate remediation projects and/or to address legacy contamination, no assimilative capacity is assumed to exist.
For detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (July, 2000).
This table reflects all revisions requested and approved by the TIN/TDS Task Force since original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).

Table 3-2
Water Quality Objectives, Ambient Water Quality, and Assimilative Capacity for TDS

Groundwater Basin	Management Zone	Nitrate-Nitrogen (NO_3-N)				
		Water Quality Objective *(mg/L)*	Historical Ambient[1] *(mg/L)*	1997 Current Ambient[2] *(mg/L)*	2003 Current Ambient[3] *(mg/L)*	Assimilative Capacity *(mg/L)*
San Bernardino Valley & Yucaipa/Beaumont Plains						
	Beaumont -- "max benefit"[4]	5.0	1.5	2.6	2.0	3.0
	Beaumont -- "antideg"	1.5	1.5	2.6	2.0	
	Bunker Hill-A	2.7	2.7	4.5	4.3	
	Bunker Hill-B	7.3	7.3	5.5	5.8	1.5
	Lytle	1.5	1.5	2.8	2.7	
	San Timoteo -- "max benefit"	5.0	2.7	2.9	?	
	San Timoteo -- "antideg"	2.7	2.7	2.9	?	
	Yucaipa -- "max benefit"	5.0	4.2	5.2	5.4	
	Yucaipa -- "antideg"	4.2	4.2	5.2	5.4	
San Jacinto Basins						
	Canyon	2.5	2.5	1.6	2.1	0.4
	Hemet-South	4.1	4.1	5.2	5.4	
	Lakeview/Hemet-North	1.8	1.8	2.7	3.4	
	Menifee	2.8	2.8	5.4	6.0	
	Perris-North	5.2	5.2	4.7	6.7	
	Perris-South	2.5	2.5	4.9	5.9	
	San Jacinto-Lower	1.0	1.0	1.9	1.8	
	San Jacinto-Upper	1.4	1.4	1.9	1.7	
Chino, Rialto/Colton, & Riverside Basins						
	Chino-North -- "max benefit"	5.0	3.7	7.4	8.7	
	Chino 1 -- "antideg"	5.0	5.0	8.4	8.9	
	Chino 2 -- "antideg"	2.9	2.9	7.2	9.5	
	Chino 3 -- "antideg"	3.5	3.5	6.3	6.8	
	Chino-East	10.0	13.3	29.1	9.6	0.4
	Chino-South	4.2	4.2	8.8	15.3	
	Colton	2.7	2.7	2.9	2.9	
	Cucamonga -- "max benefit"	5.0	2.4	4.4	4.3	0.7
	Cucamonga -- "antideg"	2.4	2.4	4.4	4.3	
	Rialto	2.0	2.0	2.7	2.6	
	Riverside-A	6.2	6.2	4.4	4.9	1.3
	Riverside-B	7.6	7.6	8.0	7.8	
	Riverside-C	8.3	8.3	15.5	15.3	
	Riverside-D	10.0	19.5	?	?	
	Riverside-E	10.0	13.3	14.8	15.4	
	Riverside-F	9.5	12.1	9.5	10.6	
	Prado Basin	surface water objective applies	4.3	22.0		surface water objective applies
Elsinore/Temescal Valleys						
	Arlington	10.0	25.5	?	26.0	
	Bedford	?	?	?	2.8	
	Coldwater	1.5	1.5	2.6	2.4	
	Elsinore	1.0	1.0	2.6	2.4	
	Lee Lake	?	?	?	?	
	Temescal	10.0	11.8	13.2	12.8	
	Warm Springs Valley	?	?	?	?	
Orange County Basins						
	Irvine	5.9	5.9	7.4	6.5	
	La Habra	?	?	?		
	Orange County	3.4	3.4	3.4	3.1	0.3
	Santiago	?	?	?		

? = Not enough data to estimate nitrate-nitrogen concentrations; management zone is presumed to have no assimilative capacity. If assimilative capacity is demonstrated by an existing or proposed discharger, that discharge would be regulated accordingly.

[1] Data sampling period was 20 years (1954-1973) for historical ambient water quality computations.

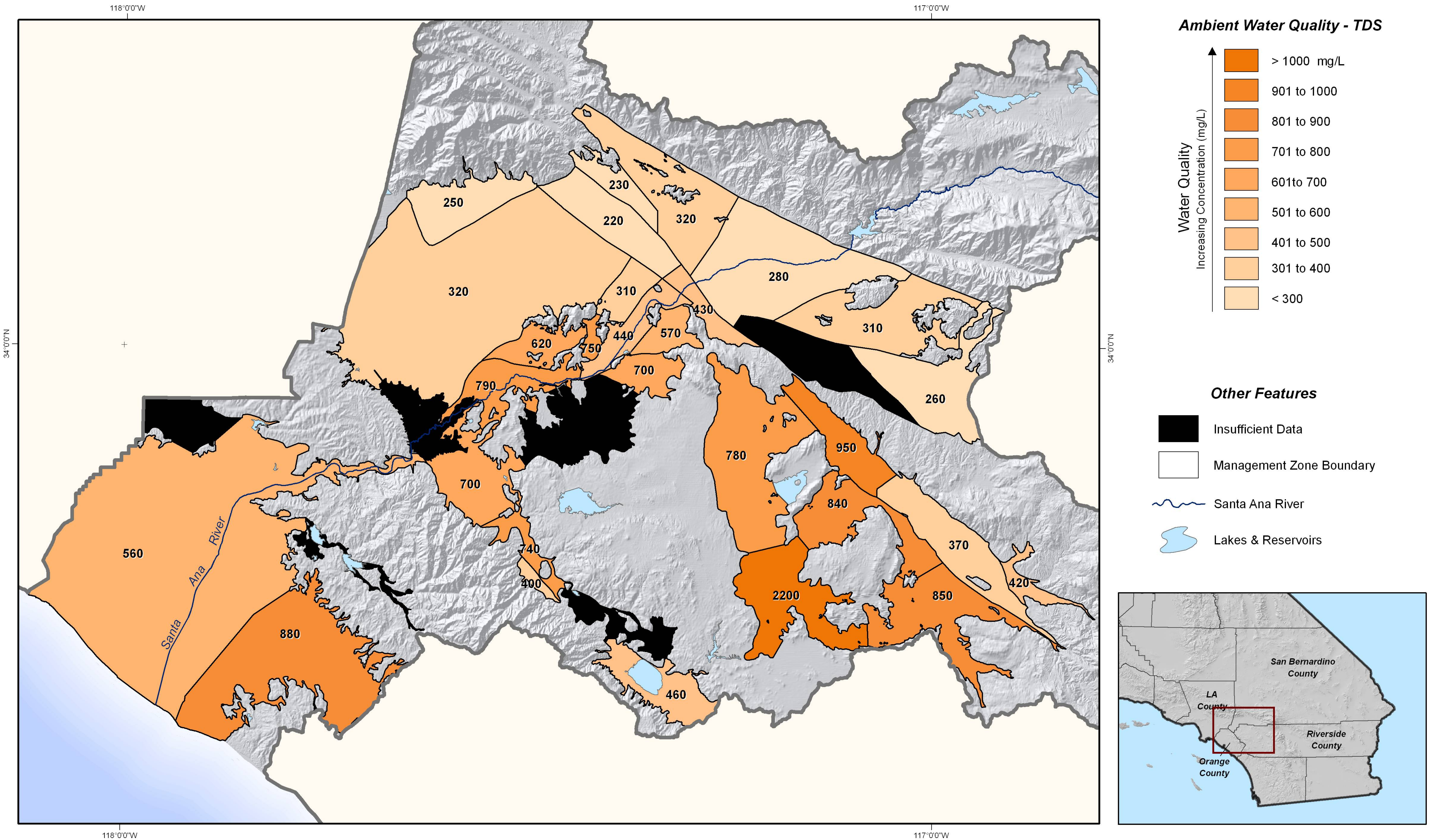
[2] Data sampling period was 20 years (1978-1997) for current ambient water quality computations.

[3] Data sampling period was 20 years (1984-2003) for current ambient water quality computations.

[3] Assimilative capacity created by “maximum benefit” objectives is allocated solely to agency(ies) responsible for “maximum benefit” implementation.

For detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (July, 2000).

This table reflects all revisions requested and approved by the TIN/TDS Task Force since original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).



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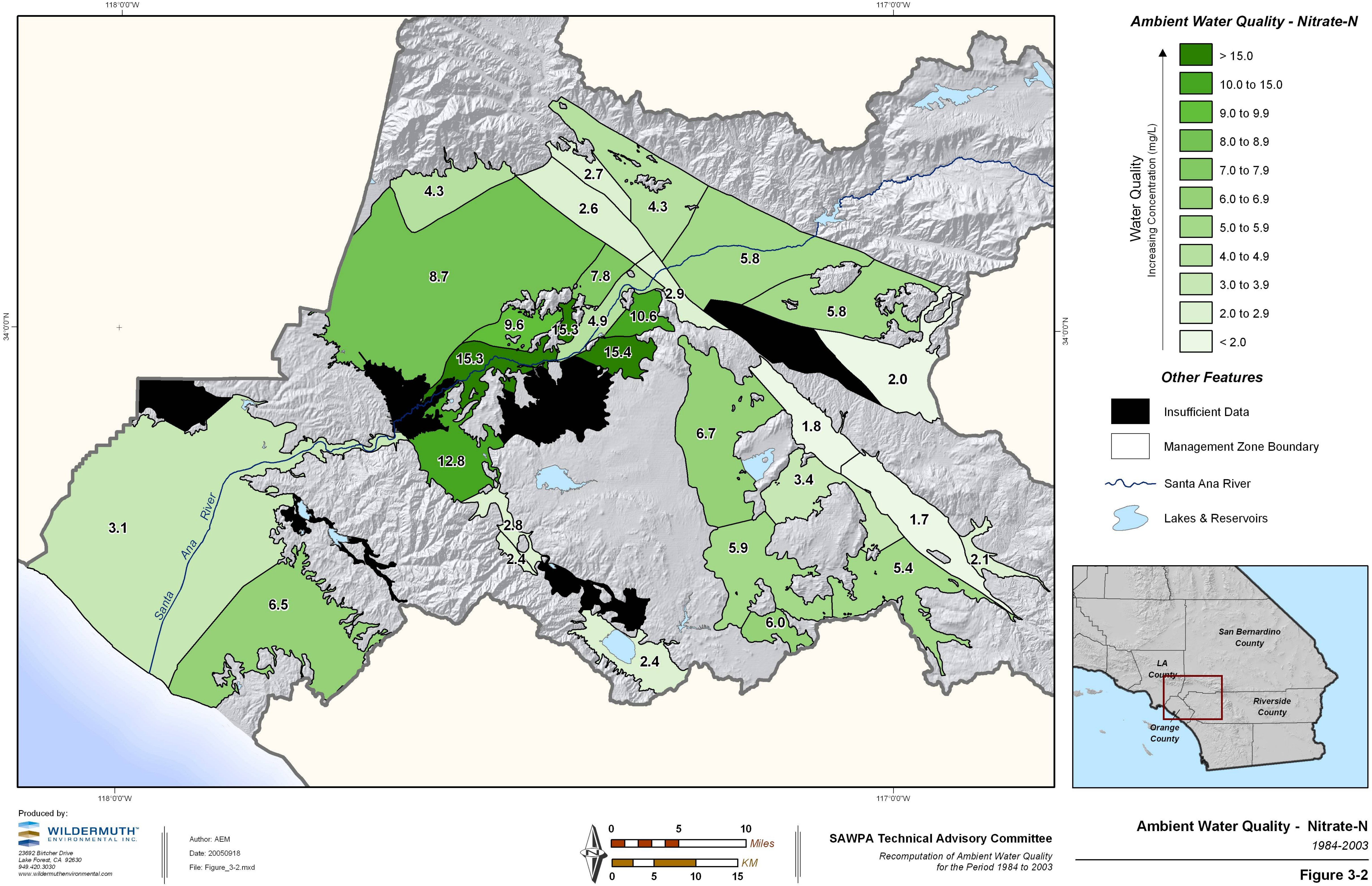
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Ambient Water Quality - TDS

1984-2003

Figure 3-1



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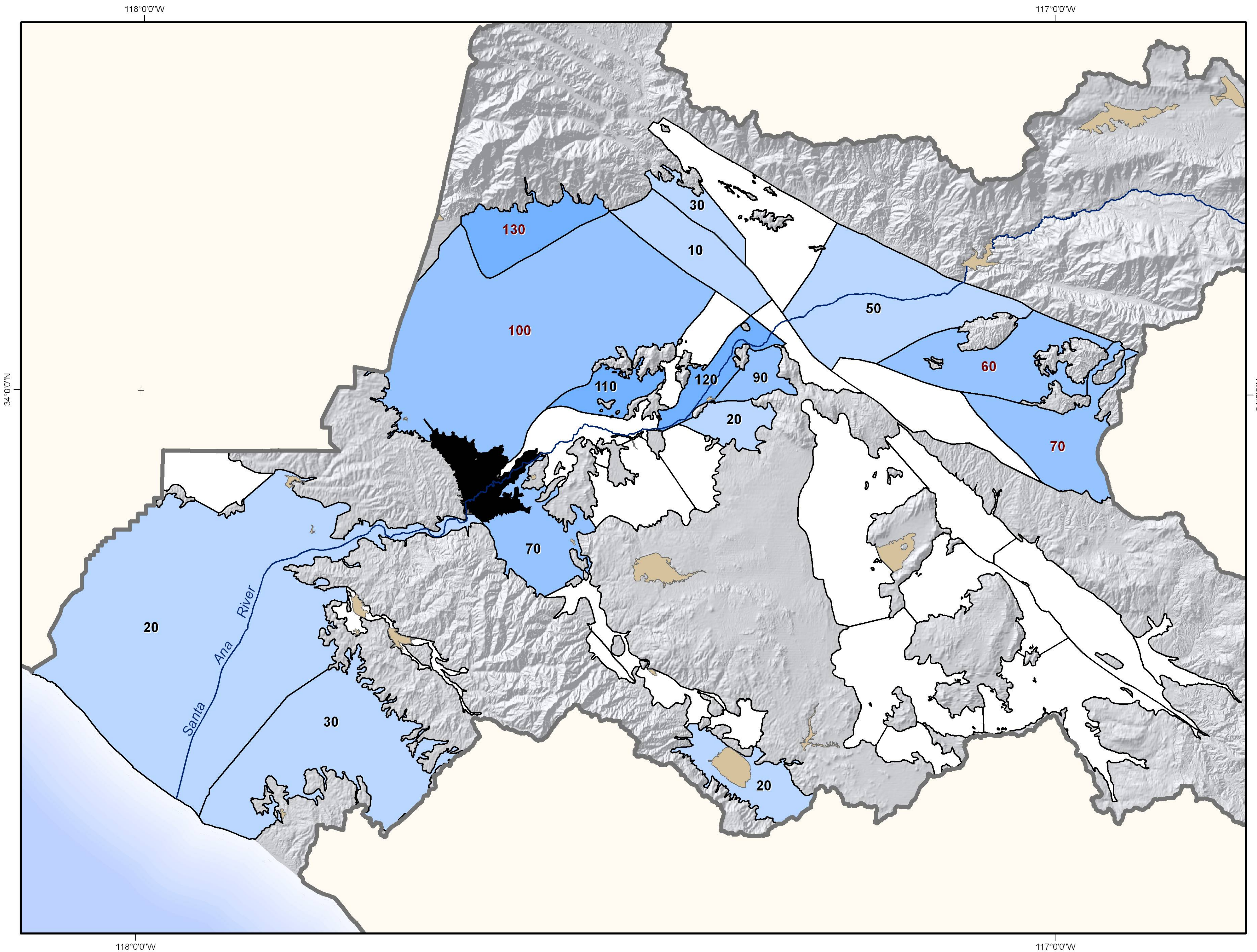
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Ambient Water Quality - Nitrate-N

1984-2003

Figure 3-2



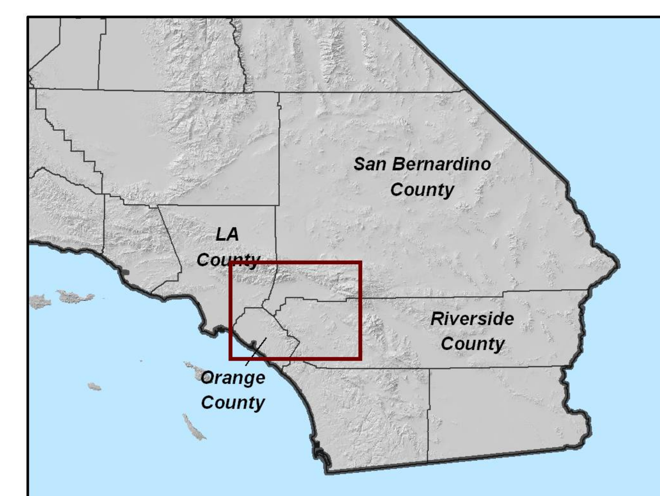
Assimilative Capacity for TDS

> 101 mg/L
51 to 100
1 to 50
0

Note: Values in RED indicate management zones with water quality objectives based on "Maximum Benefit."

Other Features

Management Zone Boundary
Santa Ana River
Lakes & Reservoirs



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0 5 10 Miles
0 5 10 15 KM

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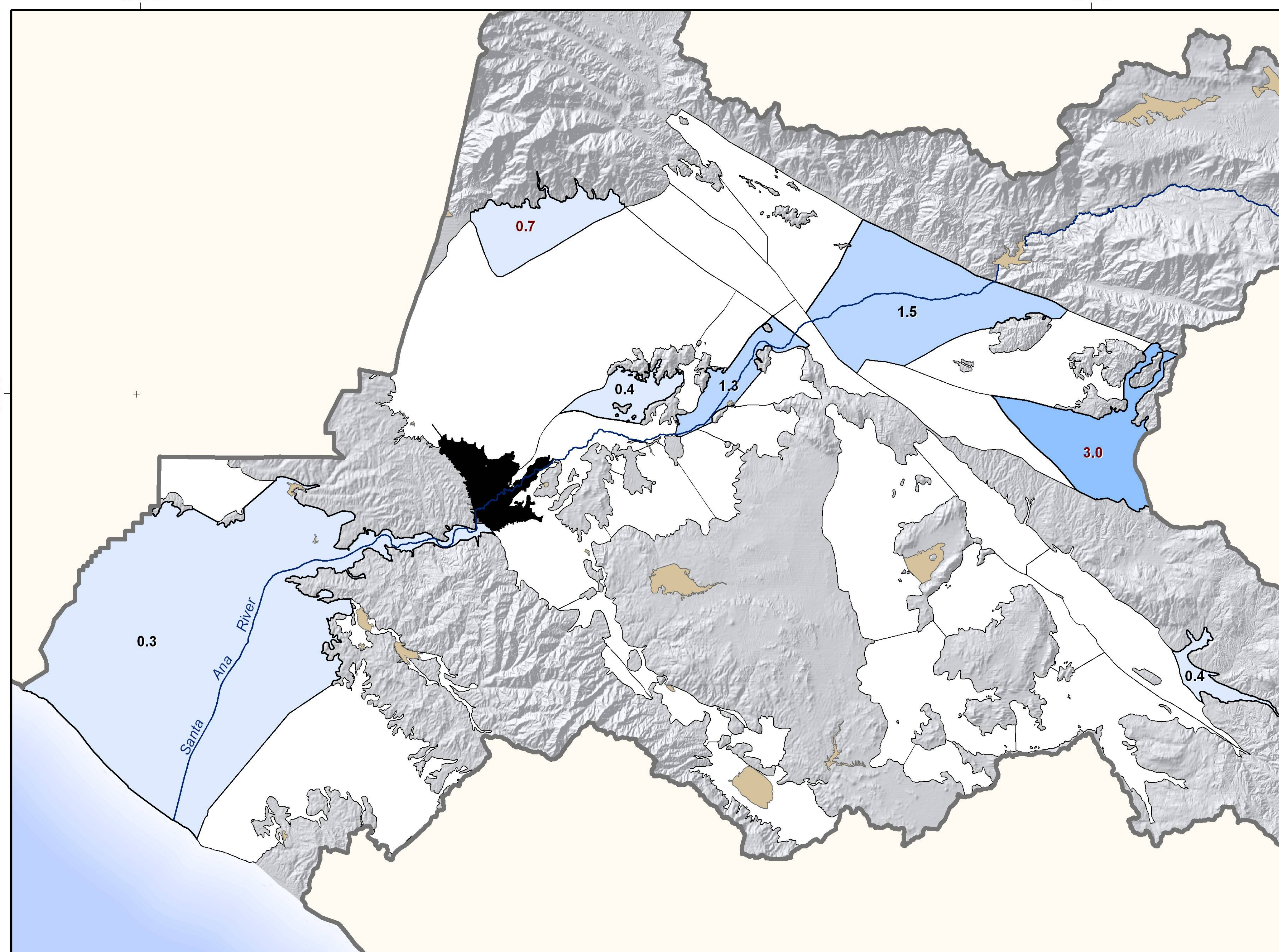
Recomputation of Ambient Water Quality for the Period 1984 to 2003

Assimilative Capacity for TDS

2003

Figure 3-3

118°0'0"W 117°0'0"W



118°0'0"W 117°0'0"W

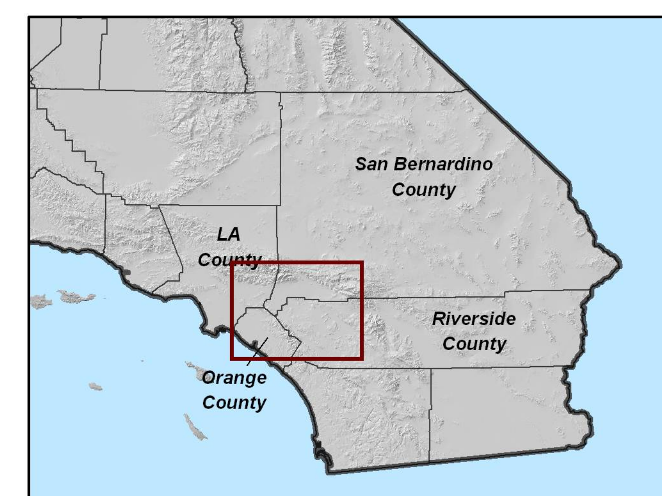
Assimilative Capacity for Nitrate-N

- > 2.1 mg/L
- 1.1 to 2.0
- 0.1 to 1.0
- 0

Note: Values in RED indicate management zones with water quality objectives based on "Maximum Benefit."

Other Features

- Management Zone Boundary
- Santa Ana River
- Lakes & Reservoirs



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0 5 10 Miles
0 5 10 15 KM

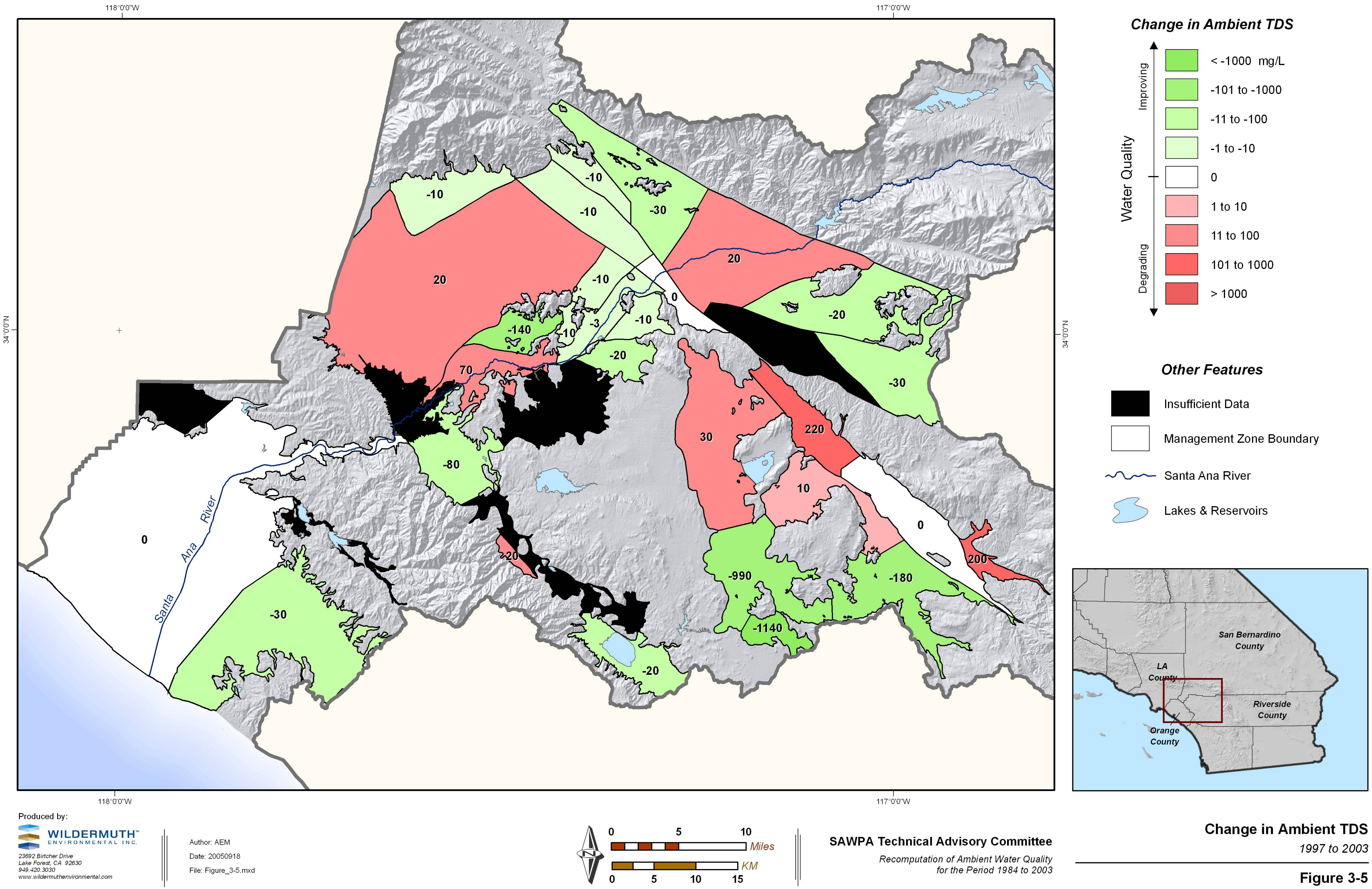
SAWPA Technical Advisory Committee

Recomputation of Ambient Water Quality for the Period 1984 to 2003

Assimilative Capacity for Nitrate-N

2003

Figure 3-4



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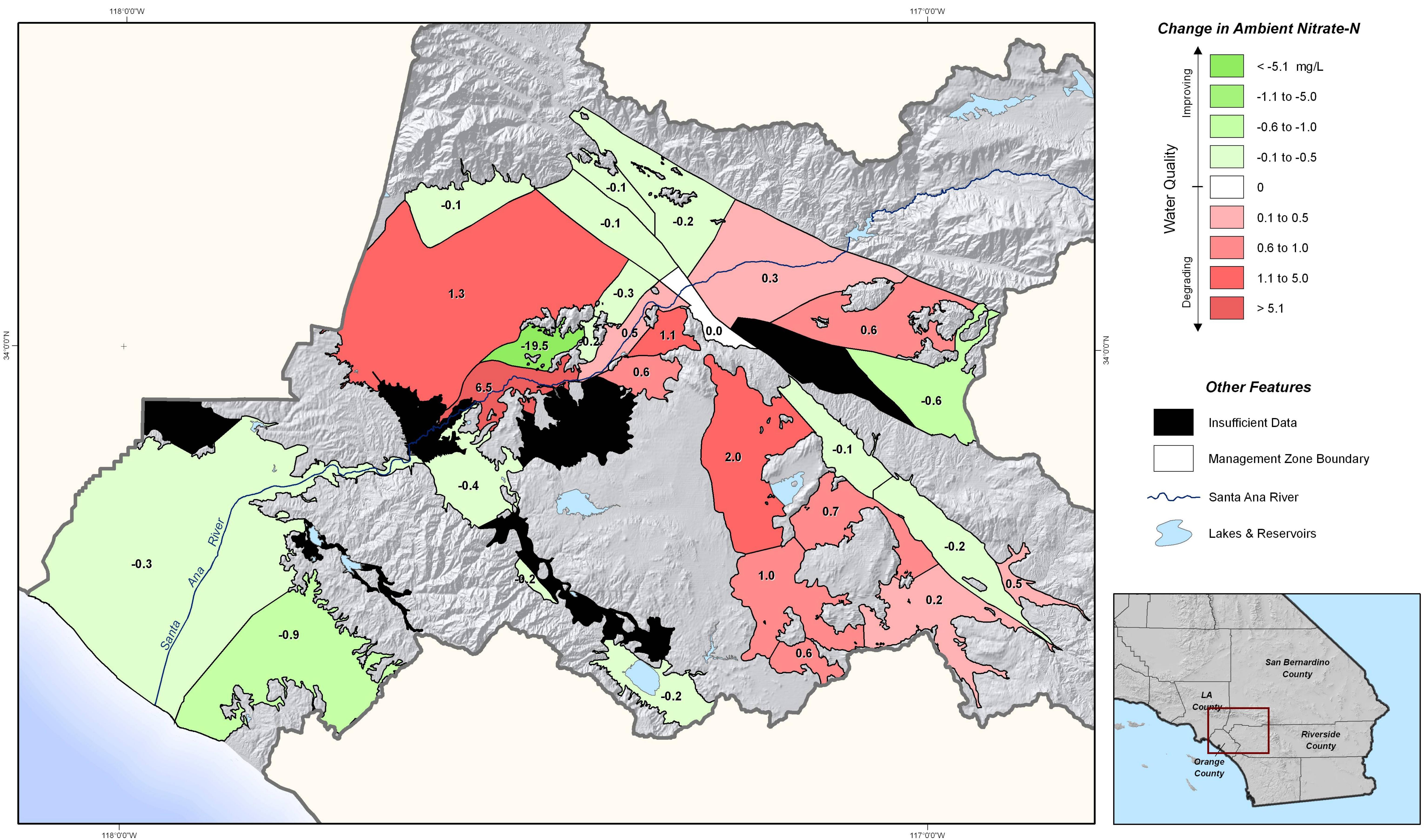
SAWPA Technical Advisory Committee

Recomputation of Ambient Water Quality for the Period 1984 to 2003

Change in Ambient TDS

1997 to 2003

Figure 3-5



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0 5 10 Miles
0 5 10 15 KM

SAWPA Technical Advisory Committee

Recomputation of Ambient Water Quality for the Period 1984 to 2003

Change in Ambient Nitrate-N

1997 to 2003

Figure 3-6

4. References

Gibbons, R. D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons. New York.

Greenberg, A. E., L. S. Clesceri, and A. D. Eaton. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition. American Public Health Association/American Water Works Association/Water Environment Federation.

Shapiro, S.S., and M.B. Wilk. 1965. An Analysis of Variance Test for Normality (Complete Samples). Biometrika 52:591-611.

US EPA. 1992. Definitions for the Minimum Set of Data Elements for Ground Water Quality. Office of Water (WH55OG)EPA 813/B-92-002. July 1992.

Wildermuth Environmental, Inc. 2000a. TIN/TDS Phase 2A: Tasks 1 through 5. TIN/TDS Study of the Santa Ana Watershed. Technical Memorandum. July 2000.

Wildermuth Environmental, Inc. 2000b. TIN/TDS Phase 2A: MS Access Database for TIN/TDS Study of the Santa Ana Watershed. Technical Memorandum. July 2000. Appendix A

APPENDIX A:
COMMENTS AND RESPONSES

A-1. SAWPA Comments and Responses

Comment Number	Reference	Comment	Response
1	Title	Please add "in the Santa Ana Watershed" after "Quality" in the title. Please change references to "SAWPA Technical Advisory Committee" on the title page, all page footers, and all figures throughout the document to "Basin Monitoring Program Task Force". This is the name of the organization that is responsible party for the study.	Comment noted. Revised text as appropriate.
2	Page 1-1 Bullet List	Please change "advisory member" after SAWPA to "task force administrator".	Comment noted. Revised text as appropriate.
3	Page 1-3 Paragraph 1, 2	Please replace the first two paragraphs with a discussion on the formation of the Task Force to conduct basin monitoring. There is good background about the Task Force and its purposes in the Task Force Agreement. Please see the enclosed agreement.	Comment noted. Revised text as appropriate.
4	Figure 1-5	The line between Orange County basin and the Irvine basin lightens up in the middle and should be a dark line throughout for clarity.	Comment noted. Revised figure as appropriate.
5	Page 2-2 Paragraph 2	The font size in this paragraph is not consistent.	Comment noted. Revised text as appropriate.
6	Page 2-4 3rd Bullet Line 4	Please add "TIN TDS" before "Task Force" to distinguish from the Basin Monitoring Program Task Force	Comment noted. Revised text as appropriate.

7	Page 2-8 Paragraph 4 Line 4	Please change "the SAWPA TAC" to "SAWPA, the Basin Monitoring Program Task Force participants"	Comment noted. Revised text as appropriate.
8	Page 3-3 Paragraph 3 Line 1,2	Please change the spelling of "roll" and "rolls" to "role" and "roles", respectively.	Comment noted. This was Joe LeClaire's mistake. Revised text as appropriate.

A-2. RWQCB Comments and Responses

Comment Number	Reference	Comment	Response
1	Section 2	The report indicates that there are several management zones where there were insufficient data to calculate ambient quality. The list of Management Zones where this is the case includes the San Timoteo Management Zone. This is of concern to us given that the San Timoteo Management Zone is one of the "Maximum Benefit" Management Zones that has specific requirements related to tracking and monitoring ambient TDS and nitrate-nitrogen water quality. The Basin Plan amendment requires TDS and nitrate-nitrogen ambient quality determination by July 1 2005 and every three years thereafter. If the ambient TDS and nitrate-nitrogen cannot be determined for 2005, the Regional Board may need to assess if the management programs incorporated into the Basin Plan as part of Yucaipa Valley Water District's (YVWD) and the City of Beaumont/San Timoteo Watershed Management Agency's (STWMA) "Maximum Benefit" commitments, have been met. While we realize this issue may be out of the scope of effort to recompute ambient water quality, we believe it is important to point out this concern at this time. We certainly plan to follow-up on this issue with YWVD and the City of Beaumont/STWMA.	Comment noted. A paragraph expressing these concerns was added to the end of Section 3.4 – Recommendations for Future Ambient Water Quality Recomputations.
2	Section 3	For TDS, we note the following results: • There are 44 management zones; • 20 Management Zone have better TDS quality in 2003 compared to 1997, and 10 management zones have worse TDS quality;	Comment noted. Much of the comment is noted in the table included in the text of Section 3.

		• 5 management zones have no change in ambient TDS quality between 1997 and 2003; • Ambient TDS quality was able to be determined for 1 management zone (Bedford) where previously there were insufficient data; and • Ambient TDS quality could not be determined for 8 management zones due to insufficient data. For nitrate-nitrogen, we note the following results: • There are 44 management zones; • 17 management zone have better quality in 2003 compared to 1997, and 17 management zones have worse nitrate-nitrogen quality; • 1 management zone has no change in ambient nitrate-nitrogen quality between 1997and 2003; • Ambient nitrate-nitrogen quality was able to be determined for 1 management zone (Bedford) where previously there were insufficient data; and • Ambient nitrate-nitrogen quality could not be determined for 8 management zones due to insufficient data.	

3	Section 3	We agree with the report conclusion that these results should be considered in light of the impact of both "artificial" and "true" factors. As such, we believe that the recomputation of ambient TDS and nitrate-nitrogen quality every 3 years will enable the Regional Board to better evaluate the true trends in TDS and nitrate-nitrogen water quality. The recommendations for future ambient recomputation effort appear reasonable and we would look for these ideas to be incorporated into future recomputation efforts of the SAWPA Basin Monitoring Task Force	Comment noted.

A-3. CBWM Comments and Responses

Comment Number	Reference	Comment	Response
1	Throughout	Miscellaneous editorial comments. These comments were provided as written annotation to a copy of the draft technical memorandum.	Comments noted. Revised text as appropriate.
2	Throughout	Assimilative capacity results, both in the tables and maps throughout the report, show those management zones without assimilative capacity as having zero assimilative capacity, when in fact these management zones have current ambient water quality that is poorer than the objective (i.e. negative assimilative capacity or a deficit of assimilative capacity). The commenter suggests that in these cases the assimilative capacity should be shown as a deficit of assimilative capacity.	From a regulatory perspective, the magnitude of "negative" assimilative capacity (where the objective is lower than the current ambient concentration) matters not. The magnitude of assimilative capacity matters only for those management zones with "positive" assimilative capacity (where the objective is higher than the current ambient concentration). However, after discussion with the Regional Board, we feel that displaying the magnitude of "negative" assimilative capacity has merit, and should be displayed in future recomputations of ambient water quality. For this report, these data can be easily obtained for any management zone through simple subtraction of columns (objective minus 2003 current ambient) in Tables 3-1 and 3-2.