BASIN PLAN AMENDMENT
REQUIRED MONITORING AND ANALYSES

Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1990 to 2009

Final Technical Memorandum

Prepared for

Santa Ana Watershed Project Authority
Basin Monitoring Program Task Force

Prepared by

Wildermuth Environmental, Inc.

August 2011

August 31, 2011

Santa Ana Watershed Project Authority
Attention: Mr. Mark Norton
11615 Sterling Avenue
Riverside, CA 92503

Subject: ***Final Technical Memorandum - Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1990 to 2009***

Dear Task Force Members:

Wildermuth Environmental, Inc. (WEI) is proud to submit the above referenced report to the Basin Monitoring Program Task Force in fulfillment of our agreement (Task Order: WILD374-01). This report summarizes our efforts to estimate current TDS and Nitrate-N concentrations in each groundwater management zone within the Santa Ana River watershed, and is the third triennial recomputation in accordance with the 2004 Basin Plan Amendment.

We have very much enjoyed the opportunity to work on this important project, and the staff at WEI would like to express their appreciation to all members of the Task Force for their ongoing commitment to watershed management.

Very truly yours,

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Acronyms, Abbreviations, and Initialisms

μg/L	micrograms per liter
BMPTF	Basin Monitoring Program Task Force
CBWCD	Chino Basin Water Conservation District
CBWM	Chino Basin Watermaster
CDFM	cumulative departure from the mean
DPH	State of California, Department of Public Health
EMWD	Eastern Municipal Water District
EVMWD	Elsinore Valley Municipal Water District
GIS	Geographic Information System
IEUA	Inland Empire Utilities Agency
JCSD	Jurupa Community Services District
mg/L	milligrams per liter
meq/L	milliequivalents per liter
N/TDS	nitrogen/total dissolved solids
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
POTW	Publicly-Owned Treatment Works
RWQCB	Regional Water Quality Control Board
SAW DMS	Santa Ana Watershed Data Management System
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
US EPA	United States 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

1.1 Introduction and Background

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 (later renamed the Nitrogen/TDS Task Force) included:

- California Regional Water Quality Control Board, Santa Ana Region (RWQCB) – Advisory Member
- 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)
- 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 Nitrogen/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 documented in *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 Figure 1-1) and replaced the groundwater subbasins of the 1995 Basin Plan (RWQCB, 2004).

Table 1-1 and 1-2 display the ambient water quality determinations (for TDS and nitrate-nitrogen) for groundwater management zones that were generated during the Phase 2A study for the periods of 1954-1973 and 1978-1997. The ambient water quality determinations from the "historical" period (1954-1973) were used as the basis for the new water quality objectives in the 2004 Basin Plan Amendment (RWQCB, 2004). The ambient water quality determinations 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, assimilative capacity does not exist. If the current quality is better than the water quality objectives, assimilative capacity exists. In the latter case, the difference between the objectives and current quality is the amount of assimilative capacity available.

Note that in Tables 1-1 and 1-2, 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 "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 further revised to accompany the maximum benefit water quality objectives.

As part of the agreement to adopt the 2004 Basin Plan Amendment, the affected parties have agreed to recompute ambient water quality for the individual management zones every three years. The determination of current ambient quality shall be accomplished using a methodology consistent with that employed by the Nitrogen/TDS Task Force (20-year running averages) to develop the TDS and nitrate-nitrogen 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 referenced 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 recomputation of ambient water quality encompassed the period of 1984-2003 (reported by July 1, 2005). This recomputation of ambient water quality encompasses the period of 1990-2009 (reported by July 1, 2011). WEI was retained by the BMPTF to perform the current recomputation in June of 2010.

A draft technical memorandum was submitted to the BMPTF, the RWQCB, other affected public agencies, and interested parties for comment in June 2011. Once collected, these comments were addressed with revisions, where appropriate, and responses to the comments were composed and compiled as Appendix A.

This technical memorandum describes, in detail, the specific tasks involved in and the results derived from the recomputation of ambient water quality for all of the groundwater management zones listed in Tables 1-1 and 1-2 for the period of 1990 to 2009.

Table 1-1
TIN/TDS Phase 2A Results for TDS (WEI, 2000a)

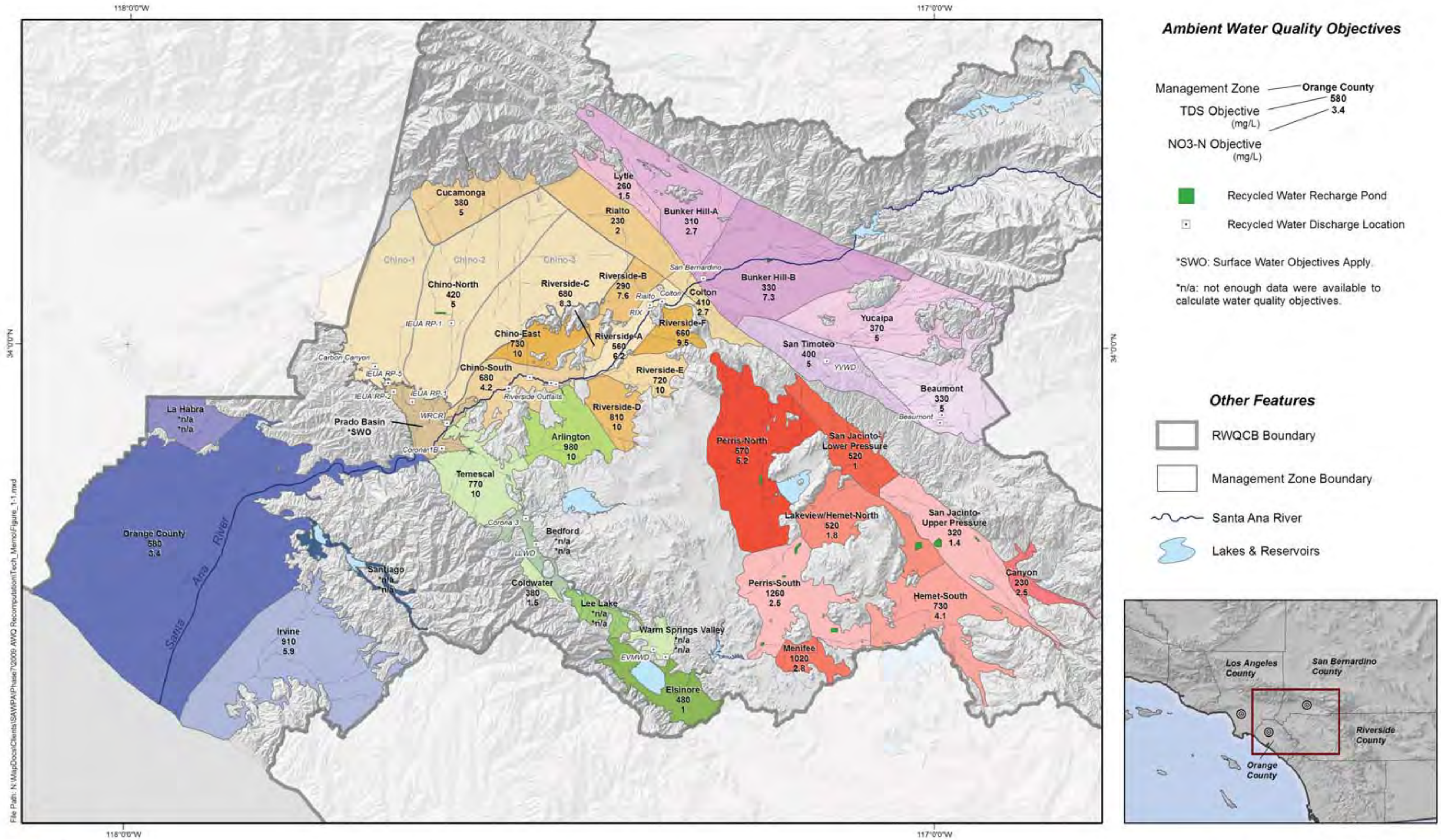
Groundwater Basin	Management Zone	Total Dissolved Solids (TDS) Water Quality Objective (mg/L)	Historical Ambient[1] (mg/L)	1997 Ambient[2] (mg/L)	Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains					
	Beaumont -- "max benefit"	330	233	290	40
	Beaumont -- "antideg"	230	233	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[3]	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] 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 a detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (WEI, 2000a).
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 (WEI, 2000a).

Table 1-2
TIN/TDS Phase 2A Results for Nitrate-Nitrogen (WEI, 2000a)

Groundwater Basin	Management Zone	Nitrate-Nitrogen (NO3-N) Water Quality Objective (mg/L)	Historical Ambient[1] (mg/L)	1997 Ambient[2] (mg/L)	Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains					
	Beaumont -- "max benefit"	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.
For a detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (WEI, 2000a).
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 (WEI, 2000a).



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Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Management Zone Boundaries

Santa Ana Watershed - 2004 Basin Plan Amendment

Figure 1-1

Section 2 – Methods to Recompute Ambient Water Quality

Ambient water quality was calculated for the 20-year period of January 1, 1990 to December 31, 2009. The first portion of this recomputation effort involved collecting, processing, and storing all data belonging to this period in a central database. The most efficient way to accomplish this was to update the database that was used in the previous recomputation for 1987-2006 (WEI, 2008) with well information, water level data, and water quality data through 2009. The database developed for the Phase 2A study (WEI, 2000b) contained all historical groundwater data from 1954 through 1997 and was subsequently updated to include data through 2006 during the two subsequent episodes of recomputation (WEI, 2005; WEI, 2008). Following the completion of previous recomputation efforts, the data originating from the EMWD and the OCWD were expunged from the database at the agencies' request. In the current recomputation effort, these two agencies delivered complete datasets encompassing the entire recomputation period (1990-2009). For all other agencies, data from 2007 through 2009 were collected and appended to the existing database by WEI.

The second portion of the recomputation effort involved the technical process of recalculating ambient water quality in management zones throughout the watershed, which did not commence until the first portion of the effort was completed. This technical process included the following:

- Development of water quality point statistics for TDS and nitrate-nitrogen at wells
- Estimation (mapping) of regional TDS and nitrate-nitrogen in groundwater across the watershed
- Computation of ambient TDS and nitrate-nitrogen for each management zone in the watershed

The tasks listed in this section describe, in detail, the process of computing ambient water quality for all of the management zones listed in Tables 1-1 and 1-2 for the period of 1990 to 2009.

2.1 Task 1 – Meet with Agencies and Collect Data

In July 2010, the RWQCB sent letters to the SAWPA agencies and sub-agencies, asking for cooperation and participation in the recomputation of ambient water quality in the Santa Ana Watershed, as required by the Basin Plan. An outline of the data required for the analysis, based on guidelines established by the United States Environmental Protection Agency (US EPA, 1992), was included in the RWQCB letter (see Table 2-1). Following the RWQCB letter, a WEI water quality specialist made initial and follow-up phone calls, reminding agency data managers of the request for historical data. Staff engineers and scientists visited the notified agencies' offices, as necessary, to make hard copies of data that were not available in digital format.

A complete set of water quality and water level data through 2009 was collected from each agency. Well site information was gathered where new or revised data existed. The specific water quality analytes required for the recomputation effort are listed in Table 2-2.

Where available, copies of each agency's database or electronic archives were collected. For those agencies that did not have these data available in digital format, 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 Public Health (DPH) database. Table 2-3 summarizes the agencies contacted and the format in which the data were received.

This process was documented carefully as part of a concurrent effort by SAWPA to establish a regional database and data-collection/data-loading processes. This effort is known as the Santa Ana Watershed Data Management System (SAW DMS).

2.2 Task 2 – Process and Upload Historical Data

The objective of this task was to process the station information, water quality data, and water level data into a normalized format for upload to the database. This was accomplished in one of two ways:

- Four agencies provided data in database format, which required reformatting and normalization before it could be incorporated into the central database. This involved identifying necessary database fields in the agency databases and mapping those fields to the current database. This process often required performing chemical (e.g. NO3 to NO3 as N) and unit (e.g. µg/L to mg/L) conversions to ensure a standardized dataset.
- The remaining agencies archive data in customized digital spreadsheet files and/or hard copy. Hard copy lab reports and water level measurements were manually entered into a normalized upload file. Digital documents were reformatted and normalized into the same digital format as the keypunched hardcopy data. This process often required performing chemical (e.g. NO3 to NO3 as N) and unit (e.g. µg/L to mg/L) conversions to ensure a standardized dataset prior to upload. The populated upload templates were checked for accuracy and duplicate records were removed before these data were assimilated into the database.

Following the data upload, a visual check of all processed data was performed using proprietary database interface software capable of simultaneously displaying data spatially and temporally. Hydrographs of water level and water quality data spanning the entire period of recomputation were scrutinized for discrepancies. If data anomalies were identified visually, WEI staff reviewed the original data source and verified the reported values. This method identified any data inconsistencies that were introduced during processing, such as incorrect well assignment or incorrect analyte/unit assignment.

2.3 Task 3 – 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 the TIN/TDS Phase 2A study (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 and to the right) in CDFM curves indicate dry periods, and positively sloping segments (trending up and to the right) indicate wet periods. The time histories are included in Appendix B.

- *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, 1990 to December 31, 2009. Current ambient water quality will always be computed as a rolling 20-year average.

- *Conducted a series of data quality tests and rejected data.* Four tests were conducted, based on the results of general mineral analyses if the data were available. Samples that failed the data quality tests were rejected from the analysis. These tests are described in *Standard Methods for the Examination of Water and Wastewater* (Greenberg et al., 1992):

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	±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 sample had nitrate-nitrogen or TDS data but did not have all of the prerequisite data to perform the above listed data quality tests [e.g. well owner sampled for nitrate but not for general minerals], the sample passed to the next level of statistical tests for normality and outliers.)

- *Computed statistics*. Before performing the statistical tests for normality and outliers, the *mean* and *standard deviation* statistics for each well were computed for both TDS and nitrate-nitrogen.
- *Annualized data*. Sample results of TDS or nitrate-nitrogen were averaged for each calendar year where more than one observation occurred during that year. Thus, only one value per year, the annual average, was used in the computation of ambient water quality. A well may have a maximum of 20 annualized averages where data exist each year of the recomputation period but must have a minimum of 3 annualized averages to continue to the statistical tests for normality and outliers. This means a statistic (*mean plus t*standard error of the mean)* cannot be computed for a well that does not have qualified data in at least three separate calendar years.
- *Applied appropriate statistical tests for normality and outliers*. The assumption of the "mean plus 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 Nitrogen/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 "Ambient Water Quality statistic" that was plotted on maps and used to define historical and current ambient water quality.

2.4 Task 4 – Estimate Regional TDS/Nitrate-N in Groundwater

The following steps were executed to estimate regional TDS/nitrate-nitrogen in groundwater

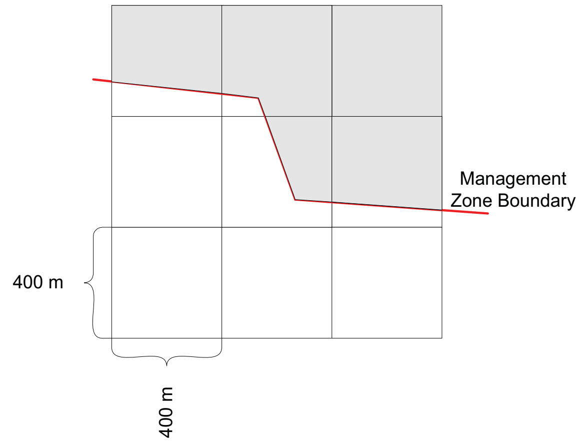
(WEI, 2000a):

- *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]) were also plotted. For each management zone, the following maps were developed and are included in Appendix B:
  - TDS statistic – current ambient (1990 to 2009)
  - Nitrate-nitrogen statistic – current ambient (1990 to 2009)
- *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.
  - Contours from previous recomputation efforts were plotted alongside current statistics and were used to guide the current contouring effort. This is done for two reasons: to minimize the impact of subjective contouring decisions and to identify areas with new data or areas where old data are no longer present.

2.5 Task 5 – Compute Ambient TDS/Nitrate-N for Management Zones

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

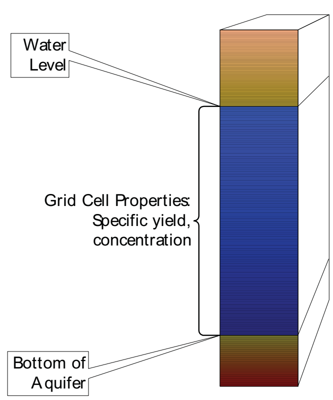
- *Developed fine rectangular grid.* The grid resolution is the same in each management zone and is fine enough so that the resulting ambient quality determinations are not significantly influenced by grid resolution. Numerical tests were done previously (WEI, 2000a) to determine the appropriate grid resolution. The grid cell size used in the Phase 2A study was 400x400 meters. The same grid cell dimension was used in this effort. Where a grid cell is split by a management zone boundary, it 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 2006 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:

$$V_i = A_i \cdot (WL_i - B_i) \cdot SY$$

where V_i = volume of groundwater in i^{th} grid cell (cubic meters)
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 (meters above mean sea level [MSL])
B_i = average elevation of the effective base of aquifer in i^{th} grid cell (meters above MSL)
SY = specific yield



GIS layers of specific yield were previously developed to estimate specific yield at each grid cell (WEI, 2000a). 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 is the sum of the volume in each aquifer layer.
- *Computed volume of groundwater in a management zone.* The total volume of groundwater within the management zones was calculated by summing the volume of groundwater in all grid cells within each management zone.
- *Estimated value of the water quality statistics for each grid cell.* The values of the TDS and nitrate-nitrogen statistics 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.* Ambient water quality was calculated using the following formula:

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

where: C_{avg} = the ambient concentration of TDS or nitrate-nitrogen in a management zone

VT = the total volume of groundwater within a management zone

C_i = the concentration in grid cell i

V_i = the volume of water stored in grid cell i

The methodology described above was used to compute ambient TDS and nitrate-nitrogen concentrations for the management zones. In some instances, the methodology was modified to accommodate 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 and water quality data are sparse; hence, ambient water quality could not be characterized.
- For the Bunker Hill Groundwater Basin, the shallow and middle aquifers within the 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 and water quality data are sparse; 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 the Chino-1, Chino-2, and Chino-3 (together, Chino-North) Management Zones. The confining units that separate the aquifers in Chino-North become thin or "pinch out" within the Chino-East and Chino-South Management Zones; hence, Chino-East and Chino-South were treated as single-aquifer systems in the recomputation of ambient water quality.
- For the Orange County Groundwater Basin, the OCWD provided groundwater level contour GIS shapefiles for spring 2009, which were used to estimate groundwater levels in the Orange County and Irvine Management Zones.

- For the San Jacinto Groundwater Basins, the EMWD provided groundwater level contour GIS shapefiles for spring 2009, which were used to estimate groundwater levels in the San Jacinto-Upper Pressure, San Jacinto-Lower Pressure, Canyon, Hemet-South, Lakeview/Hemet-North, Menifee, Perris-North, and Perris-South Management Zones.
- For the Orange County Groundwater Basin, the 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 is small or non-existent.
- In some instances, where data were not sufficient, ambient concentrations were not computed for management zones, including the Bedford, Warm Springs Valley, Lee Lake, Santiago, La Habra, and Riverside-D Management Zones.
- In the San Timoteo Management Zone, the small number of wells and the short length of data records at existing wells precludes the computation of ambient water quality. However, the BMPTF and the RWQCB agreed upon a surrogate analysis method to estimate the ambient TDS and nitrate-nitrogen in this management zone to be performed concurrent to the 1990-2009 recomputation effort. The time period used in the surrogate study was 1990-2010. The additional year included in the modified time period allowed for the maximum participation of newly constructed wells in the management zone. This separate study is described in detail in *Preliminary Assessment of Assimilative Capacity in the San Timoteo Management Zone* (WEI, 2010), which is included herewith as Appendix C. It is the expectation of the BMPTF and the RWQCB that the continued sampling at new and existing wells will allow for the computation of ambient water quality in the San Timoteo Management Zone along with the rest of the watershed during the 1993-2012 recomputation effort.

2.6 Task 6 – Prepare Technical Memorandum

A draft technical memorandum, summarizing the results of the recomputation of ambient water quality for the period of 1990 to 2009, was prepared in June 2011. The memorandum contained pertinent text, tables, and maps, describing the recomputation methods and results. The draft technical memorandum was submitted to SAWPA, BMPTF members, the RWQCB, all other affected public agencies, and other interested parties for comment. Comments from all parties were addressed, with revisions where applicable, and the comments and responses have been included as Appendix A of this final technical memorandum.

Table 2-1
Requested Groundwater Data Descriptions by Data Type

General Well Information	Description
Well Name	Unique well name and/or identifiers used by well owner
Well Status	*e.g.* active, inactive, abandoned, destroyed
Well Location	Geographic coordinates (X,Y) and description of well location
Well Elevations	Ground surface and water level measurement point elevations
Geographic Information	Datum of coordinates, coordinate units (*e.g.* degrees, meters), name and parameters of coordinate projection, elevation units and vertical datum, method used to determine well elevations
Perforated Interval	"From" and "To" fields (depth in feet-below ground surface)
Groundwater Level Information	**Description**
Date and Time Measured	Date and time of water level measurement
Depth to Water	Distance from measurement point to groundwater level (including units)
Measurement Point Description	Physical description of water level measurement point (*e.g.* top of well casing)
Measurement Point Elevation	Elevation of water level measurement point
Well Activity at Time of Measurement	Description and comments related to the well activity at the time of measurement (*e.g.* was the well pumping or was the well turned off?)
Groundwater Quality Information	**Description**
Date and Time Sampled	Date and time water quality sample collected
Chemical Name or Code	Name or code of constituent analyzed
Detection Limit	Detection limit of the sample method used
Result	Concentration/value and units of analysis
Analytical Method	Analytical method used by laboratory
Analytical Laboratory	Laboratory used for sample analysis

Table 2-2
Analytes Required for the Computation of Ambient Water Quality

Analytes of Interest
Alkalinity, Total (as $CaCO_3$)
Bicarbonate
Calcium
Carbonate
Chloride
Electrical Conductivity (Specific Conductance)
Fluoride
Magnesium
Nitrate as NO_3 or Nitrate as N
pH
Potassium
Silica
Sodium
Sulfate
Total Dissolved Solids

Table 2-3
Summary of Data Collection Effort by Agency

Agency	Data Deliverable Format
Chino Basin Watermaster	Database
Colton, City of	Hardcopy
Corona, City of	Hardcopy
East Valley Water District	Spreadsheet
Eastern Municipal Water District	Database Tables/Spreadsheet
Elsinore Valley Municipal Water District	Spreadsheet
Elsinore Water District	Hardcopy
Loma Linda, City of	Hardcopy
Muscoy Mutual Water Company	Hardcopy/DPH Database
Orange County Water District	Database
Rialto, City of	Hardcopy
Riverside, City of	Database
Riverside-Highland Water Company	Spreadsheet
San Bernardino, City of	Spreadsheet
San Bernardino, County of (Landfill Monitoring)	Spreadsheet
San Bernardino Valley Municipal Water District	Spreadsheet
San Timoteo Watershed Management Authority	Database
West Valley Water District	Hardcopy
Western Municipal Water District	Spreadsheet

CBWM Includes:
Chino Hills, City of
Chino, City of
Cucamonga Valley Water District
Fontana Water Company
Golden State Water Company
Inland Empire Utilities Agency
Jurupa Community Services District
Marygold Mutual Water Company
Monte Vista Water District
Norco, City of
Ontario, City of
Pomona, City of
San Antonio Water Company
Santa Ana River Water Company
Upland, City of

STWMA Includes:
Banning, City of
Beaumont Cherry Valley Water District
Redlands, City of
San Gorgonio Pass Water Agency
South Mesa Water Company
Western Heights Water Company
Yucaipa Valley Water District

OCWD Includes:
Anaheim, City of
Buena Park, City of
East Orange County Water District
Fountain Valley, City of
Fullerton, City of
Garden Grove, City of
Huntington Beach, City of
Irvine Ranch Water District
Mesa Consolidated Water District
Newport Beach, City of
Orange, City of
Santa Ana, City of
Serrano Water District
Tustin, City of
Westminster, City of
Yorba Linda Water District

EMWD Includes:
Box Springs Mutual Water Company
Hemet, City of
Lake Hemet Municipal Water District
Nuevo Water Company
Perris, City of
San Jacinto, City of

Section 3 – Ambient Water Quality Results for the Period 1990 to 2009

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

3.1 Ambient TDS and Nitrate-N Concentrations for Management Zones (1990 to 2009)

The results of the recomputation of ambient TDS/nitrate-nitrogen concentrations for each management zone in the Santa Ana River Watershed for the period of 1990 to 2009 are presented in Tables 3-1 (TDS) and 3-2 (nitrate-nitrogen). Figures 3-1 and 3-2 show these results as map graphics.

3.2 Assimilative Capacity for TDS and Nitrate-N (2009)

The ambient water quality determinations from the "historical" period (1954-1973) were used as the basis for the new water quality objectives in the 2004 Basin Plan Amendment (RWQCB, 2004). The ambient water quality determinations from the current period (1990-2009) are used to assess compliance with the 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, assimilative capacity does not exist. If the current quality is better than the water quality objectives, assimilative capacity exists. In the latter case, the difference between the objective and current quality is the magnitude of assimilative capacity. Where assimilative capacity exists, the RWQCB may, at its discretion, permit wastewater discharges containing TDS and/or nitrate-nitrogen at concentrations higher than the basin objective (RWQCB, 2004).

The magnitudes of assimilative capacity for TDS and nitrate-nitrogen at each management zone for the current period of recomputation are presented in Tables 3-1 and 3-2 and as map graphics in Figures 3-3 and 3-4. Note that in Tables 3-1 and 3-2, 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 (RWQCB, 2004). These "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 Trends in Ambient Water Quality Determinations at Management Zones

The ambient water quality of Santa Ana River Watershed management zones has been computed for four 20-year periods (1978-1997 [WEI, 2000a], 1984-2003 [WEI, 2005], 1987-2006 [WEI, 2008], and 1990-2009 [this technical memorandum]) since the initial computation of historical ambient water quality (1954-1973 [WEI 2000a]). The results of these computations are shown in Tables 3-1 and 3-2.

The changes in ambient TDS and nitrate-nitrogen since the last recomputation are shown in Table 3-3 and graphically displayed in Figures 3-5 and 3-6 for TDS and nitrate-nitrogen, respectively. An interpretive well analysis of trends in ambient water quality can be found in the *Interpretive Tools* section of this report (see Section 4).

Table 3-4 lists the number of wells with statistics in each management zone. Table 3-5 lists the management zones that could benefit from additional groundwater level and quality data and the water agencies that overlie them. Additional groundwater monitoring at appropriate locations and/or depths within the management zones listed in Table 3-5 will increase the number of wells with ambient water quality statistics, better constrain TDS and nitrate-nitrogen contouring, and ultimately make the management zones less susceptible to methodological factors that influence the computation of ambient water quality and mask actual trends in groundwater quality (see Section 4).

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

Groundwater Basin	Management Zone	Total Dissolved Solids (TDS): Water Quality Objective (mg/L)	Historical Ambient[1] (mg/L)	1997 Ambient[2] (mg/L)	2003 Ambient[3] (mg/L)	2006 Ambient[4] (mg/L)	2009 Current Ambient[5] (mg/L)	Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains								
	Beaumont -- "max benefit"	330	233	290	260	260	280	**50**
	Beaumont -- "antideg"	230	233	290	260	260	280	-50
	Bunker Hill-A	310	313	350	320	330	340	-30
	Bunker Hill-B	330	332	260	280	280	270	**60**
	Lytle	260	264	240	230	230	240	**20**
	San Timoteo -- "max benefit"[6]	400	303	300	?	?	*420*	-20
	San Timoteo -- "antideg"	300	303	300	?	?	*420*	-120
	Yucaipa -- "max benefit"	370	319	330	310	310	320	**50**
	Yucaipa -- "antideg"	320	319	330	310	310	320	0
San Jacinto Basins								
	Canyon	230	234	220	420	370	420	-190
	Hemet-South	730	732	1030	850	920	910	-180
	Lakeview/Hemet-North	520	519	830	840	880	890	-370
	Menifee	1020	1021	3360	2220	2140	2050	-1030
	Perris-North	570	568	750	780	730	770	-200
	Perris-South	1260	1258	3190	2200	2600	2470	-1210
	San Jacinto-Lower	520	520	730	950	810	800	-280
	San Jacinto-Upper	320	321	370	370	350	350	-30
Chino, Rialto/Colton, & Riverside Basins								
	Chino-North -- "max benefit"	420	260	300	320	340	340	**80**
	Chino 1 -- "antideg"	280	280	310	330	340	340	-60
	Chino 2 -- "antideg"	250	250	300	340	360	360	-110
	Chino 3 -- "antideg"	260	260	280	280	310	320	-60
	Chino-East	730	733	760	620	650	770	-40
	Chino-South	680	676	720	790	940	980	-300
	Colton	410	407	430	430	450	430	-20
	Cucamonga -- "max benefit"	380	212	260	250	250	250	**130**
	Cucamonga -- "antideg"	210	212	260	250	250	250	-40
	Rialto	230	230	230	220	230	230	0
	Riverside-A	560	560	440	440	440	430	**130**
	Riverside-B	290	289	320	310	340	340	-50
	Riverside-C	680	684	760	750	740	740	-60
	Riverside-D	810	812	?	?	?	?	--
	Riverside-E	720	721	720	700	710	700	**20**
	Riverside-F	660	665	580	570	570	570	**90**
	Prado Basin	surface water objective applies	618	819				surface water objective applies
Elsinore/Temescal Valleys								
	Arlington	980	983	?	1020	960	1020	-40
	Bedford	?	?	?	740	?	?	--
	Coldwater	380	381	380	400	420	440	-60
	Elsinore	480	476	480	460	470	470	**10**
	Lee Lake	?	?	?	?	?	?	--
	Temescal	770	771	780	700	780	790	-20
	Warm Springs Valley	?	?	?	?	?	?	--
Orange County Basins								
	Irvine	910	908	910	880	920	910	0
	La Habra	?	?	?	?	?	?	--
	Orange County[7]	580	585	560	560	590	600	-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] Data sampling period was 20 years (1987-2006) for current ambient water quality computations.

[5] Data sampling period was 20 years (1990-2009) for current ambient water quality computations.

[6] Current ambient water quality computations for the San Timoteo management zone were not made during this study. These values were published in *Preliminary Assessment of Assimilative Capacity in the San Timoteo Management Zone* (WEI, 2010), using a surrogate methodology.

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

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

Groundwater Basin	Management Zone	Nitrate-Nitrogen (NO_3-N) Water Quality Objective (mg/L)	Historical Ambient[1] (mg/L)	1997 Ambient[2] (mg/L)	2003 Ambient[3] (mg/L)	2006 Ambient[4] (mg/L)	2009 Current Ambient[5] (mg/L)	Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains								
	Beaumont -- "max benefit"	5.0	1.5	2.6	2.0	1.6	2.5	**2.5**
	Beaumont -- "antideg"	1.5	1.5	2.6	2.0	1.6	2.5	-1.0
	Bunker Hill-A	2.7	2.7	4.5	4.3	4.0	4.0	-1.3
	Bunker Hill-B	7.3	7.3	5.5	5.8	5.4	5.4	**1.9**
	Lytle	1.5	1.5	2.8	2.7	2.7	2.6	-1.1
	San Timoteo -- "max benefit"[6]	5.0	2.7	2.9	?	?	0.8	**4.2**
	San Timoteo -- "antideg"	2.7	2.7	2.9	?	?	0.8	**1.9**
	Yucaipa -- "max benefit"	5.0	4.2	5.2	5.4	5.3	6.2	-1.2
	Yucaipa -- "antideg"	4.2	4.2	5.2	5.8	5.3	6.2	-2.0
San Jacinto Basins								
	Canyon	2.5	2.5	1.6	2.1	1.9	2.7	-0.2
	Hemet-South	4.1	4.1	5.2	5.4	5.5	5.2	-1.1
	Lakeview/Hemet-North	1.8	1.8	2.7	3.4	2.7	2.6	-0.8
	Menifee	2.8	2.8	5.4	6.0	4.7	4.4	-1.6
	Perris-North	5.2	5.2	4.7	6.7	6.5	7.4	-2.2
	Perris-South	2.5	2.5	4.9	5.9	5.5	5.8	-3.3
	San Jacinto-Lower	1.0	1.0	1.9	1.8	1.2	1.1	-0.1
	San Jacinto-Upper	1.4	1.4	1.9	1.7	1.6	1.5	-0.1
Chino, Rialto/Colton, & Riverside Basins								
	Chino-North -- "max benefit"	5.0	3.7	7.4	8.7	9.7	9.5	-4.5
	Chino 1 -- "antideg"	5.0	5.0	8.4	8.9	9.3	9.1	-4.1
	Chino 2 -- "antideg"	2.9	2.9	7.2	9.5	10.7	10.3	-7.4
	Chino 3 -- "antideg"	3.5	3.5	6.3	6.8	8.2	8.4	-4.9
	Chino-East	10.0	13.3	29.1	9.6	12.7	15.7	-5.7
	Chino-South	4.2	4.2	8.8	15.3	25.7	26.8	-22.6
	Colton	2.7	2.7	2.9	2.9	2.9	2.8	-0.1
	Cucamonga -- "max benefit"	5.0	2.4	4.4	4.3	4.0	4.1	**0.9**
	Cucamonga -- "antideg"	2.4	2.4	4.4	4.3	4.0	4.1	-1.7
	Rialto	2.0	2.0	2.7	2.6	2.9	3.1	-1.1
	Riverside-A	6.2	6.2	4.4	4.9	4.9	5.2	**1.0**
	Riverside-B	7.6	7.6	8.0	7.8	8.3	8.4	-0.8
	Riverside-C	8.3	8.3	15.5	15.3	15.3	14.8	-6.5
	Riverside-D	10.0	19.5	?	?	?	?	--
	Riverside-E	10.0	13.3	14.8	15.4	15.3	15.2	-5.2
	Riverside-F	9.5	12.1	9.5	10.6	10.3	10.6	-1.1
	Prado Basin	surface water objective applies	4.3	22.0				surface water objective applies
Elsinore/Temescal Valleys								
	Arlington	10.0	25.5	?	26.0	20.4	18.1	-8.1
	Bedford	?	?	?	2.8	?	?	--
	Coldwater	1.5	1.5	2.6	2.4	2.6	2.8	-1.3
	Elsinore	1.0	1.0	2.6	2.4	2.4	2.2	-1.2
	Lee Lake	?	?	?	?	?	?	--
	Temescal	10.0	11.8	13.2	12.8	12.6	12.0	-2.0
	Warm Springs Valley	?	?	?	?	?	?	--
Orange County Basins								
	Irvine	5.9	5.9	7.4	6.5	6.5	6.7	-0.8
	La Habra	?	?	?	?	?	?	--
	Orange County	3.4	3.4	3.4	3.1	3.0	3.0	**0.4**
	Santiago	?	?	?	?	?	?	--

? = Not enough data to estimate Nitrate-N 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] Data sampling period was 20 years (1987-2006) for current ambient water quality computations.

[5] Data sampling period was 20 years (1990-2009) for current ambient water quality computations.

[6] Current ambient water quality computations for the San Timoteo management zone were not made during this study. These values were published in *Preliminary Assessment of Assimilative Capacity in the San Timoteo Management Zone* (WEI, 2010) using a surrogate methodology.

For a detailed description of the 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 the original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).

Table 3-3
Change in Ambient Water Quality by Management Zone

Management Zone	Change in Ambient Water Quality (2006 to 2009)	
	TDS *mg/L*	Nitrate-N *mg/L*
Arlington	60	-2.3
Beaumont	20	0.9
Bedford	--	--
Bunker Hill-A	10	0.0
Bunker Hill-B	-10	0.0
Canyon	50	0.8
Chino 1	0	-0.2
Chino 2	0	-0.4
Chino 3	10	0.2
Chino-East	120	3.0
Chino-North	0	-0.2
Chino-South	40	1.1
Coldwater	20	0.2
Colton	-20	-0.1
Cucamonga	0	0.1
Elsinore	0	-0.2
Hemet-South	-10	-0.3
Irvine	-10	0.2
La Habra	--	--
Lakeview/Hemet-North	10	-0.1
Lee Lake	--	--
Lytle	10	-0.1
Menifee	-90	-0.3
Orange County	10	0.0
Perris-North	40	0.9
Perris-South	-130	0.3
Prado Basin	--	--
Rialto	0	0.2
Riverside-A	-10	0.3
Riverside-B	0	0.1
Riverside-C	0	-0.5
Riverside-D	--	--
Riverside-E	-10	-0.1
Riverside-F	0	0.3
San Jacinto-Lower	-10	-0.1
San Jacinto-Upper	0	-0.1
San Timoteo	--	--
Santiago	--	--
Temescal	10	-0.6
Warm Springs Valley	--	--
Yucaipa	10	0.9

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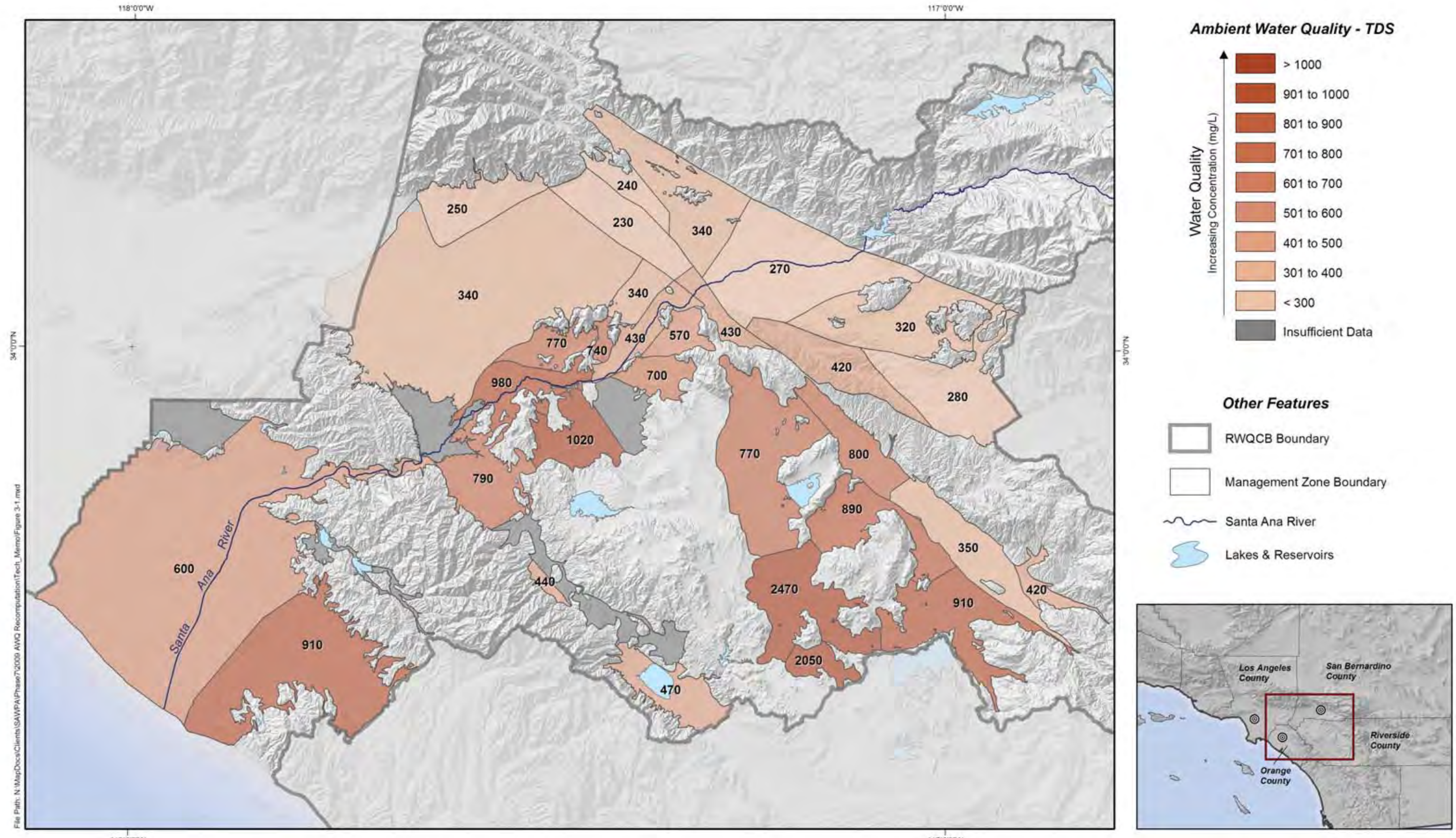
Table 3-4
Number of Wells with Ambient Water Quality Statistics by Management Zone (1990-2009)

Management Zone	Number of Wells w/ Statistics	
	TDS *mg/L*	Nitrate-N *mg/L*
Arlington	5	5
Beaumont	49	51
Bedford	4	4
Bunker Hill-A	110	102
Bunker Hill-B	121	122
Canyon	21	21
Chino-East	15	168
Chino-North	409	424
Chino-South	30	44
Coldwater	8	8
Colton	5	5
Cucamonga	28	28
Elsinore	11	11
Hemet-South	42	42
Irvine	53	56
La Habra	1	1
Lakeview/Hemet-North	65	66
Lee Lake	7	7
Lytle	39	41
Menifee	19	19
Orange County	806	764
Perris-North	37	36
Perris-South	52	51
Prado Basin	21	14
Rialto	60	63
Riverside-A	42	43
Riverside-B	11	11
Riverside-C	2	2
Riverside-D	0	0
Riverside-E	4	4
Riverside-F	21	21
San Jacinto-Lower Pressure	13	13
San Jacinto-Upper Pressure	92	89
San Timoteo	14	12
Santiago	3	3
Temescal	38	41
Warm Springs Valley	0	0
Yucaipa	69	59

Table 3-5
Management Zones in Need of Additional Data

Management Zone	2009 Ambient Water Quality TDS mg/L	2009 Ambient Water Quality Nitrate-N mg/L	Overlying Agencies
Arlington	1020	18.1	WMWD/City of Riverside
Bedford	n/a	n/a	WMWD/Lee Lake Water District
Chino-East	770	15.7	CBWM/WMWD/Santa Ana River Water Company
Colton	430	2.8	SBVMWD
Elsinore	470	2.2	WMWD/Elsinore Valley Municipal Water District
La Habra	n/a	n/a	n/a
Lee Lake	n/a	n/a	WMWD/Elsinore Valley Municipal Water District
Riverside-C	740	14.8	WMWD/City of Riverside
Riverside-D	n/a	n/a	WMWD/City of Riverside
Riverside-E	700	15.2	WMWD/City of Riverside
San Jacinto Pressure - Lower	800	1.1	EMWD
San Timoteo	420	0.8	YVWD/City of Beaumont
Santiago	n/a	n/a	OCWD overlies a portion of the management zone
Temescal	790	12.0	WMWD/City of Corona
Warm Springs Valley	n/a	n/a	WMWD/Elsinore Valley Municipal Water District



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Date: 20110831
File: Figure 3-1

0 5 10 15 Miles
0 5 10 15 20 25 KM

Basin Monitoring Program Task Force

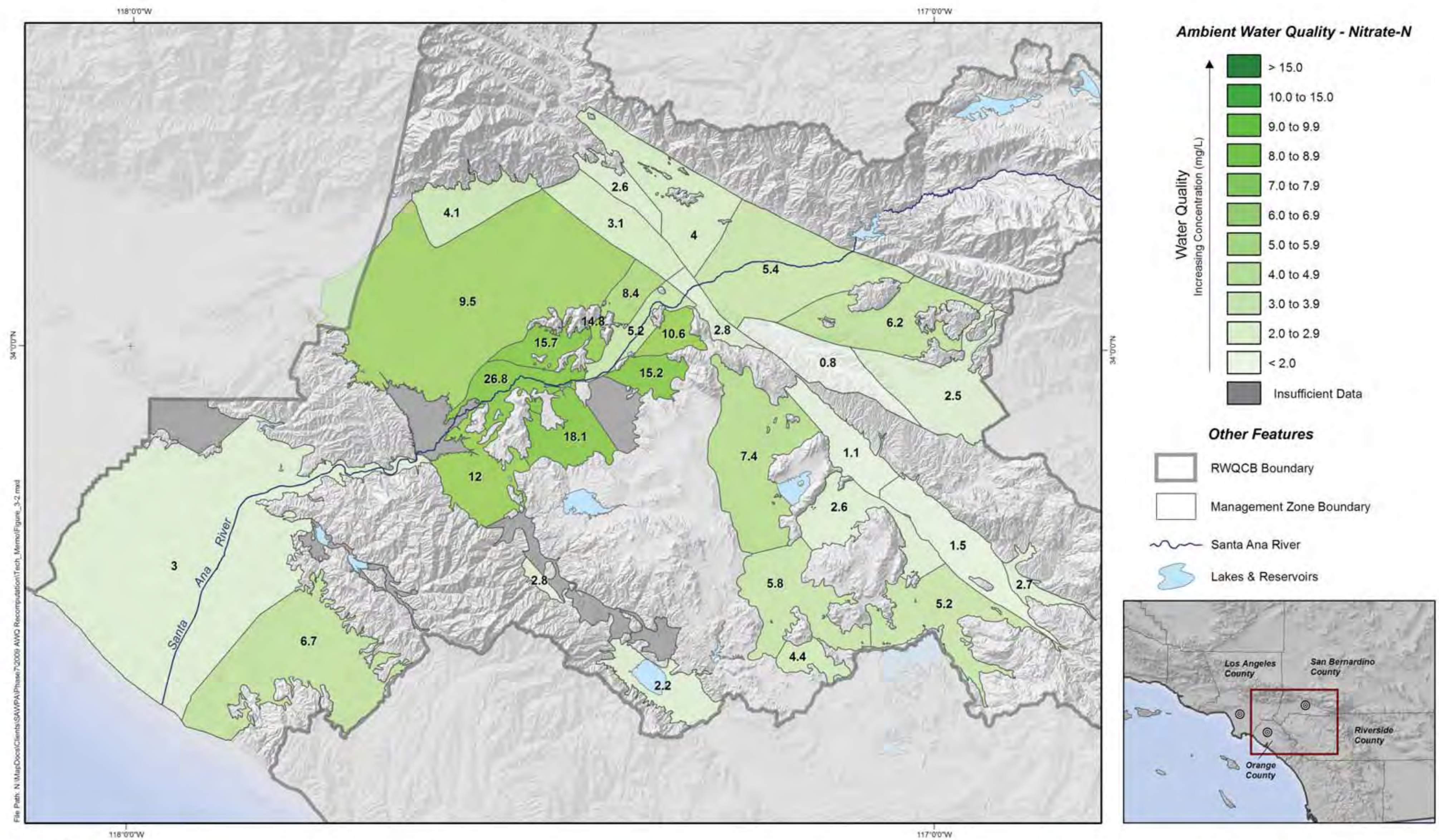
Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Ambient Water Quality - TDS

Santa Ana Watershed - 1990-2009

Figure 3-1



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0 5 10 15 Miles
0 5 10 15 20 25 KM

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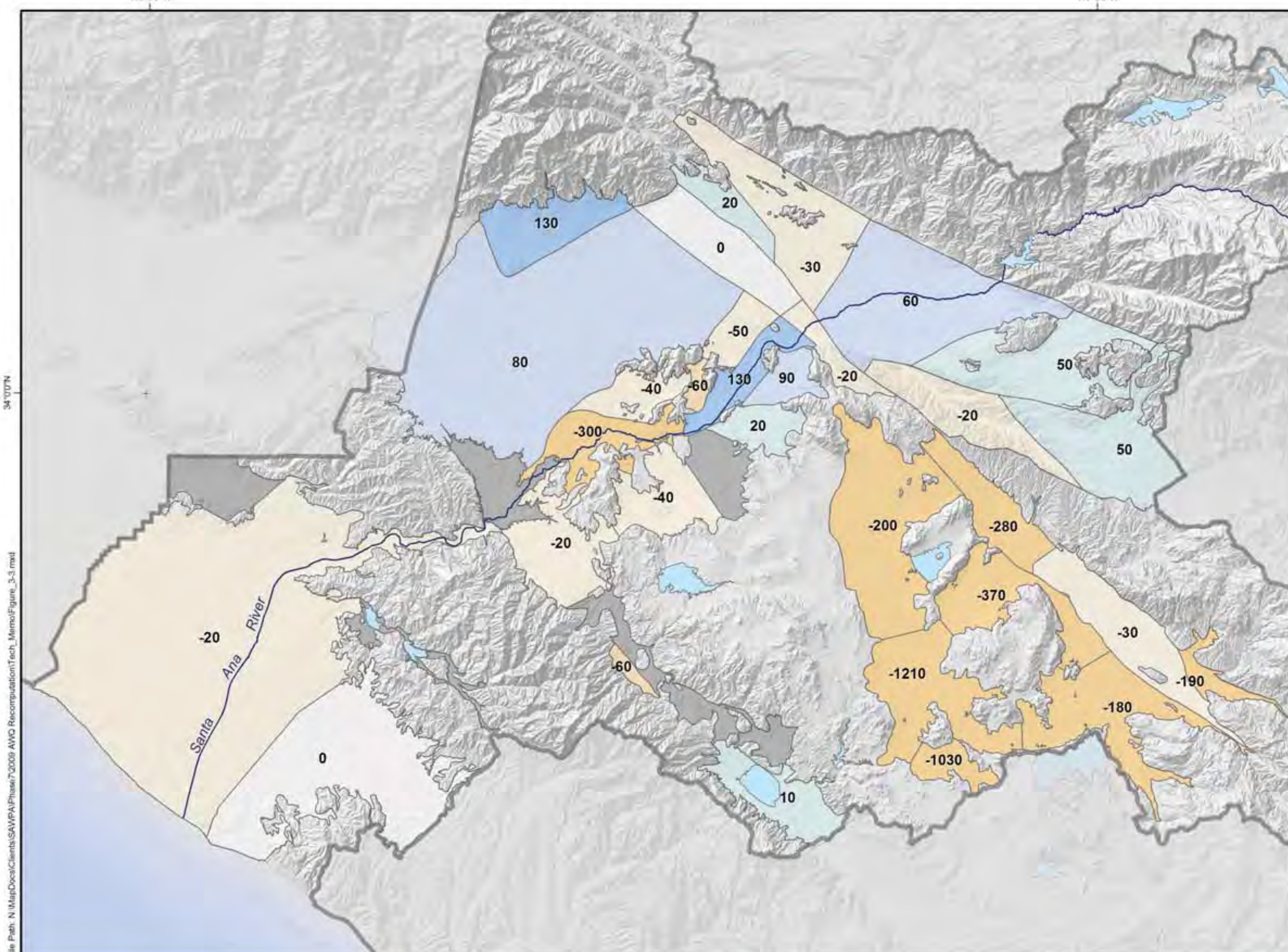
Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Ambient Water Quality - Nitrate-N

Santa Ana Watershed - 1990-2009

Figure 3-2



Assimilative Capacity for TDS

- < -100 mg/L
- -51 to -100
- -1 to -50
- 0
- 1 to 50
- 51 to 100
- >100
- Insufficient Data

Note: A negative value means that the current ambient quality is worse than the water quality objective, and no assimilative capacity exists for that management zone.

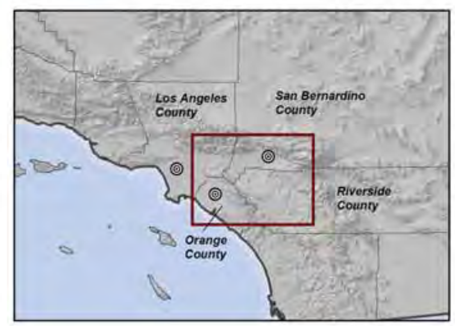
A positive value means that the current ambient quality is better than the water quality objective, and assimilative capacity exists for that management zone.

Each management zone in this figure is symbolized and labeled by the difference between the current ambient water quality and the water quality objective.

Where assimilative capacity exists, the RWQCB may, at its discretion, permit wastewater discharges containing TDS and/or nitrate-nitrogen at concentrations higher than the basin objective.

Other Features

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



File Path: N:\MapDocs\Clients\SAWPA\Phase7\2009 AWQ Recomputation\Tech_Memo\Figure_3-3.mxd

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0 5 10 15 Miles
0 5 10 15 20 25 KM

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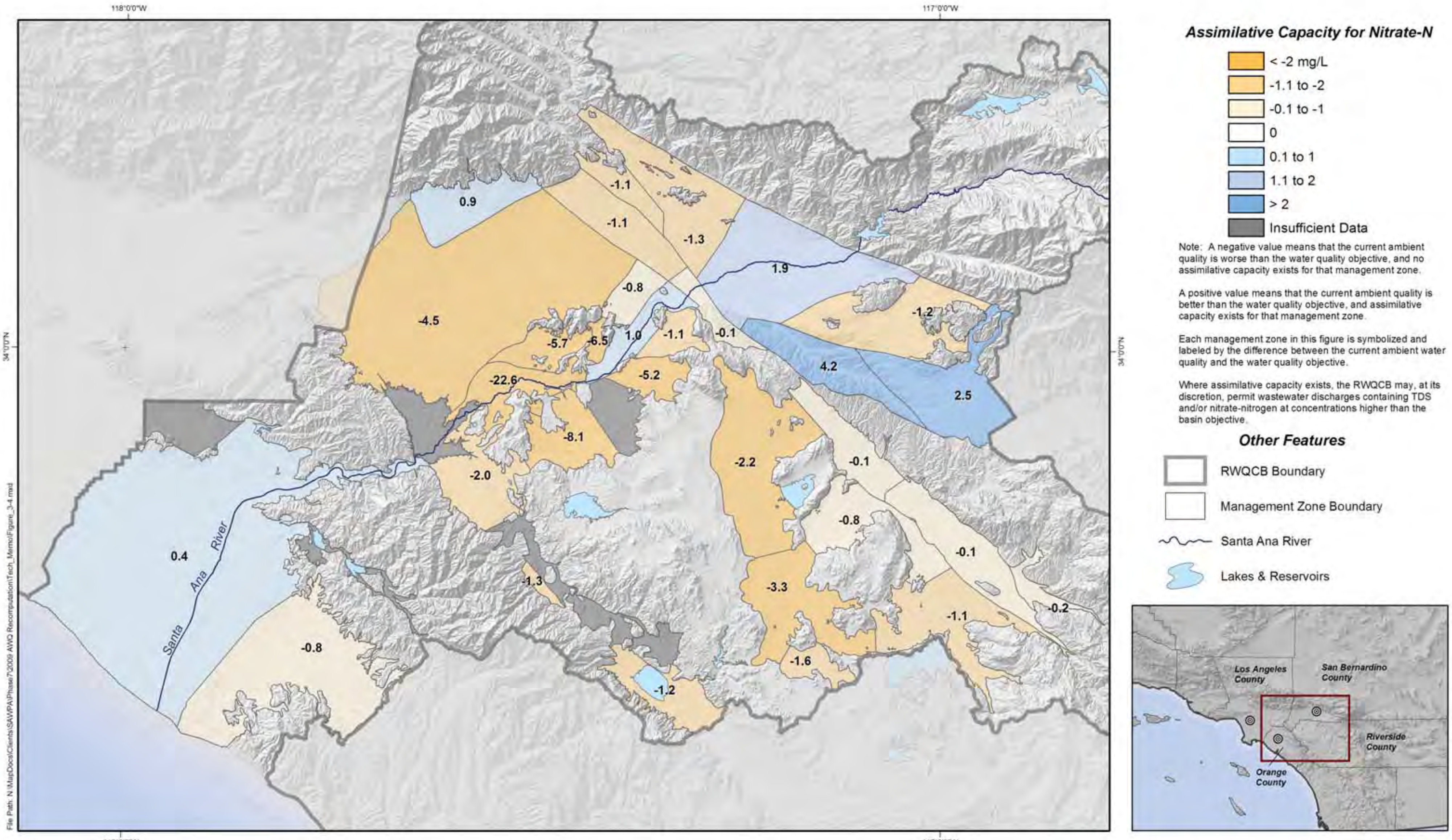
Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Assimilative Capacity for TDS

Santa Ana Watershed - 1990-2009

Figure 3-3



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0 5 10 15 Miles

0 5 10 15 20 25 KM

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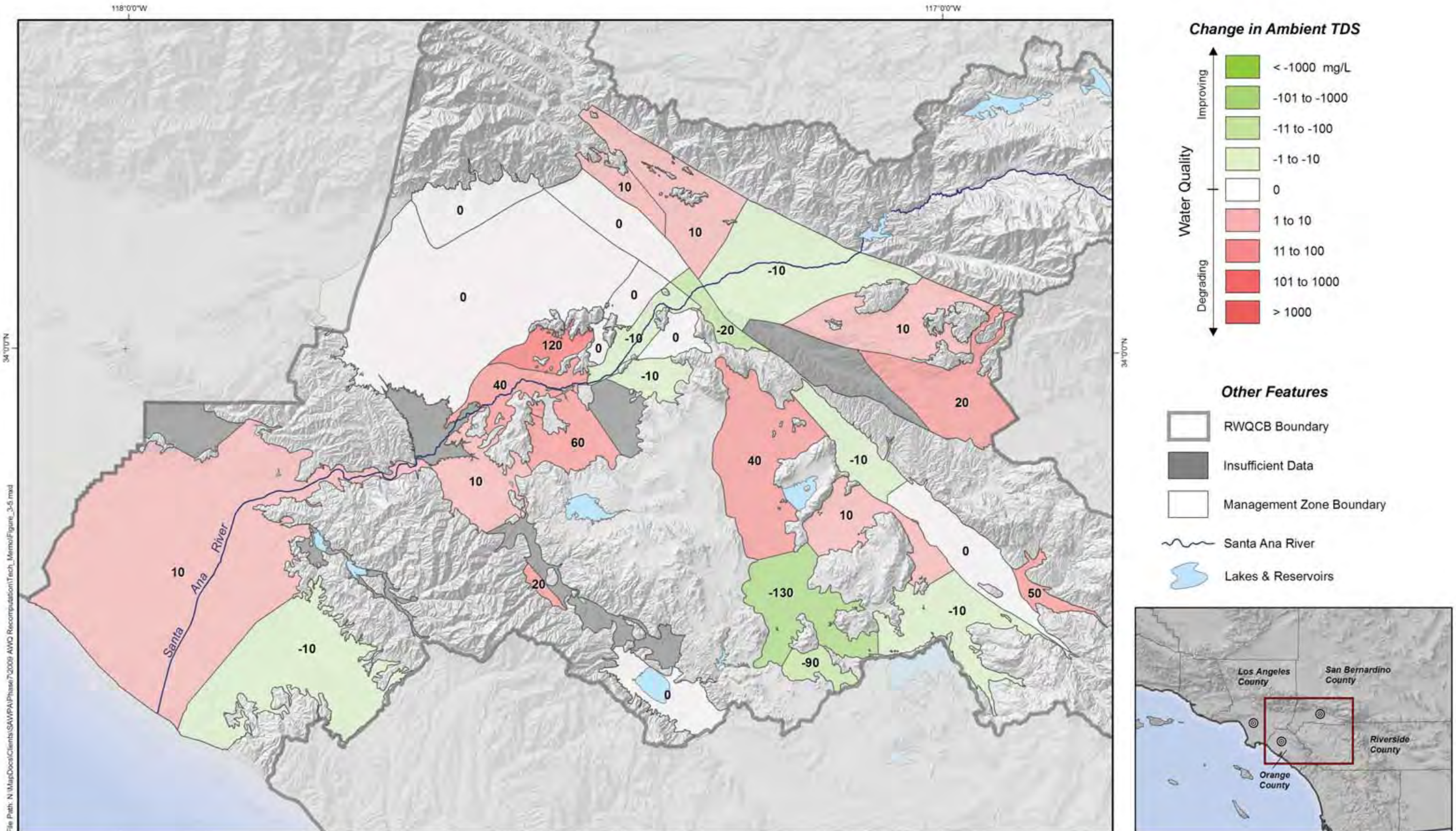
Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Assimilative Capacity for Nitrate-N

Santa Ana Watershed - 1990-2009

Figure 3-4



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0 5 10 15 Miles
0 5 10 15 20 25 KM

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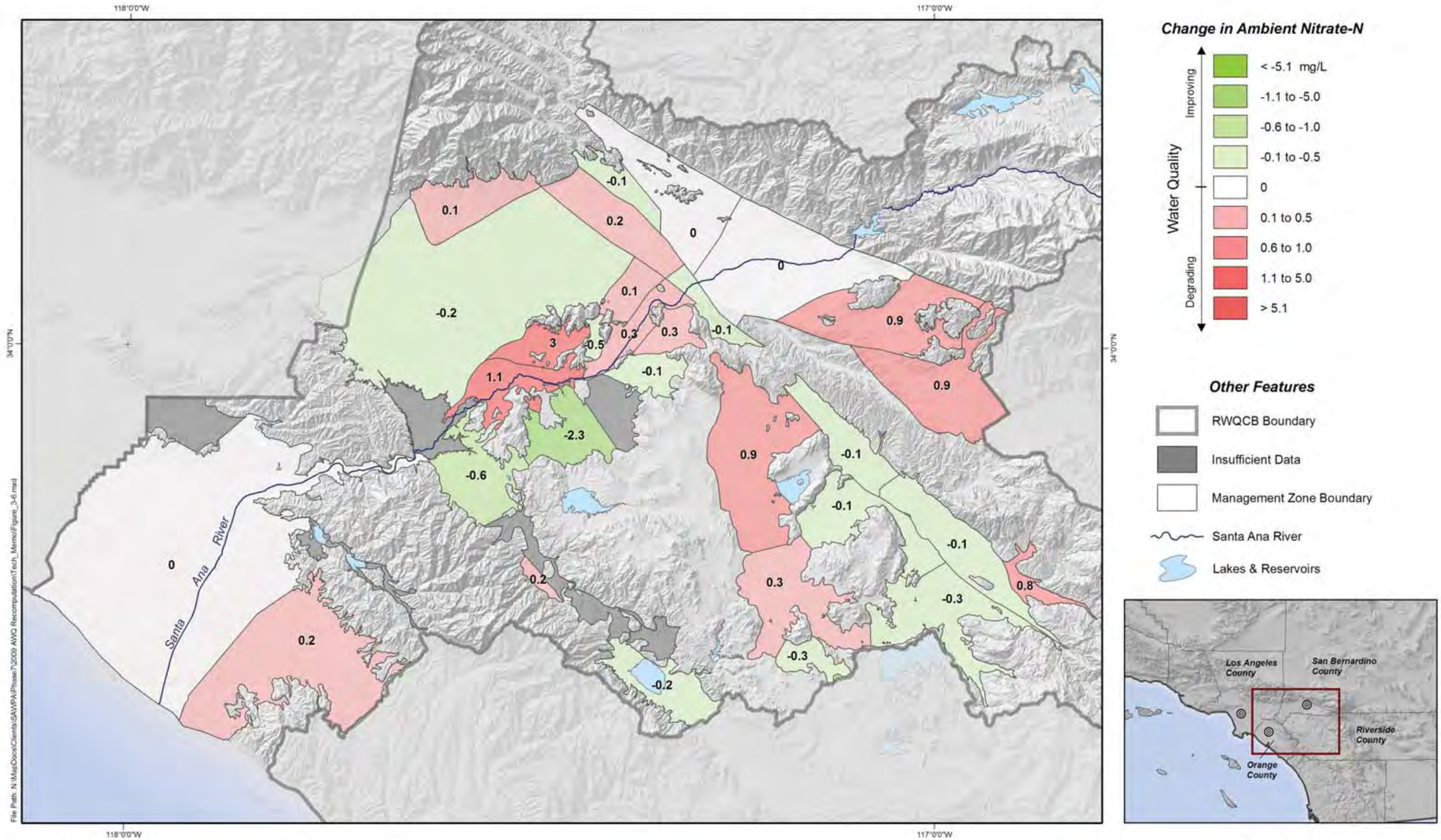
Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change in Ambient TDS

Santa Ana Watershed - 2006 to 2009

Figure 3-5



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File: Figure_3-6

0 5 10 15 Miles
0 5 10 15 20 25 KM

Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change in Ambient Nitrate-N

Santa Ana Watershed - 2006 to 2009

Figure 3-6

Section 4 – Interpretive Tools

The results of the ambient water quality computations indicate that groundwater quality has changed over time in most management zones. Listed below are a number of factors that can influence the estimation of ambient water quality:

- The discharge of solutes from the vadose zone to the saturated zone
- 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-nitrogen constituents in groundwater
- The gain/loss of wells with ambient statistics within the management zones
- The geographic distribution of gained/lost wells with ambient statistics within the management zones
- Differences in the techniques employed to contour and interpolate ambient water-quality statistics
- The elimination of three years (1987-89) of data from the analysis
- The addition of three years (2007-09) of data to the analysis

Changes in ambient water quality that result from the first three factors are measurable hydrologic and water chemistry changes that have occurred in the aquifer system. Herein, we refer to these changes as *systemic* factors. Changes in ambient water quality that result from the last five factors are driven by the methods and techniques employed in the recomputation. Herein, we refer to these changes as *methodological* factors. Note that the addition and elimination of data to the analysis are intentional factors that were designed to account for temporal water quality changes.

In most instances, both systemic and methodological factors play a role in the computed changes in ambient water quality for a management zone. The relative roles of each factor for each management zone, however, are not easily quantified, and rigorous analyses have not been scoped in past recomputation efforts.

In the comments submitted on the technical memorandum for the 1987-2006 recomputation effort (WEI, 2008), the BMPTF members posed the following questions (paraphrased):

- When the recomputation indicates a significant change in ambient water quality in a management zone, how can we distinguish between the methodological and systemic factors that may have influenced this change? (Addressed in Tasks 1 and 2 below.)
- Is there a method to characterize current groundwater-quality trends in the management zones that could be compared against the ambient water quality results? (Addressed in Tasks 1 and 2 below.)
- What can be done to minimize the methodological factors that influence ambient water quality? (Addressed in Task 3 below.)

The following tasks, or Interpretive Tools, were developed to address these questions:

- Task 1 – Prepare Change Maps for TDS and Nitrate-N in Management Zones
- Task 2 – Perform Interpretive Well Analysis of Water-Quality Trends
- Task 3 – Well Attrition Analysis for the Recomputation of Ambient Water Quality for 1993-2012

4.1 Change Maps for TDS and Nitrate-N in Management Zones (2006 to 2009)

The objective of this task was to show how and why the 2009 estimates of ambient water quality changed from the 2006 estimates for each management zone—essentially, an attempt to characterize the methodological and systemic factors that may have influenced changes in ambient water quality.

Eleven maps were prepared that display a two-dimensional, color-ramped grid of regional changes in TDS and nitrate-nitrogen concentrations within each management zone and each layer, where appropriate (see Figs 4-1 through 4-11). The maps cover the five major regions of the watershed: the San Bernardino Valley and the Beaumont/Yucaipa Plain, the Chino/Riverside Basins, the San Jacinto Basins, the Elsinore/Temescal Valley, and the Orange County Basin.

Change maps show the difference between prior (1987-2006) and current (1990-2009) mapping of regional nitrate-nitrogen and TDS concentrations in groundwater. Shades of red indicate areas where TDS and nitrate-nitrogen concentrations increased between the two periods. Shades of green indicate areas where TDS and nitrate-nitrogen concentrations decreased. The change maps also display wells that were used in one or both recomputation periods. A well symbolized with hollow circle means that it had an ambient water quality statistic for the first time in the 1990-2009 recomputation. A well symbolized with a hollow square means that it had an ambient water quality statistic for the 1987-2006 recomputation but not for 1990-2009 recomputation. Wells that had ambient water quality statistics in both periods (persistent wells) are symbolized with small black dots.

The most common factor that results in a significant change in the regional mapping of TDS and nitrate-nitrogen concentrations in groundwater is the addition of wells with ambient water quality statistics (hollow circles) where few or no wells with statistics existed previously. These areas are labeled and explained in Figures 4-1 through 4-11.

Changes in the regional mapping of TDS and nitrate-nitrogen concentrations in groundwater in areas where many persistent wells exist are likely due to measured trends in water quality at those wells. These areas are labeled and explained in Figures 4-1 through 4-11 and further described below in Section 4.2 – *Interpretive Well Analysis of Water-Quality Trends*.

4.2 Interpretive Well Analysis of Water-Quality Trends

As shown on the change maps, methodological factors can have a significant influence on the determination of ambient water quality in management zones. As a result, the methodological factors can mask the real trends in groundwater quality that might be occurring in management zones or in certain portions of management zones. This section describes the historical and current trends in groundwater quality in each management zone and, where possible, how these trends have influenced past estimates of ambient water quality and how they may influence future estimates.

A number of Interpretive Wells were selected for each management zone. These wells were selected based on location, perforated depths, the density and period of available water quality data, and the quality of the dataset. Since the management zones were designed as hydrologic units with defined areas of recharge and discharge, the locations of the Interpretive Wells were typically aligned along groundwater flow paths. The water quality trends at each Interpretive Well were compared to water quality data at the surrounding wells in an effort to choose Interpretive Wells that were generally representative of the groundwater quality within their respective portions of each management zone. The exact number of Interpretive Wells chosen was based on the size and complexity of each management zone. The Interpretive Wells are symbolized and labeled in Figures 4-1 through 4-11. Trends in groundwater quality at these wells were examined for the period of 1954 to 2009, with emphasis on trends within the current 20-year period (1990-2009).

Figures 4-12 through 4-77 are TDS and nitrate-nitrogen concentration time-history charts that were prepared for each management zone. The charts display the measured groundwater-quality data for the Interpretive Wells (1954-2009) and the five ambient water quality estimates for the management zone (1973, 1997, 2003, 2006, and 2009). The charts also illustrate how groundwater quality has changed over time in certain areas within each management zone and how these changes are influencing ambient water quality recomputations.

The Orange County Management Zone is a special case. The main objective of the Interpretive Well analysis here was to answer the question: *How is groundwater quality in the Orange County Management Zone being influenced by the recharge of the Santa Ana River?* Three sets of Interpretative Wells were selected. The first set of wells is located just up-gradient from the Anaheim Forebay recharge facilities, where it is assumed that water chemistry is influenced by the recharge of Santa Ana River water and minor underflows from up-gradient areas. Santa Ana River water is composed of storm flows, base flow (POTW discharge, rising groundwater, urban runoff), imported water, and other non-tributary flows. The second set of wells is located just down-gradient from the Anaheim Forebay recharge facilities, where Santa Ana River water is diverted and recharged. In addition to Santa Ana River water, Groundwater Replenishment System water is recharged at these facilities. A third set of wells were selected to characterize water quality trends throughout the rest of the management zone.

Table 4-1 lists the Interpretive Wells selected for each management zone, the well owners (or the data-supplying agency in the case of the OCWD and EMWD), well names, screened intervals (if known), which aquifer layer wells are screened across (if applicable), well selection criteria, and water quality trend interpretations for each well. The table also shows the five determinations of ambient water quality (1973, 1997, 2003, 2006, and 2009) for each management zone and management zone sizes.

Listed below are the conclusions derived from the analysis of the Interpretive Wells for several management zones.

Chino-1, Chino-2, and Chino-3 (collectively Chino-North). Practically all of the Interpretive Wells in these management zones display persistent trends of degradation for both TDS and nitrate-nitrogen. The trends in degradation appear to be occurring at higher rates during the last 20 years, compared to prior periods. These trends in degradation are, in part, responsible for the increased concentrations in past estimates of ambient water quality and will likely result in higher future estimates of ambient TDS and nitrate-nitrogen concentrations for these management zones. The only area that has not experienced degradation of groundwater quality is the northern portion of Chino-2 (as illustrated by well CVWD-5), which is directly downgradient of artificial recharge facilities that have historically recharged stormwater runoff and imported water from the Sacramento Delta.

Chino-South. The Interpretive Wells in the Chino-South Management Zone display a historical trend of degradation for both TDS and nitrate-nitrogen from about 1990 to 2000. Since 2000, TDS and nitrate-nitrogen concentrations in groundwater have remained relatively stable or have improved slightly. The recent trends in groundwater quality may be due to agricultural land-use conversions to urban uses and by the enhancement of recharge of the Santa Ana River caused by drawdown associated with pumping at the Chino Desalter Well Field. That said, the Interpretive Well data do not explain the large increases in ambient TDS and nitrate-nitrogen for this management zone in 2003, 2006, and 2009. The increased monitoring by Chino Basin Watermaster at wells in this area resulted in an improved characterization of ambient water quality but at higher concentrations (methodological factor).

Orange County. As previously stated, the main objective of the Interpretive Well analysis in the Orange County Management Zone was to answer the question: *How is groundwater quality in the Orange County Management Zone being influenced by the recharge of the Santa Ana River?* Two Interpretative Wells were selected up-gradient from the Anaheim Forebay recharge facilities, and five were selected directly down-gradient, all within the principal aquifer. The OCWD has determined that groundwater in the area of the downgradient wells originated as surface-water percolation at the recharge facilities and is less than about 25 years old.

These two sets of Interpretive Wells are under the direct influence of recharge of Santa Ana River water and display a general trend of improvement for both TDS and nitrate-nitrogen from about 1990 through 2009. In particular, well SCWD-PLJ2/1 shows a rapid decrease in TDS concentrations from about 500 mg/L in 2008 to about 300 mg/L in 2010, which is due to the recent recharge of water from the OCWD's Groundwater Replenishment System. The ambient TDS concentration for the Orange County Management Zone has increased from 2003 (560 mg/L) to 2006 (590 mg/L) and to 2009 (600 mg/L). This increase in ambient TDS concentrations is not explained by the decreased TDS concentrations in groundwater both up-gradient and downgradient from the Anaheim Forebay recharge facilities but is mainly due to the increased monitoring of seawater intrusion in the coastal regions of the management zone (see the Change Maps in Figures 4-10 and 4-11).

Coldwater. TDS concentrations at the Interpretive Wells in the Coldwater Management Zone react to trends in precipitation: concentrations increase during dry periods and decrease during wet periods. However, since the 1990s, the TDS concentrations in groundwater have gradually increased, which has caused the ambient TDS concentration to increase from 380 mg/L in 1997 to 440 mg/L in 2009.

Beaumont. From the 1960s to present, TDS concentrations at the Interpretive Wells in this management zone have gradually increased. Nitrate-nitrogen concentrations at the Interpretive Wells increased from the 1960s to the early 1980s. Since 1980, nitrate-nitrogen concentrations have increased in the western portion of the basin (YVWD 35) and in the area of the Beaumont Basin below Edgar Canyon (BCVWD 16), while nitrate-nitrogen concentrations have remained relatively stable in Edgar Canyon (BCVWD 04A) and in the central portion of the Beaumont Basin (BCVWD 01). These general trends in degradation are, in part, responsible for the increased ambient water quality concentrations from 1973 to 2009 and will result in higher future estimates of ambient TDS and nitrate-nitrogen concentrations for this management zone if the trends continue.

Yucaipa. TDS concentrations at the Interpretive Wells across much of this management zone have fluctuated over time but have generally remained stable. A gradual trend of TDS degradation occurred in the central part of the management zone since about 1980, as shown by the TDS concentrations at wells YVWD-10 and YVWD-12. The ambient TDS concentration for the management zone has remained relatively stable since 1973 (between 310 mg/L to 330 mg/L). Nitrate-nitrogen concentrations gradually increased at the Interpretive Wells from the 1970s to the mid-1990s but have remained relatively stable or decreased since. The ambient nitrate-nitrogen concentration for the management zone has increased since 1973, which is due, in part, to the long-term increases in nitrate-nitrogen in groundwater from the 1970s to the mid-1990s.

Bunker Hill-A and Bunker Hill-B. TDS concentrations at the Interpretive Wells across much of the Bunker Hill-A Management Zone have gradually increased over time. This trend in TDS degradation is particularly evident the areas north of the Pressure Zone and within the Pressure Zone (wells PL-27 and SBWD-Mill&D). Nitrate-nitrogen concentrations at the Interpretive Wells in Bunker Hill-A have remained relatively stable or have decreased over the past 20 years. In the Bunker Hill-B management zone, the TDS and nitrate-nitrogen concentrations at the Interpretive Wells have generally remained stable or improved over the last 20 years.

San Jacinto – Lower Pressure. Since 2000, TDS concentrations at the Interpretive Wells in this management zone have generally decreased. These general trends in improvement are, in part, responsible for the decreased concentration of ambient TDS from 2003 to 2009 and will result in lower future estimates of ambient TDS concentrations for this management zone if these trends continue.

San Jacinto – Upper Pressure. TDS concentrations at the Interpretive Wells in this management zone gradually decreased from the mid-1990s until 2008-09, when TDS concentrations at four of the five Interpretive Wells increased. The most significant TDS concentration increase was at the Lauda Beebower well, where TDS concentrations increased from about 550 mg/L in 2007 to over 5,100 mg/L in 2009. Ambient TDS concentrations for this management zone were stable from 1973 to 2009, fluctuating between 320 mg/L to 370 mg/L. If the recent trend of increasing TDS in groundwater continues, future estimates of ambient TDS concentrations will increase. Nitrate-nitrogen concentrations at the Interpretive Wells have remained stable over time.

Riverside-A. During the 1990s, TDS concentrations at the Interpretive Wells in this management zone decreased. Since about 2000, TDS concentrations at the Interpretive Wells have remained stable or increased slightly. The ambient TDS concentration for this management zone has remained relatively stable since 1997. For nitrate-nitrogen, the Interpretive Wells indicate that concentrations in groundwater across much the management zone have increased since the mid-1990s. This trend in degradation is, in part, responsible for the increased concentrations of ambient nitrate-nitrogen for the management zone since 1997 and will likely result in higher future estimates of ambient nitrate-nitrogen concentrations. These trends are significant because the assimilative capacity of this management zone has eroded since 1997. The 2009 (current) ambient nitrate-nitrogen concentration is 5.2 mg/L and the objective is 6.2 mg/L.

Canyon. Since the 1980s, TDS concentrations at the Interpretive Wells in this management zone have gradually increased to the present. These trends in degradation are, in part, responsible for the increased concentrations of ambient TDS from 1973 to 2009 and will result in higher future estimates of ambient TDS concentrations for this management zone if the trends continue.

4.3 Well Attrition Analysis for the 1993-2012 Period

The next triennial ambient water quality recomputation will involve the analysis of water quality data for the period of 1993-2012. The objective of this task is to identify wells that will be lost from the next recomputation if no water quality data are collected during 2010-2012. Table 4-2 lists these wells, and their locations are shown in Figure 4-78. The well attrition analysis consisted of the following steps:

- Develop ambient water quality statistics for 1993-2012 using the 1990-2009 database. In effect, this removes three years of data from the backend of the study period, while no new data will be added to the front end, as data from 2010-12 have not yet been collected. This is considered the 'worst case' scenario, simulating a condition where no sampling occurs after 2009.
- Compare wells that have statistics in the 1990-2009 period to those that have statistics in the 1993-2012 period, and identify wells that will be lost if no new data are obtained. Table 4-2

lists these wells. Wells that may be lost were categorized using the following criteria:

- Wells that are known to be destroyed or have a status of "unknown" are listed as such and are shown in grey. It is assumed that these wells cannot be sampled. The Task Force and local agencies may wish to pursue the replacement of destroyed wells that are deemed to be critical to the recomputation effort on a case by case basis.
- Wells with statuses of active, inactive, or abandoned have been considered potentially able to be sampled. Of these wells, a small subset of "high priority" wells was selected based on the estimated impact of their loss to the contouring effort. In Table 4-2, these wells are shown in red. Sampling the remaining wells is considered a lower priority.

The well attrition analysis identified 93 wells and 113 wells that may be lost from the recomputation of nitrate-nitrogen and TDS, respectively, if no water quality data are collected from these wells during 2011-12 (Table 4-2). A total of 148 unique wells are at risk of losing one or both of their ambient water quality statistics. These wells were plotted on watershed maps alongside nearly 2,400 wells that will not be lost (see Figure 4-78). Of the potential lost wells, 78 are assumed to be destroyed or are otherwise unable to be sampled (shown in grey on Table 4-2). Of the 70 wells that are able to be sampled, eight are considered "high priority" and must be sampled in 2011 and 2012 in an effort to continue to produce ambient water quality statistics at those wells (shown in red on Table 4-2). The eight "high priority" wells were identified as being critical to the contouring of ambient water quality. The loss of these wells from future studies would adversely affect the mapping of regional groundwater quality, thus affecting the ambient water quality determination of the management zones in which they are located (methodological factor).

The well attrition analysis is a forward-looking tool that provides an opportunity for the Task Force to prevent the loss of wells in the next triennial recomputation. WEI recommends that wherever possible, "high priority" wells (shown in red on Table 4-2) be sampled for TDS, nitrate-nitrogen, and the general minerals listed in Table 2-2 during calendar years 2011 and 2012. Annual sampling at these wells would be preferred.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Beaumont	110	1973 1997 2003 2006 2009	330 290 260 260 280	5 2.6 2 1.6 2.5	Beaumont Cherry Valley Water District	BCVWD 04A	18 to 245		Well located in the northern, up-gradient portion of the management zone, near areas of imported water and storm water recharge.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained relatively flat. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated.
					Beaumont Cherry Valley Water District	BCVWD 16	530 to 1100		Well located in the northern, up-gradient portion of the management zone, near areas of imported water and storm water recharge.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Yucaipa Valley Water District	YVWD 35	150 to 790		Well located in the western portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Beaumont Cherry Valley Water District	BCVWD 01	320 to 694		Well located in the central portion of the management zone, away from recharge facilities.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained relatively stable. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					private owner	Ranch Well	unknown		New well is located in the South Beaumont area and is sampled regularly as part of maximum benefit monitoring. Well is located in an isolated area of high TDS/NO3-N concentrations.	There is not enough data to identify a trend at this well. TDS and nitrate-nitrogen concentrations in groundwater are high in South Beaumont.
Yucaipa	103	1973 1997 2003 2006 2009	370 330 310 310 320	5 5.2 5.4 5.3 6.2	Yucaipa Valley Water District	YVWD 14	unknown		Well is located in the northern, up-gradient portion of the management zone, in an area of mountain front recharge.	TDS and nitrate-nitrogen concentrations in groundwater decreased through 2000 but have increased during the past 10 years.
					Yucaipa Valley Water District	YVWD 18	294 to 584		Well is located in the central portion of the management zone, downgradient of recharge facilities.	TDS concentrations decreased through 2000 but have increased during the past 5 years, while nitrate-nitrogen concentrations have increased slightly over the past 20 years.
					Yucaipa Valley Water District	YVWD 12	250 to 564		Well is located in the central portion of the management zone.	TDS concentrations have increased over the past 20 years, while nitrate-nitrogen concentrations have decreased through 2000 and have remained stable during the past 10 years. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation.
					Western Heights Water Company	WHWC 10	330 to 670		Well is located in the central-western portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Yucaipa Valley Water District	YVWD 28	unknown		Well is located in the eastern portion of the management zone, in areas of storm water percolation.	TDS concentrations have decreased through 2000, and have increased during the past 5 years, while nitrate-nitrogen concentrations have remained relatively stable over the past 15 years.
					City of Redlands	Redlands 10	unknown		Well is located in the western portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Bunker Hill-A	110	1973 1997 2003 2006 2009	310 350 320 330 340	2.7 4.5 4.3 4 4	City of San Bernardino	SBWD Devil Canyon 2	177 to 400		Well is located in the northern, up-gradient portion of the management zone, near areas of storm water and artificial recharge.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					City of San Bernardino	SBWD Newmark 1	186 to 406		Well is located in the northern, up-gradient portion of the management zone, downgradient from areas of storm water and artificial recharge.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					East Valley Water District	PL-27	188 to 546		Well is located in the central, up-gradient portion of the management zone, near areas of storm water and artificial recharge.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					City of San Bernardino	SBWD Mill & D	144 to 417	12	Well is located in the southern, downgradient portion of the management zone, in the Bunker Hill Pressure Zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of San Bernardino	SBWD Cajon Canyon	40 to 169		Well is located in the northern, up-gradient portion of the management zone, near areas of storm water recharge.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
Bunker Hill-B	180	1973 1997 2003 2006 2009	330 260 280 280 270	7.3 5.5 5.8 5.4 5.4	City of Redlands	E LUGONIA 4	120 to 192		Well is located in the northern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Redlands	Redlands 30-A	200 to 482		Well is located in the central, up-gradient portion of the management zone, near areas of historical agricultural land uses.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
					City of Redlands	Redlands 41	150 to 442		Well is located in the central, up-gradient portion of the management zone, near areas of historical agricultural land uses.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					East Valley Water District	PL-12A	474 to 593	2	Well is located in the southern, downgradient portion of the management zone, in the Bunker Hill Pressure Zone	TDS concentrations have remained flat in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well are not likely to change in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					East Valley Water District	PL-40	245 to 750		Well is located in the central portion of the management zone, adjacent to the Santa Ana River.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
Colton	25	1973 1997 2003 2006 2009	410 430 430 450 430	2.7 2.9 2.9 2.9 2.8	City of Colton	CLT 23	200 to 930		Well is located adjacent to the Santa Ana River, in an area of storm water recharge.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Colton	CLT 22	160 to 850		Well is located south and up-gradient of the Santa Ana River.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS (mg/L)	NO_3-N (mg/L)	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer (if applicable)	Selection Criteria	Interpretations
Lytle	28	1973 1997 2003 2006 2009	260 240 230 230 240	1.5 2.8 2.7 2.7 2.6	City of San Bernardino	SBWD Mallory 03	380 to 628		Well is located in the southern, downgradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient TDS or nitrate-nitrogen statistics are anticipated at this well in the 2012 recomputation.
					Fontana Water Company	F42A	80 to 140		Well is located in the north eastern, up-gradient portion of the management zone, near areas of storm water recharge	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Fontana Water Company	F28A	10 to 380		Well is located in the central portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Muscoy Mutual Water Company	WELL 03	240 to 433		Well is located in the north-central portion of the management zone, adjacent to the management zone boundary.	TDS and nitrate-nitrogen concentrations in groundwater have been flat in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
Rialto	71	1973 1997 2003 2006 2009	230 230 220 230 230	2 2.7 2.6 2.9 3.1	City of Colton	CLT 17	194 to 778		Well is located in the southern, downgradient portion of the management zone, closest to the Santa Ana River.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					West Valley Water District	WVWD 11	310 to 787		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					County of San Bernardino	MID F-9	unknown		Well is located in the northern, up-gradient portion of the management zone, near areas of storm water recharge.	TDS and nitrate-nitrogen concentrations in groundwater have been flat in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
Riverside-A	38	1973 1997 2003 2006 2009	560 440 440 440 430	6.2 4.4 4.9 4.9 5.2	Riverside Highland Water Company	RN 20	unknown		Well located in the northern, up-gradient portion of the management zone, where recharge occurs along the Santa Ana River and groundwater enters the basin via underflow from the Colton Management Zone.	TDS and nitrate-nitrogen concentrations in groundwater have generally increased in this portion of the basin during the past 50 years. In the last 20 years, TDS concentrations decreased for a period between the early and mid 1990s but have increased during the 15 years since. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Riverside	FLUME 6	152 to 438		Well located in the northern up-gradient portion of the management zone, where recharge occurs along the Santa Ana River.	TDS concentrations have decreased in this portion of the basin over the past 40 years. Nitrate-nitrogen concentrations have increased since the early 1990s, by about 2 mg/L over that 20 year period. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the nitrate-nitrogen statistic is likely to increase.
					City of Riverside	GARNER B	unknown		Well located in the central portion of the management zone, adjacent to the Santa Ana River. Recharge occurs here from river infiltration as well as underflow from the Riverside F Management Zone.	TDS concentrations have decreased in this portion of the basin over the past 40 years. Nitrate-nitrogen concentrations have increased since the early 1990s, by about 4 mg/L over that 20 year period. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the nitrate-nitrogen statistic is likely to increase.
					Rubidoux Community Services District	RCSD #4 Old Skotty	87 to 252		Well located in the central portion of the management zone, adjacent to the Santa Ana River. Recharge occurs here from river infiltration.	TDS concentrations are decreasing in this portion of the basin over the past 30 years. Nitrate-nitrogen concentrations peaked to above 15 mg/L in the early 1990s but have decreased since then by about 3 mg/L over that 20 year period. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Rubidoux Community Services District	RCSD #2 Troyer	unknown		Well located in the southern downgradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	Ambient Water Quality: TDS mg/L	Ambient Water Quality: NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Riverside-B	27	1973 1997 2003 2006 2009	290 320 310 340 340	7.6 8 7.8 8.3 8.4	City of Rialto	CHINO 2	530 to 710		Well is located in the northern, up-gradient portion of the management zone, near areas of underflow from the adjacent Rialto Management Zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					West Valley Water District	WVWD 29	162 to 236		Well is located in the central portion of the management zone.	Historical trends at this location show that nitrate-nitrogen concentrations have increased since the 1950s. A lack of recent samples precludes any trend analysis at this location over the past 20 years. This well is identified as a 'high priority' well in the Well Attrition analysis and should be sampled going forward.
					City of Colton	CLT 24	250 to 644		Well is located in the northern, up-gradient portion of the management zone, near areas of underflow from the adjacent Rialto Management Zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					West Valley Water District	WVWD 18A	320 to 520		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
Riverside-C	8	1973 1997 2003 2006 2009	680 760 750 740 740	8.3 15.5 15.3 15.3 14.8	*n/a*	*n/a*			*No active wells being sampled*	
Riverside-E	30	1973 1997 2003 2006 2009	720 720 700 710 700	10 14.8 15.4 15.3 15.2	City of Riverside	MULBERRY	143 to 300		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					City of Riverside	FILL	182 to 252		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					City of Riverside	FIRST STREET	62 to 228		Well is located in the northern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
Riverside-F	25	1973 1997 2003 2006 2009	660 580 570 570 570	9.5 9.5 10.6 10.3 10.6	Riverside Highland Water Company	RN 7	80 to 380		Well is located in the central, up-gradient portion of the management zone, closest to areas of inflow from the Riverside A Management Zone	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					City of Riverside	ELECTRIC STREET	82 to 153		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					City of Riverside	TWIN SPRINGS	240 to 375		Well is located in the central, downgradient portion of the management zone, near areas of outflow to the Riverside A Management Zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality			Interpretive Wells					
		Year	TDS mg/L	NO_3-N mg/L	Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Arlington	55	1973 1997 2003 2006 2010	980 ? 1020 960 1020	10.0 ? 26.0 20.4 18.1	City of Riverside	Army 1	unknown		Well located in the eastern portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Western Municipal Water District	AD-5	80 to 130		Well is located along the axis of the management zone, downgradient from any sources of recharge.	TDS concentrations have increased in this portion of the basin in the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate statistic at this well is likely decrease.
					Western Municipal Water District	AD-1	95 to 195		Well is located along the axis of the management zone, downgradient from any sources of recharge.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Western Municipal Water District	AD-3	80 to 180		Well is located along the axis of the management zone, downgradient from any sources of recharge and up-gradient of the point of groundwater outflow to the Temescal Management Zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
Coldwater	7	1973 1997 2003 2006 2009	380 380 400 420 440	1.5 2.6 2.4 2.6 2.8	City of Corona	COR 03	unknown		Well is located in the central portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					City of Corona	COR 01	176 to 532		Well is located in the central portion of the management zone.	TDS concentrations have increased in this portion of the basin in the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					Elsinore Valley Municipal Water District	EVMWD Station 71	239 to 588		Well is located in the southern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Elsinore Valley Municipal Water District	EVMWD Mayhew 2	400 to 700		Well is located in the southern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
Elsinore	61	1973 1997 2003 2006 2009	480 480 460 470 470	1 2.6 2.4 2.4 2.2	Santa Ana Watershed Project Authority	CEREAL STREET 3	448 to 1965		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased slightly in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well may decrease in the 2012 recomputation.
					Santa Ana Watershed Project Authority	CEREAL STREET 4	380 to 1700		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased slightly in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well may decrease in the 2012 recomputation.
					Elsinore Valley Municipal Water District	EVMWD Cereal 1	420 to 1410		Well is located in the southern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased slightly in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well may decrease in the 2012 recomputation.
					Elsinore Valley Municipal Water District	EVMWD Corydon	340 to 1260		Well is located in the southern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased slightly in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well may decrease in the 2012 recomputation.
					Elsinore Valley Municipal Water District	EVMWD Machado	570 to 960		Well is located in the northern, downgradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.

WILDERMUTH ENVIRONMENTAL INC.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	Ambient Water Quality: TDS mg/L	Ambient Water Quality: NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Temescal	73	1973 1997 2003 2006 2009	770 780 700 780 790	10 13.2 12.8 12.6 12	City of Corona	COR 15	unknown		Well is located in the northern, downgradient portion of the management zone, near areas of recycled water recharge.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					City of Corona	COR 11	126 to 234		Well is located in the northern, downgradient portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					City of Corona	COR 14	unknown		Well is located in the central portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have decreased. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to decrease.
					Riverside Co. Waste Management Dept	Corona CG-5	83 to 103		Well is located in the eastern, up-gradient portion of the management zone, near areas of underflow from the adjacent Arlington management zone and storm water recharge from Temescal Creek.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
Hemet-South	102	1973 1997 2003 2006 2009	730 1030 850 920 910	4.1 5.2 5.4 5.5 5.2	Eastern Municipal Water District	McMillan South	unknown		Well is located in the eastern portion of the management zone.	TDS concentrations have remained flat in this portion of the basin during the past 15 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is not likely to change in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
					Eastern Municipal Water District	EMWD Little Valley	unknown		Well is located in the eastern portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 15 years. No major changes in ambient TDS or nitrate-nitrogen statistics are anticipated at this well in the 2012 recomputation.
					Eastern Municipal Water District	EMWD 30 Sierra Dawn	150 to 196		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
					Eastern Municipal Water District	City of Hemet 04	300 to 676		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
Lakeview/Hemet-North	71	1973 1997 2003 2006 2009	520 830 840 880 890	1.8 2.7 3.4 2.7 2.6	Eastern Municipal Water District	Ferriera Dairy	unknown		Well is located in the northern portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
					Eastern Municipal Water District	Lauda Diesel	unknown		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable. The ambient TDS statistic is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	EMWD 32 New Dairyland	400 to 780		Well is located in the eastern portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation
					Eastern Municipal Water District	Smith C Nuevo/ Olivas	unknown		Well is located in the western portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km²)	Ambient Water Quality Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Menifee	23	1973 1997 2003 2006 2009	1020 3360 2220 2140 2050	2.8 5.4 6 4.7 4.4	Eastern Municipal Water District	EMWD 71 Menifee 01	unknown		Well is located in the central portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	EMWD 73 Menifee 03	unknown		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
Perris-North	154	1973 1997 2003 2006 2009	570 750 780 730 770	5.2 4.7 6.7 6.5 7.4	Eastern Municipal Water District	Lantz West	unknown		Well is located in the northern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					Eastern Municipal Water District	EMWD 48 Edgemont 04	unknown		Well is located in the northern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Eastern Municipal Water District	EMWD 57 New Follico	220 to 600		Well is located in the southern, downgradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Eastern Municipal Water District	EMWD 56 New Perry	unknown		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
Perris-South	102	1973 1997 2003 2006 2009	1260 3190 2200 2600 2470	2.5 4.9 5.9 5.5 5.8	Eastern Municipal Water District	EMWD Skiland 05	unknown		Well is located in the northern portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Eastern Municipal Water District	EMWD Winchester Ponds 02	unknown		Well is located in the eastern portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have fluctuated up and down in this portion of the basin during the past 20 years.
					Eastern Municipal Water District	EMWD B6	unknown		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Eastern Municipal Water District	EMWD A1	unknown		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Eastern Municipal Water District	EMWD C4	200 to 220		Well is located in the southern portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
San Jacinto-Lower	54	1973 1997 2003 2006 2009	520 730 950 810 800	1 1.9 1.8 1.2 1.1	Eastern Municipal Water District	EMWD 42 Reche Canyon	unknown		Well is located in the northern, up-gradient portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have increased. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while the ambient nitrate-nitrogen statistic is likely to increase.
					Eastern Municipal Water District	Fish & Game Bouris	unknown		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	Fish & Game Walker Duck Club	735 to 1035		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	Fish & Game Fence	unknown		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	Fish & Game Cannery Feedlot	350 to 720		Well is located in the southern, downgradient portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
San Jacinto-Upper	85	1973 1997 2003 2006 2009	320 370 370 350 350	1.4 1.9 1.7 1.6 1.5	Eastern Municipal Water District	EMWD 14 Riverbed	252 to 1000		Well is located in the southern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Eastern Municipal Water District	LHMWD 11	786 to 1360		Well is located in the southern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					Eastern Municipal Water District	Golden Era 03	unknown		Well is located in the central portion of the management zone.	TDS concentrations have decreased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L. The ambient TDS statistic at this well is likely to decrease in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	EMWD 27 Hewitt/Evans	364 to 1676		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					Eastern Municipal Water District	Lauda Beebower (N of Dike)	unknown		Well is located in the northern, downgradient portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, especially in the past 5 years where concentrations have increased from about 550 to over 5,000 mg/L. Nitrate-nitrogen concentrations have remained stable at levels below 1.0 mg/L during the past 20 years. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Canyon	18	1973 1997 2003 2006 2009	230 220 420 370 420	2.5 1.6 2.1 1.9 2.7	Eastern Municipal Water District	EMWD 17 Cienega	unknown		Well is located in the western, downgradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Eastern Municipal Water District	LHMWD 14	unknown		Well is located in the central portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained relatively stable. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
					Eastern Municipal Water District	LHMWD 04	unknown		Well is located in the eastern, up-gradient portion of the management zone.	TDS concentrations have increased in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have remained relatively stable. The ambient TDS statistic at this well is likely to increase in the 2012 recomputation, while no major change in the ambient nitrate-nitrogen statistic is anticipated at this well.
Chino-North	491	1973 1997 2003 2006 2009	420 300 320 340 340	5 7.4 8.7 9.7 9.5	*see Chino 1, Chino 2, and Chino 3 collectively*					
Chino 1	160	1973 1997 2003 2006 2009	280 310 330 340 340	5 8.4 8.9 9.3 9.1	Monte Vista Water District	MVWD 05	600 to 990	3	Well located in the northern, up-gradient portion of the management zone, near areas of artificial recharge of storm water, imported water, and recycled water.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Pomona	P-23	235 to 635	2 and 3	Well located in the northern, up-gradient portion of the management zone, near areas of artificial recharge of storm water, imported water, and recycled water, and within a regional depression of groundwater levels due to an historical imbalance of groundwater production and recharge.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Chino	05	430 to 1078	2 and 3	Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Chino Hills	CH HIL 07A	135 to 290	1 and 2	Well is located in the southern, downgradient portion of the management zone, within the shallow aquifer system.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Inland Empire Utilities Agency	HCMP-3/1	110 to 150	1	Well is located in the southern, downgradient portion of the management zone, within the shallow aquifer system.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 5 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

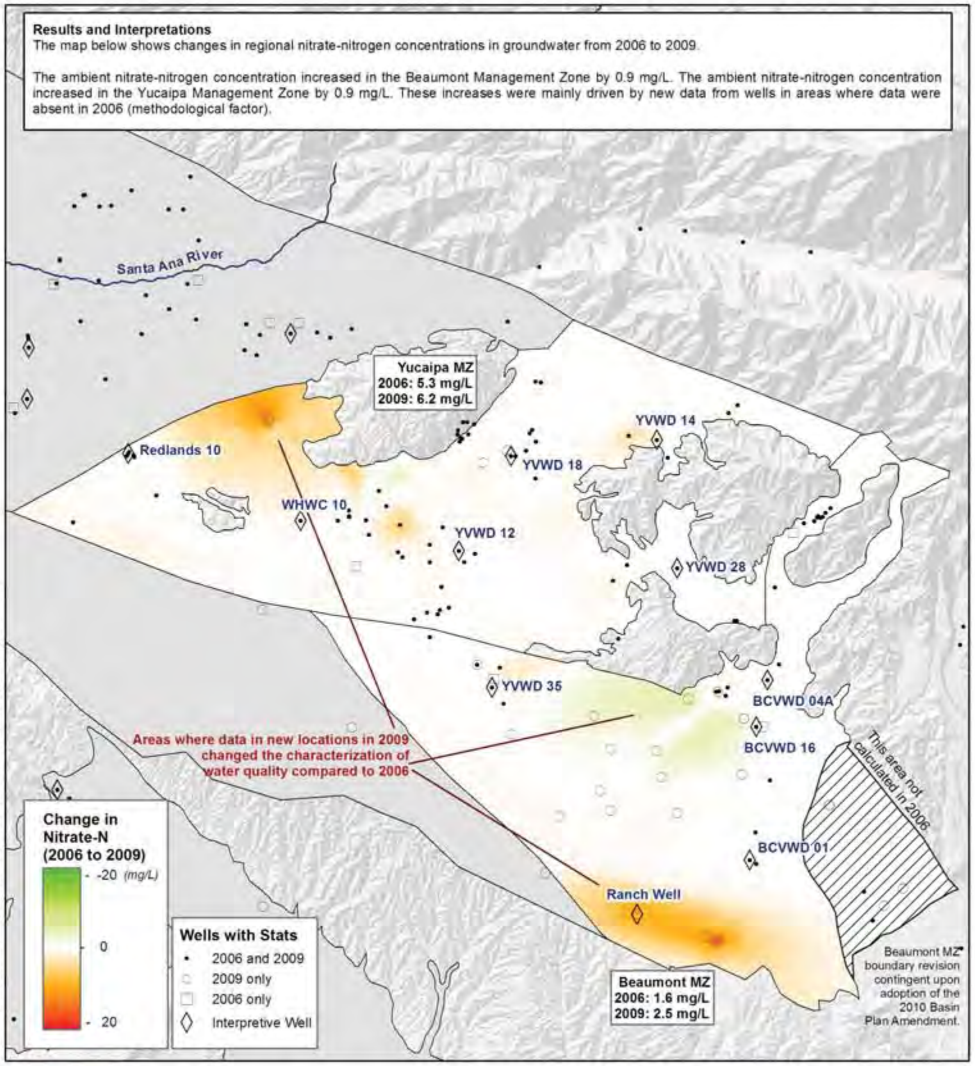
Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Chino 2	176	1973 1997 2003 2006 2009	250 300 340 360 360	2.9 7.2 9.5 10.7 10.3	Cucamonga Valley Water District	CVWD 5	538 to 1238	2 and 3	Well located in the northern, up-gradient portion of the management zone, downgradient of artificial recharge facilities.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					City of Ontario	ONT 17	415 to 1007	1, 2, and 3	Well is located in the central portion of the management zone, downgradient of artificial recharge facilities.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Chino Basin Desalter Authority	I-5	160 to 385	1 and 2	Well is located in the southern, downgradient portion of the management zone and is a supply well for the Chino Desalter facility.	TDS and nitrate-nitrogen concentrations in groundwater are high and have increased in this portion of the basin during the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Inland Empire Utilities Agency	HCMP-1/1	135 to 175	1	Well is located in the southern, downgradient portion of the management zone, within the capture zone of the Chino Desalter well field.	There is insufficient data to identify a trend at this well. TDS and nitrate-nitrogen concentrations in groundwater are high in the vicinity of the Chino Desalter well field, as shown by data collected at this well over the past 5 years.
Chino 3	156	1973 1997 2003 2006 2009	260 280 280 310 320	3.5 6.3 6.8 8.2 8.4	Fontana Water Company	F37A	378 to 810	2 and 3	Well located in the northeastern, up-gradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					City of Ontario	ONT 31	400 to 980	2 and 3	Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Jurupa Community Services District	JCSD 16	225 to 275	2 and 3	Well is located in the southern, downgradient portion of the management zone and is located downgradient of artificial recharge facilities.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Chino Basin Desalter Authority	II-2	156 to 312	2 and 3	Well is located in the southern, downgradient portion of the management zone and is a supply well for the Chino Desalter facility.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 5 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
Chino-East	32	1973 1997 2003 2006 2009	730 760 620 650 770	10 29.1 9.6 12.7 15.7	Santa Ana River Water Company	03A	198 to 250		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Chino Basin Desalter Authority	II-6	150 to 295		Well is located in the southern, downgradient portion of the management zone and is a supply well for the Chino Desalter facility. Well is located within the capture zone of the Chino Desalter well field.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 10 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					State of California, DTSC	CTP-TW1	unknown		Well is located in the, eastern up-gradient portion of the management zone and is sampled regularly as part of the Stringfellow Hazardous Waste Site monitoring program.	TDS and nitrate-nitrogen concentrations in groundwater are high in this portion of the basin, but have decreased during the past 5 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Inland Empire Utilities Agency	HCMP-9/1	110 to 150		Well is located in the southern, downgradient portion of the management zone. Well is located within the capture zone of the Chino Desalter well field.	TDS and nitrate-nitrogen concentrations in groundwater have decreased slightly in this portion of the basin during the past 5 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.

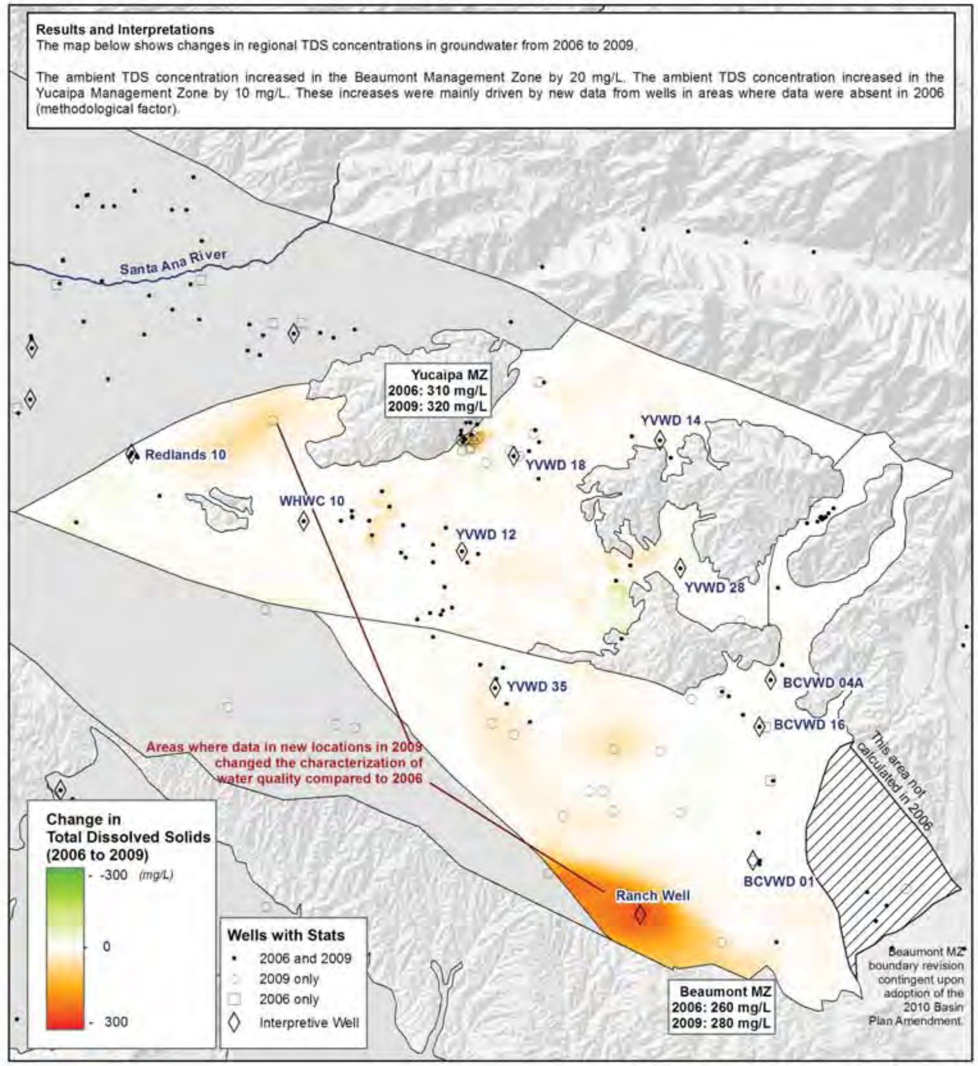
Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	TDS mg/L	NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Chino-South	53	1973 1997 2003 2006 2009	680 720 790 940 980	4.2 8.8 15.3 25.7 26.8	Chino Basin Desalter Authority	II-8	130 to 230		Well is located in the northern, downgradient portion of the management zone and within the capture zone of the Chino Desalter well field.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					Jurupa Community Services District	JCSD 01 (Sky Country #1)	unknown		Well is located in the northern, downgradient portion of the management zone and within the capture zone of the Chino Desalter well field.	TDS and nitrate-nitrogen concentrations in groundwater have increased slightly in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Inland Empire Utilities Agency	HCMP-8/1	75 to 115		Well is located in the central portion of the management zone and within the capture zone of the Chino Desalter well field.	TDS and nitrate-nitrogen concentrations in groundwater are high, but have decreased slightly in this portion of the basin during the past 5 years.
					Riverside County Waste Management Department	Pedley PMW-3	unknown		Well is located in the eastern, up-gradient portion of the management zone, adjacent to the Santa Ana River.	TDS and nitrate-nitrogen concentrations in groundwater have not changed significantly in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
Cucamonga	64	1973 1997 2003 2006 2009	380 260 250 250 250	5 4.4 4.3 4 4.1	Cucamonga Valley Water District	CVWD 13	386 to 664		Well is located in the northern, up-gradient portion of the management zone, near areas of mountain-front recharge.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Cucamonga Valley Water District	CVWD 16	280 to 810		Well is located in the northern, up-gradient portion of the management zone, near areas of mountain-front recharge.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Cucamonga Valley Water District	CVWD 24	500 to 870		Well is located in the central portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
					Cucamonga Valley Water District	CVWD 10	unknown		Well is located in the southern, downgradient portion of the management zone.	TDS and nitrate-nitrogen concentrations in groundwater have increased in this portion of the basin in the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to increase in the 2012 recomputation.
Irvine	218	1973 1997 2003 2006 2009	910 910 880 920 910	5.9 7.4 6.5 6.5 6.7	Orange County Water District	ET-1/1	220 to 490	2	Well is located in the central portion of the management zone, adjacent to and downgradient of the former El Toro airbase and areas of historical agricultural land use.	TDS concentrations have been stable in this portion of the basin during the past 20 years, while nitrate-nitrogen concentrations have gradually increased. The ambient nitrate-nitrogen statistic at this well is likely to increase in the 2012 recomputation.
					Orange County Water District	IRWD-78/1	240 to 680	23	Well is located in the central portion of the management zone, west of the former El Toro airbase.	TDS and nitrate-nitrogen concentrations in groundwater have been stable in this portion of the basin during the past 20 years. No major changes in ambient water quality statistics are anticipated at this well in the 2012 recomputation.
					Orange County Water District	MCAS-10/1	347 to 377	2	Well is located in the central portion of the management zone, at the site of the former El Toro airbase and near areas of historical agricultural land use.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	TIC-61/1	240 to 695	2	Well is located in the eastern portion of the management zone, in an area of historical citrus land use. Natural storm water recharge occurs in this area.	TDS and nitrate-nitrogen concentrations in groundwater are high but have decreased in this portion of the basin during the past 20 years. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.

Table 4-1
Interpretive Wells by Management Zone

Management Zone	Area (km^2)	Ambient Water Quality: Year	Ambient Water Quality: TDS mg/L	Ambient Water Quality: NO_3-N mg/L	Interpretive Wells: Owner	Name	Screens (ft-bgs)	Layer if applicable	Selection Criteria	Interpretations
Orange County	658	1973 1997 2003 2006 2009	580 560 560 590 600	3.4 3.4 3.1 3 3	Orange County Water District	YLWD-15/1	133 to 198	2	Well is located up-gradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the Santa Ana River.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	YLWD-5/1	90 to 340	2	Well is located up-gradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the Santa Ana River.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	SCWC-PLJ2/1	402 to 492	2	Well is located downgradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the recharge facilities and is less than about 25 years old.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. In particular, TDS concentrations have decreased significantly over the past 5 years due to GWR recharge. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	AM-13/1	252 to 270	2	Well is located downgradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the recharge facilities and is less than about 25 years old.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
Orange County	658	1973 1997 2003 2006 2009	580 560 560 590 600	3.4 3.4 3.1 3 3	Orange County Water District	AM-23/1	330 to 347	2	Well is located downgradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the recharge facilities and is less than about 25 years old.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	AM-37/1	349 to 367	2	Well is located downgradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the recharge facilities and is less than about 25 years old.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	AM-27/1	287 to 305	2	Well is located downgradient from the Anaheim Forebay recharge facilities within the principal aquifer. Groundwater in this area originated as surface-water percolation at the recharge facilities and is less than about 25 years old.	TDS and nitrate-nitrogen concentrations in groundwater have decreased in this portion of the basin over the past 20 years. The ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Mesa Consolidated Water District	MCWD-5/1	400 to 940	2	Well is located in the southern portion of the management zone, along the Santa Ana River.	TDS and nitrate-nitrogen concentrations have flat in this portion of the basin in the past 30 years.
					Orange County Water District	SB-LEI/1	420 to 840	2	Well is located in the western portion of the management zone.	TDS and nitrate-nitrogen concentrations have been flat in this portion of the basin in the past 40 years.
					Orange County Water District	T-PROS/1	270 to 630	2	Well is located in the eastern portion of the management zone, in an area of historical citrus land use.	TDS and nitrate-nitrogen concentrations have decreased in this portion of the basin in the past 20 years, after rising dramatically back in the 1980s. Ambient TDS and nitrate-nitrogen statistics at this well are likely to decrease in the 2012 recomputation.
					Orange County Water District	GG-24/1	424 to 800	2	Well is located in the central portion of the management zone, adjacent to the Santa Ana River and downgradient of various recharge projects.	TDS and nitrate-nitrogen concentrations have increased slightly in this portion of the basin in the past 30 years. Ambient water quality statistics at this well are likely to increase in the 2012 recomputation.





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Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

Change Maps of Nitrate-N and TDS

Yucaipa & Beaumont - 2006 to 2009
Unlayered

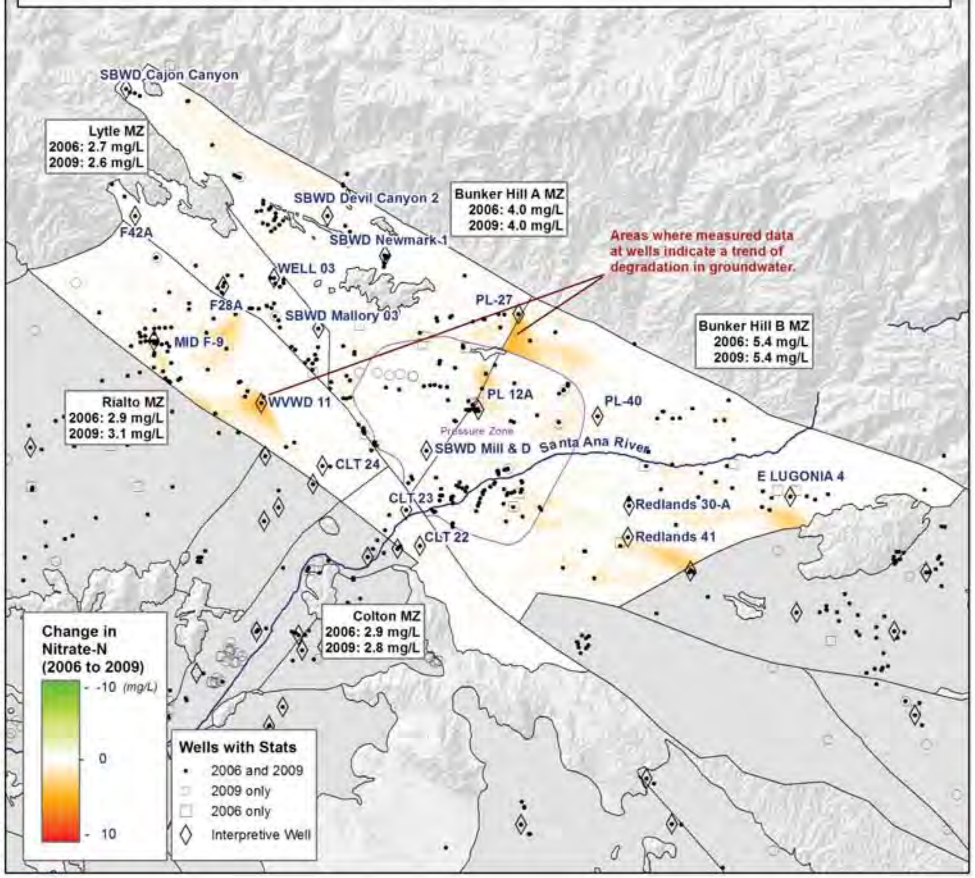
Figure 4-1

Results and Interpretations

The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009.

There were no major changes in ambient nitrate-nitrogen concentrations in the Bunker Hill, Lytle, Rialto, or Colton Management Zones. This is because there is a good spatial distribution of ambient water quality statistics at wells across these management zones, and the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional nitrate-nitrogen concentrations in groundwater compared to the 2006 analysis. Changes in regional nitrate-nitrogen concentrations shown on this map are mainly caused by measured trends in water quality at wells.

Note that this map shows the first layer of the stratified aquifer in the Bunker Hill Pressure Zone.

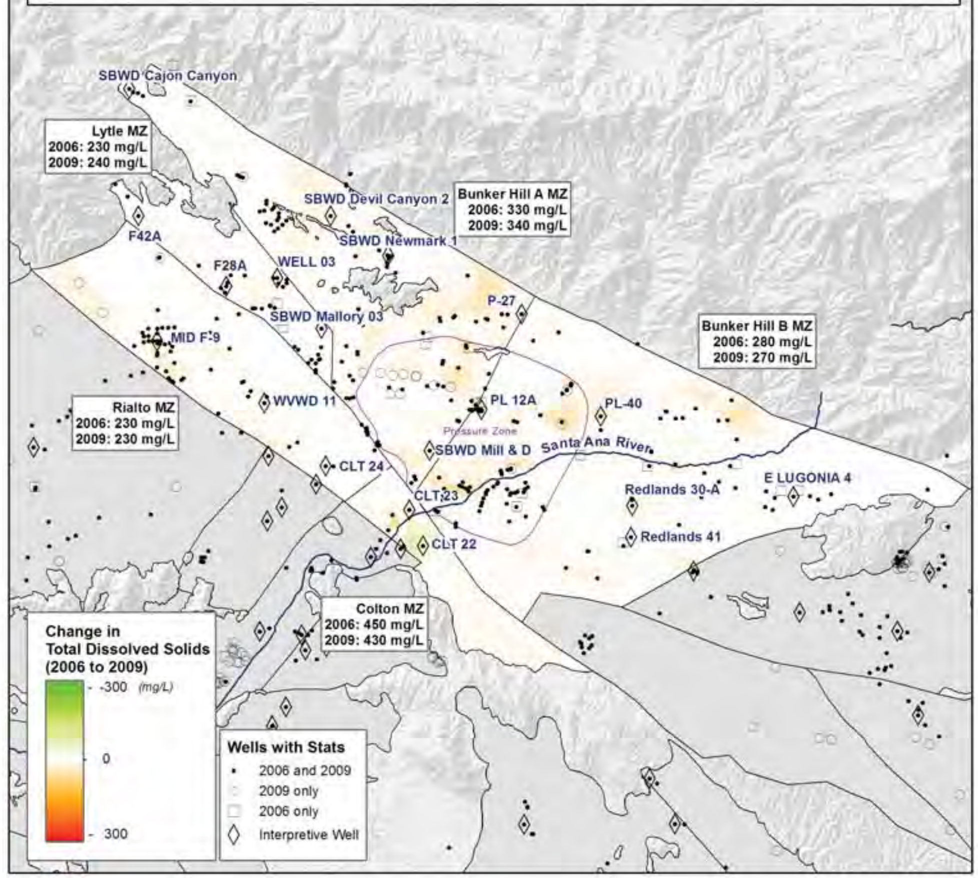


Results and Interpretations

The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009 for the shallow aquifer system.

There were no major changes in ambient TDS concentrations in the Bunker Hill, Lytle, Rialto, or Colton Management Zones. This is because there is a good spatial distribution of ambient water quality statistics at wells across these management zones, and the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional TDS concentrations in groundwater compared to the 2006 analysis. Changes in regional TDS concentrations shown on this map are mainly caused by measured trends in water quality at wells.

Note that this map shows the first layer of the stratified aquifer in the Bunker Hill Pressure Zone.



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Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change Maps of Nitrate-N and TDS

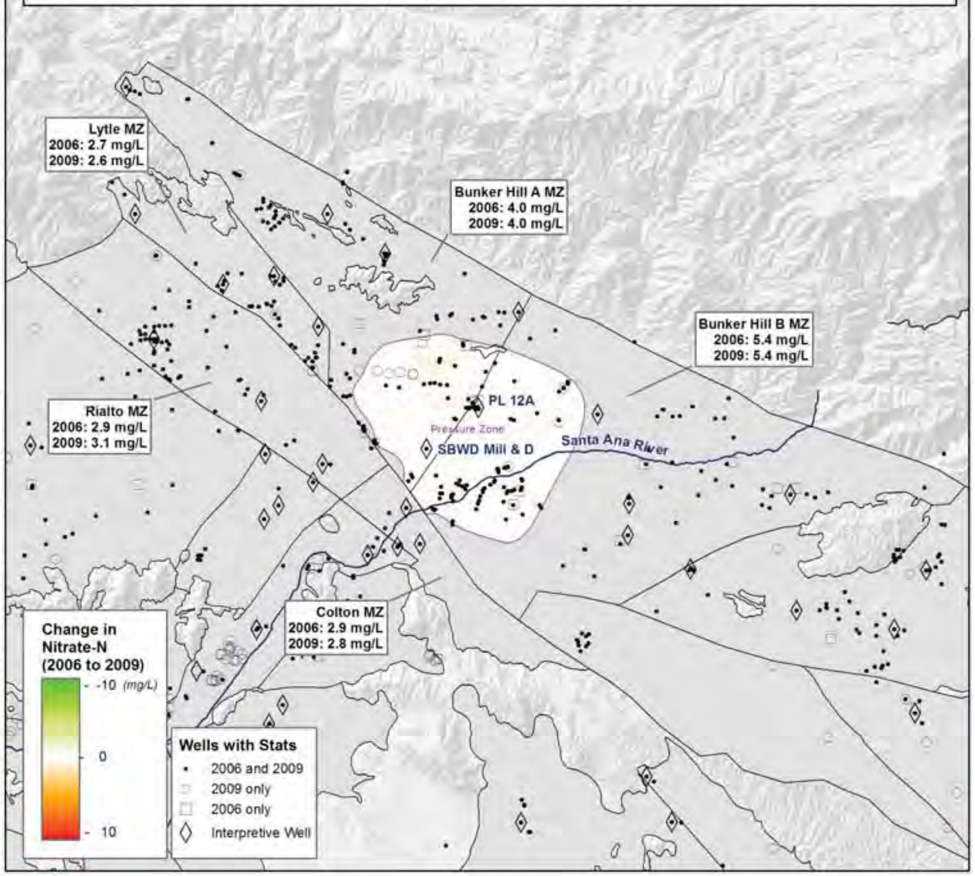
Bunker Hill A & B, Lytle, Rialto, & Colton - 2006 to 2009
Layer 1 (Bunker Hill Pressure Zone)

Figure 4-2

Results and Interpretations
The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009.

There were no major changes in ambient nitrate-nitrogen concentrations in the Bunker Hill Management Zones. This is because there is a good spatial distribution of ambient water quality statistics at wells across these management zones, and the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional nitrate-nitrogen concentrations in groundwater compared to the 2006 analysis. Changes in regional nitrate-nitrogen concentrations shown on this map are mainly caused by measured trends in water quality at wells.

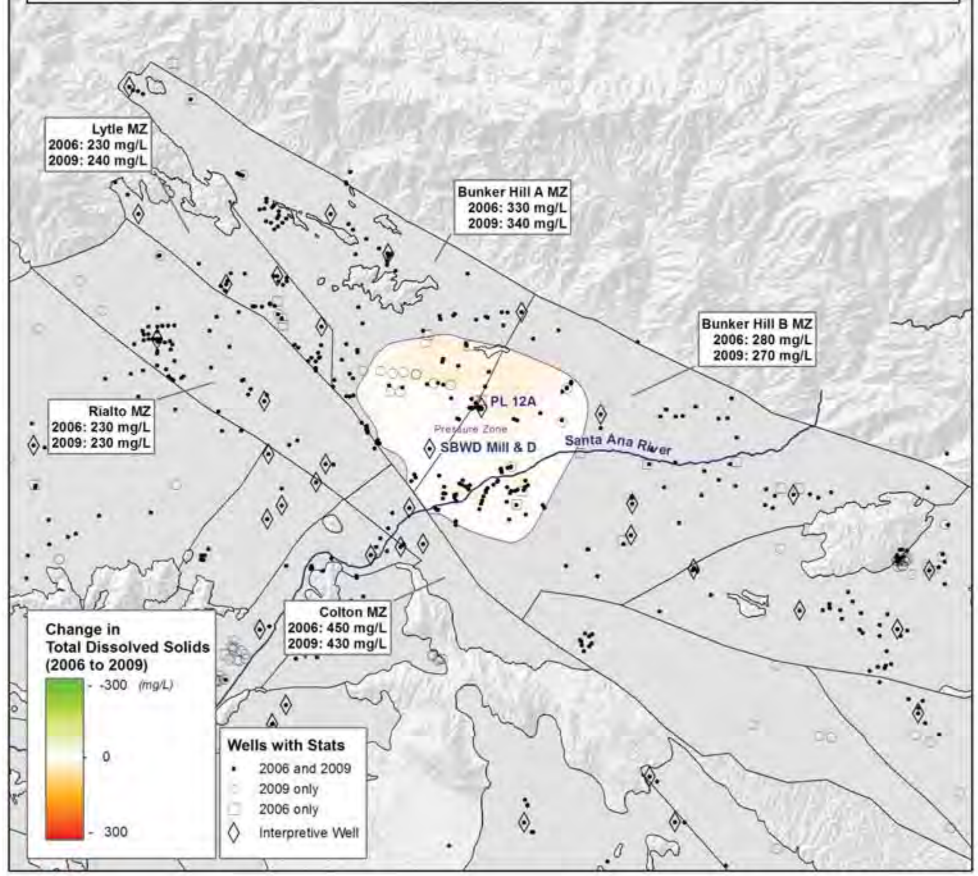
Note that this map shows the second layer of the stratified aquifer in the Bunker Hill Pressure Zone.



Results and Interpretations
The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009.

There were no major changes in ambient TDS concentrations in the Bunker Hill Management Zones. This is because there is a good spatial distribution of ambient water quality statistics at wells across these management zones, and the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional TDS concentrations in groundwater compared to the 2006 analysis. Changes in regional TDS concentrations shown on this map are mainly caused by measured trends in water quality at wells.

Note that this map shows the second layer of the stratified aquifer in the Bunker Hill Pressure Zone.



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Recomputation of Ambient Water Quality for the Period 1990 to 2009

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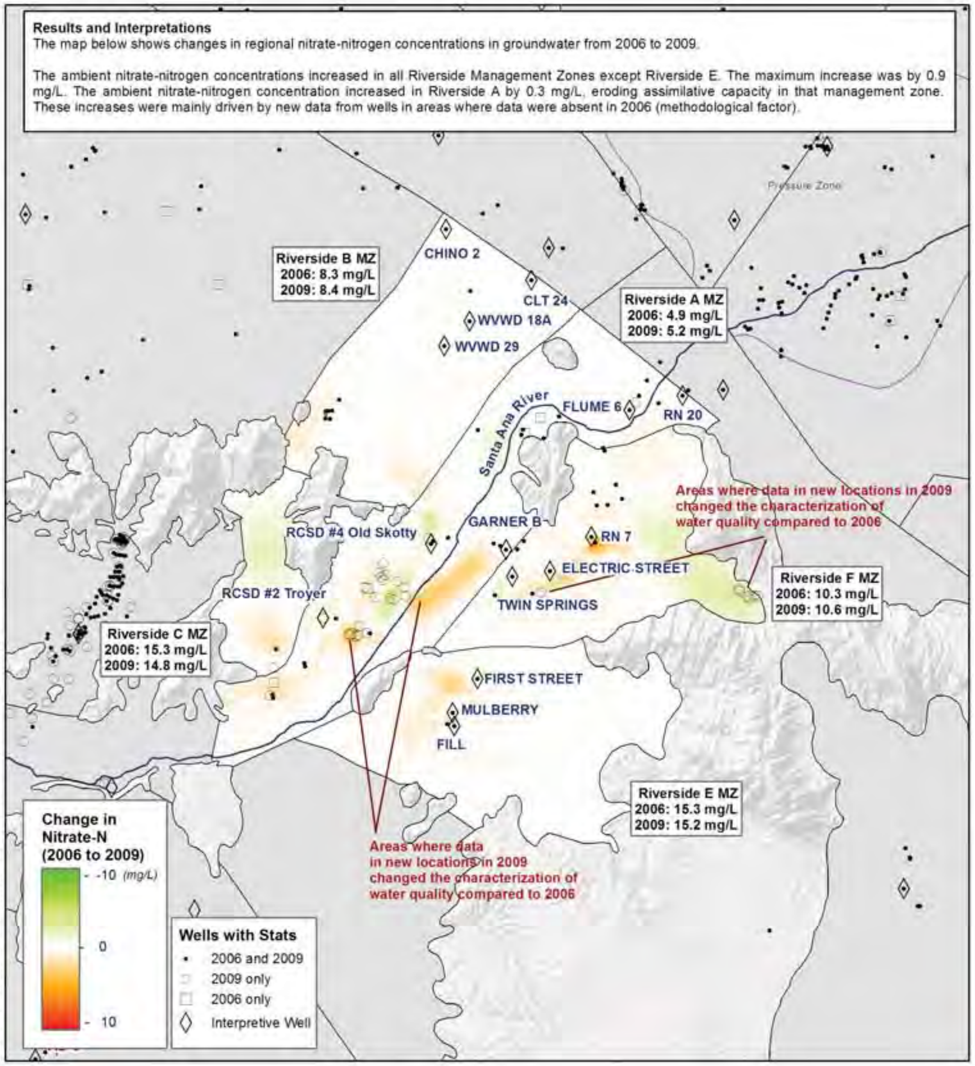
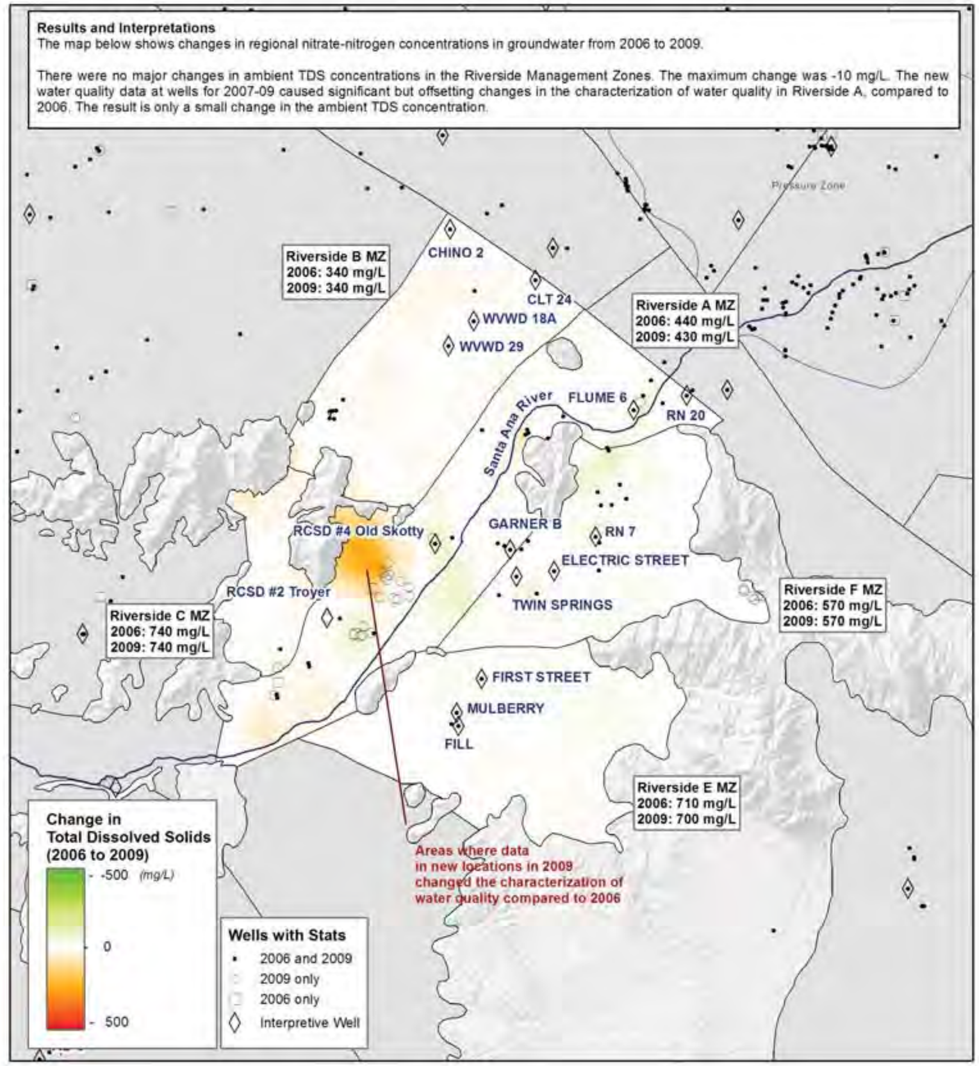
Change Maps of Nitrate-N and TDS

Bunker Hill A & B, Lytle, Rialto, & Colton - 2006 to 2009
Layer 2 (Bunker Hill Pressure Zone)

Figure 4-3





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0 1 2 3 Miles
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Basin Monitoring Program Task Force

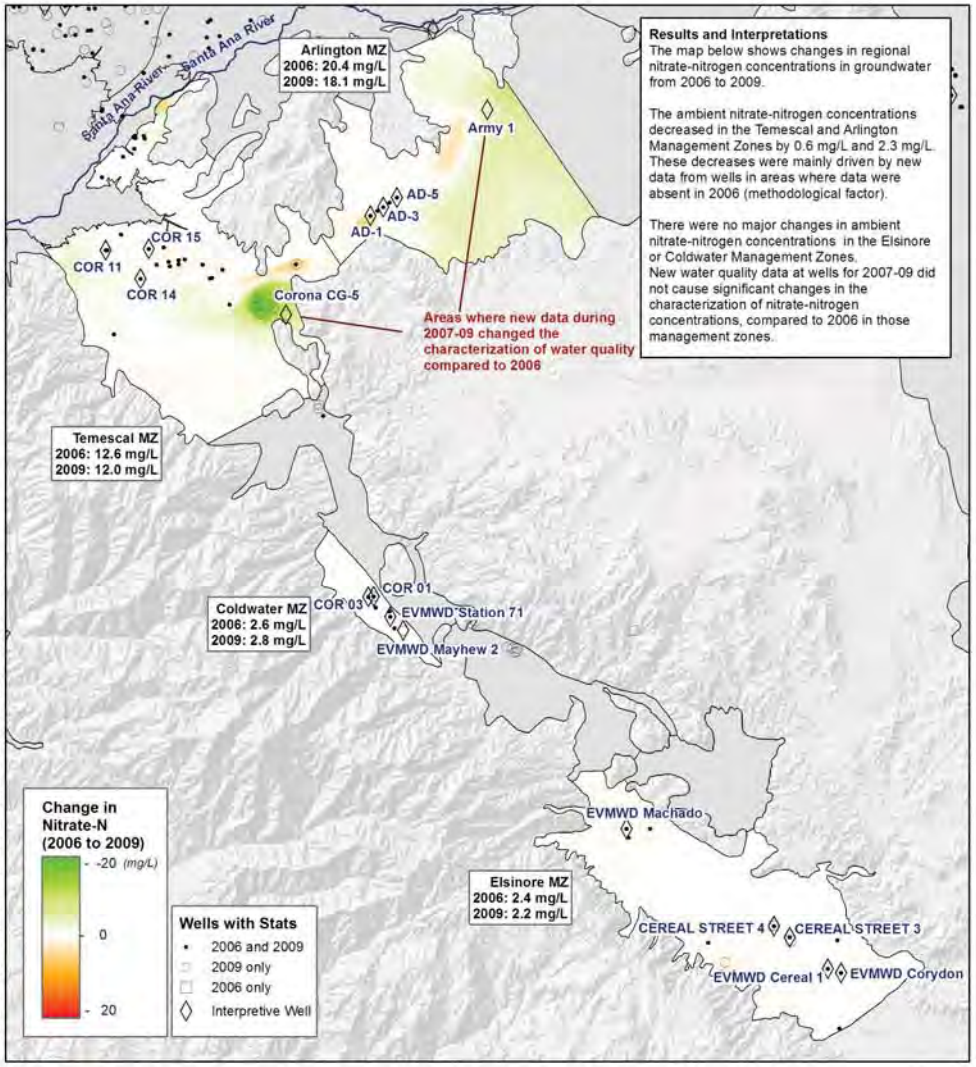
Recomputation of Ambient Water Quality for the Period 1990 to 2009

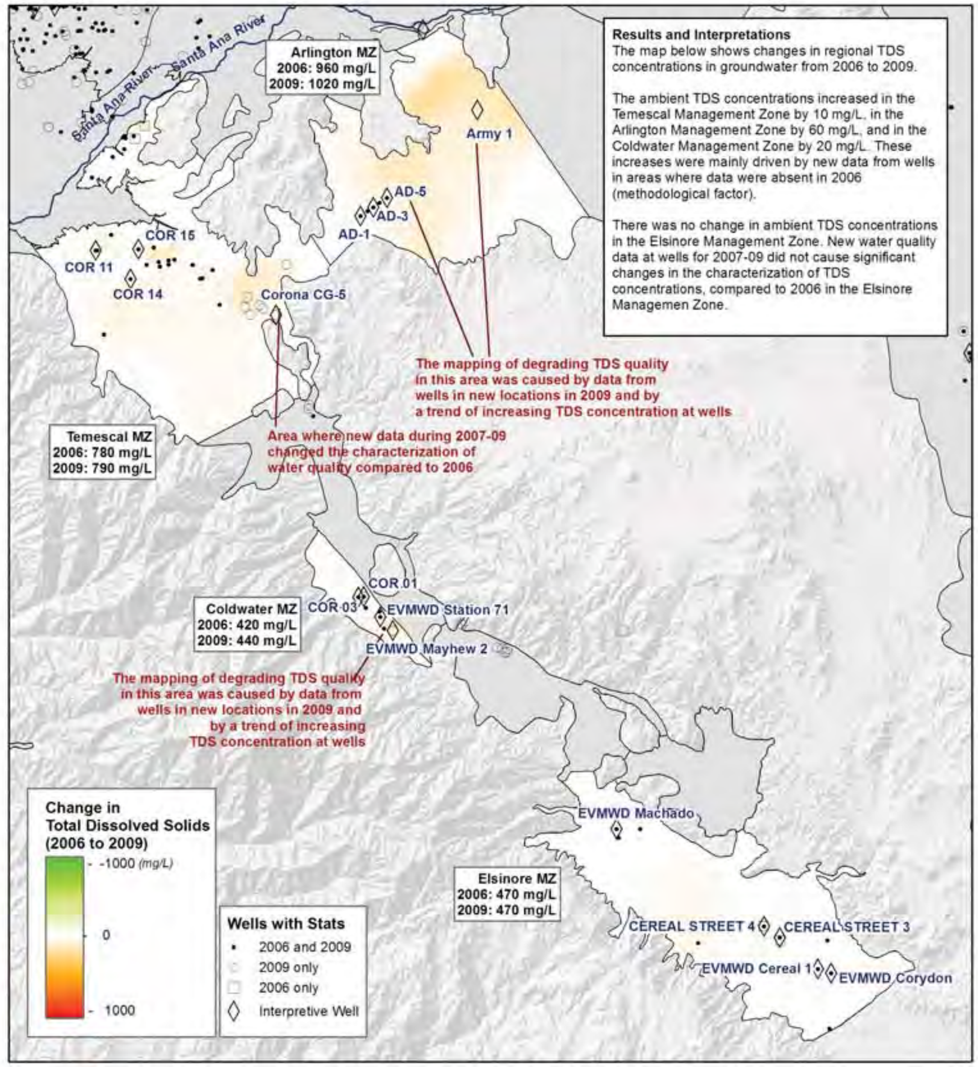
SAWPA

Change Maps of Nitrate-N and TDS

Riverside Management Zones - 2006 to 2009
Unlayered

Figure 4-4





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0 2.5 5 7.5 Miles
0 2.5 5 7.5 10 12.5 KM

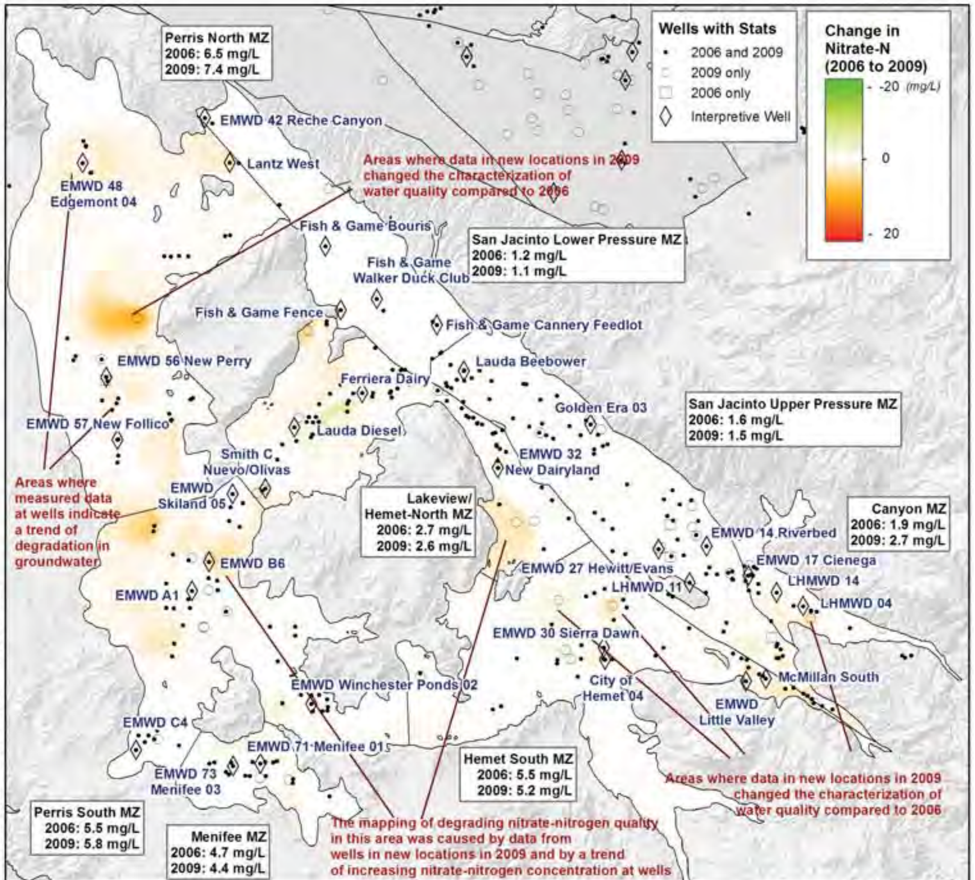
Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

Change Maps of Nitrate-N and TDS

Temescal, Arlington, Coldwater, & Elsinore - 2006 to 2009 Unlayered

Figure 4-5

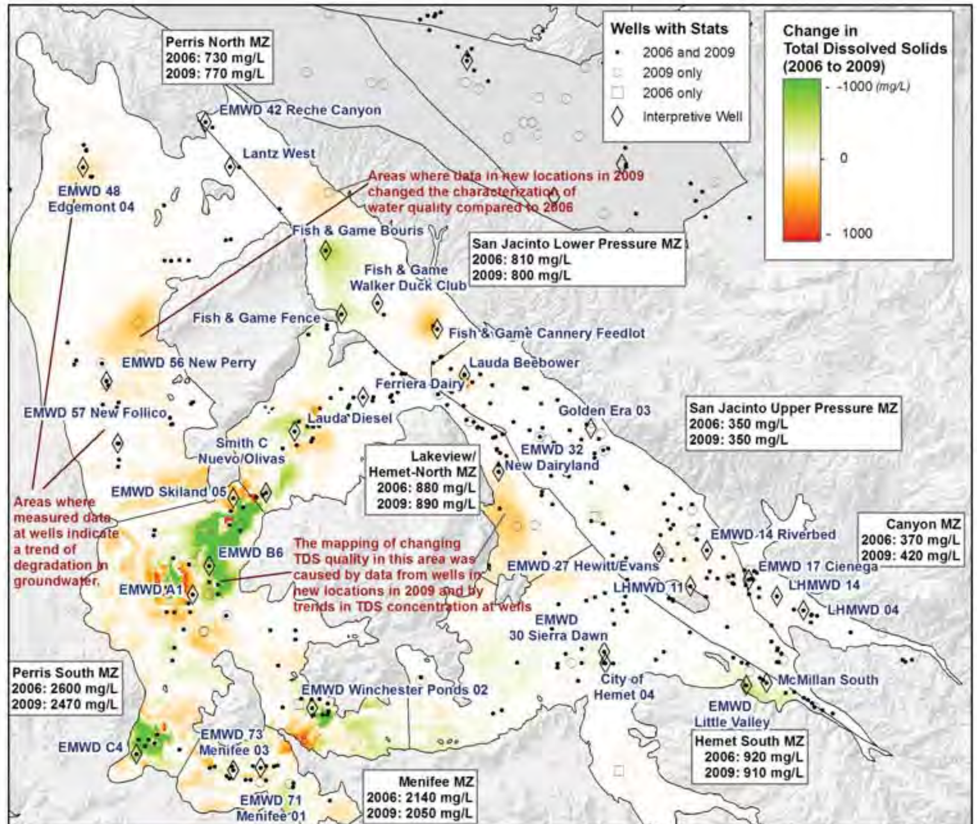


Results and Interpretations

The map above shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009.

The ambient nitrate-nitrogen concentrations increased in the Canyon, Perris North, and Perris South Management Zones by 0.8 mg/L, 0.9 mg/L, and 0.3 mg/L. These changes were driven by both new data from wells in areas where data were absent in 2006 (methodological factor) and by measured trends in water quality at wells.

Ambient nitrate-nitrogen concentrations decreased in the other management zones in the San Jacinto Basins by a maximum of 0.3 mg/L. These changes were driven by both new data from wells in areas where data were absent in 2006 (methodological factor) and by measured trends in water quality at wells.



Results and Interpretations

The map above shows changes in regional TDS concentrations in groundwater from 2006 to 2009.

The ambient TDS concentrations increased in the Canyon, Perris North, and Lakeview/Hemet-North Management Zones by 50 mg/L, 40 mg/L, and 10 mg/L, respectively. These changes were driven by both new data from wells in areas where data were absent in 2006 (methodological factor) and by measured trends in water quality at wells.

Ambient TDS concentrations decreased in the Perris South and Menifee Management Zones by 130 mg/L and 90 mg/L, respectively. The magnitude of these changes is small relative to the ambient TDS concentrations of those basins. These changes were driven by both new data from wells in areas where data were absent in 2006 (methodological factor) and by measured trends in water quality at wells.

Ambient TDS concentrations were unchanged or decreased in the remaining San Jacinto Basins by a maximum of 10 mg/L. These changes were driven by both new data from wells in areas where data were absent in 2006 (methodological factor) and by measured trends in water quality at wells.

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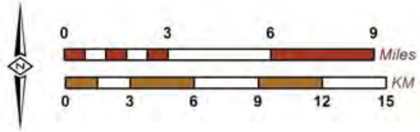


Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change Maps of Nitrate-N and TDS

San Jacinto Basins Management Zones - 2006 to 2009 Unlayered

Figure 4-6

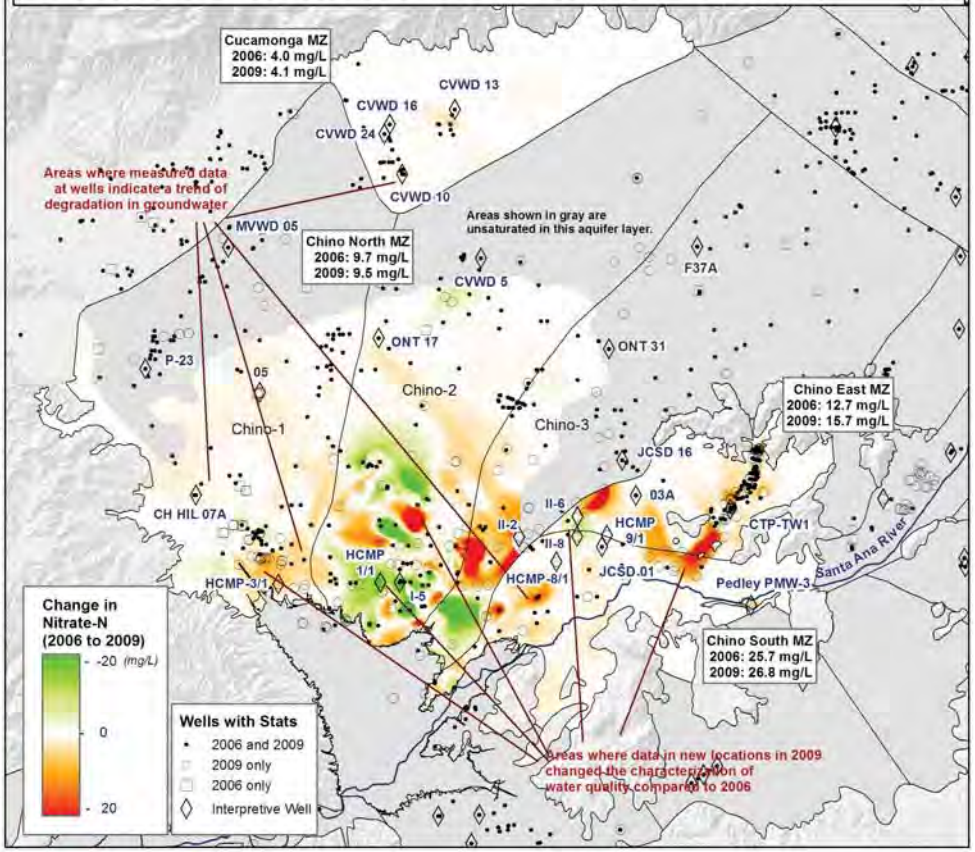
Results and Interpretations

The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009.

The ambient nitrate-nitrogen concentrations increased in the Chino-South and Chino-East Management Zones by 0.9 mg/L and 3.0 mg/L. The ambient nitrate-nitrogen concentration decreased in the Chino-North Management Zone by by only 0.2 mg/L; though, significant but offsetting changes in regional nitrate-nitrogen concentrations occurred throughout the southern portion of the management zone. These changes were mainly driven by new data from wells in areas where data were absent in 2006 (methodological factor).

The ambient nitrate-nitrogen concentration in the Cucamonga Management Zone increased by 0.1 mg/L.The new water quality data at wells for 2007-09 did not cause significant changes in the characterization of ambient water quality compared to 2006 in the Cucamonga Management Zone.

Note that these maps show only change in the first layer of the stratified aquifer system in the Chino-North Mangement Zone.

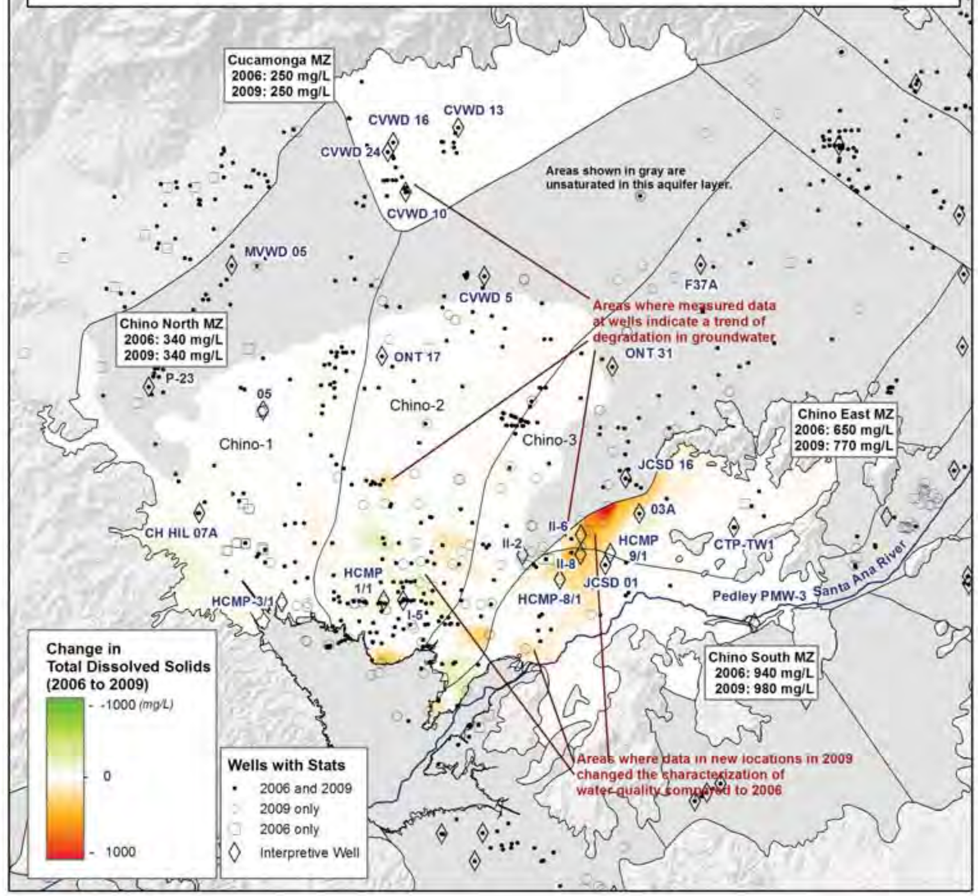


Results and Interpretations

The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009.

The ambient TDS concentrations increased in the Chino-South and Chino-East Management Zones by 40 mg/L and 120 mg/L. Ambient TDS concentrations did not change in the Chino-North Management Zone; though, offsetting local changes in regional TDS concentrations occurred. These changes were mainly driven by new data from wells in areas where data were absent in 2006 (methodological factor).

There was no change in the ambient TDS concentration in the Cucamonga Management Zone. The new water quality data at wells for 2007-09 did not cause significant changes in the characterization of ambient water quality compared, to 2006 in the Cucamonga Management Zone.



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0 2.5 5 7.5 Miles

0 2.5 5 7.5 10 12.5 KM

Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change Maps of Nitrate-N and TDS

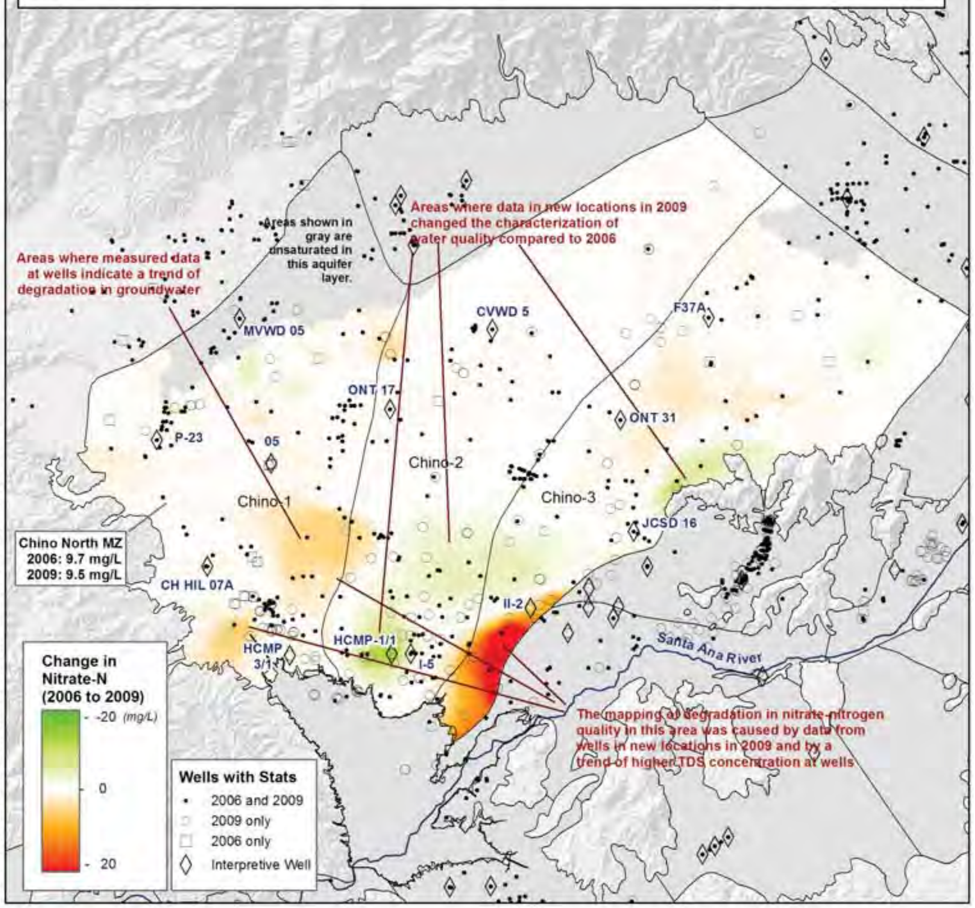
Chino Management Zones & Cucamonga - 2006 to 2009
Layer 1 (Chino North)

Figure 4-7

Results and Interpretations

The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009 for the second layer of the aquifer system.

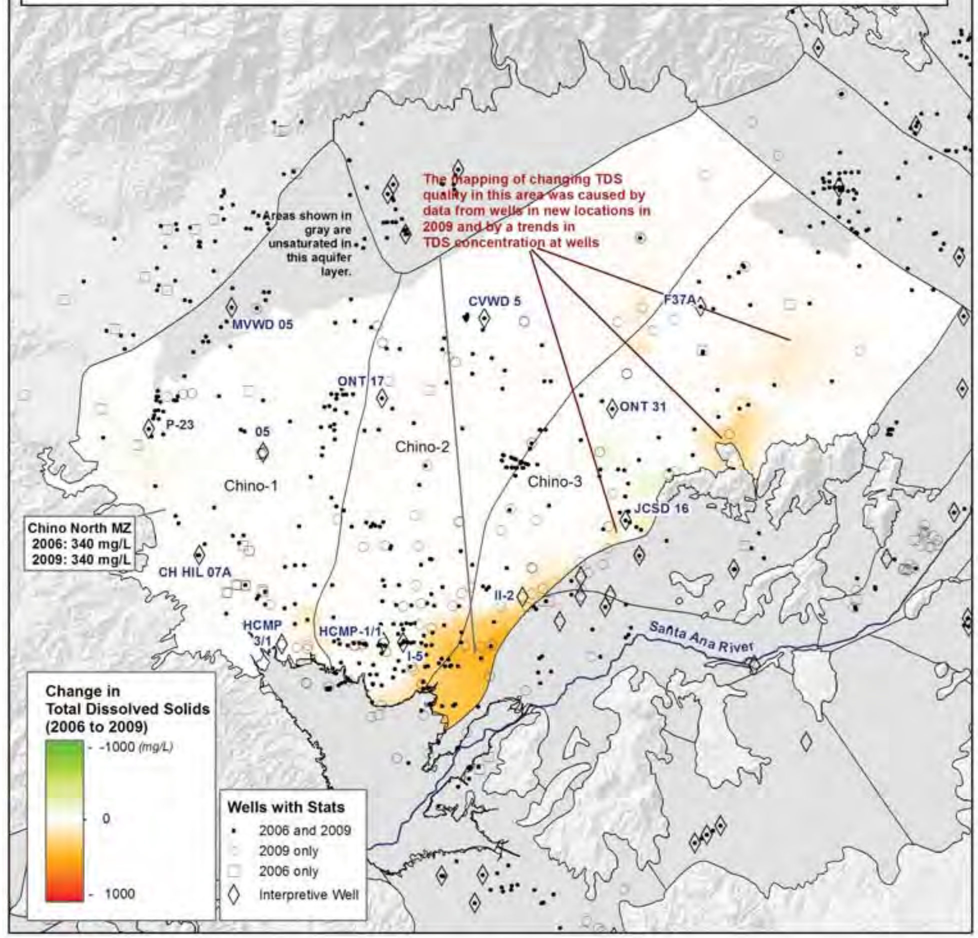
The ambient nitrate-nitrogen concentrations decreased in the Chino-North Management Zone by 0.2 mg/L. The mapping of regional nitrate-nitrogen concentrations in 2009 revealed areas of both increasing and decreasing concentrations, compared to 2006. Some of these changes were driven by new data in areas where data were absent in 2006 (methodological factor), while other changes were driven by measured trends in water quality at wells.



Results and Interpretations

The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009 for the second layer of the aquifer system.

The ambient TDS concentrations did not change in the Chino-North Management Zone despite the areas shown below, where regional TDS concentrations changed. These changes are due to both new data from wells in areas where data were absent in 2006 and measured trends in water quality at wells.



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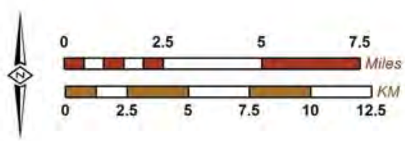


Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

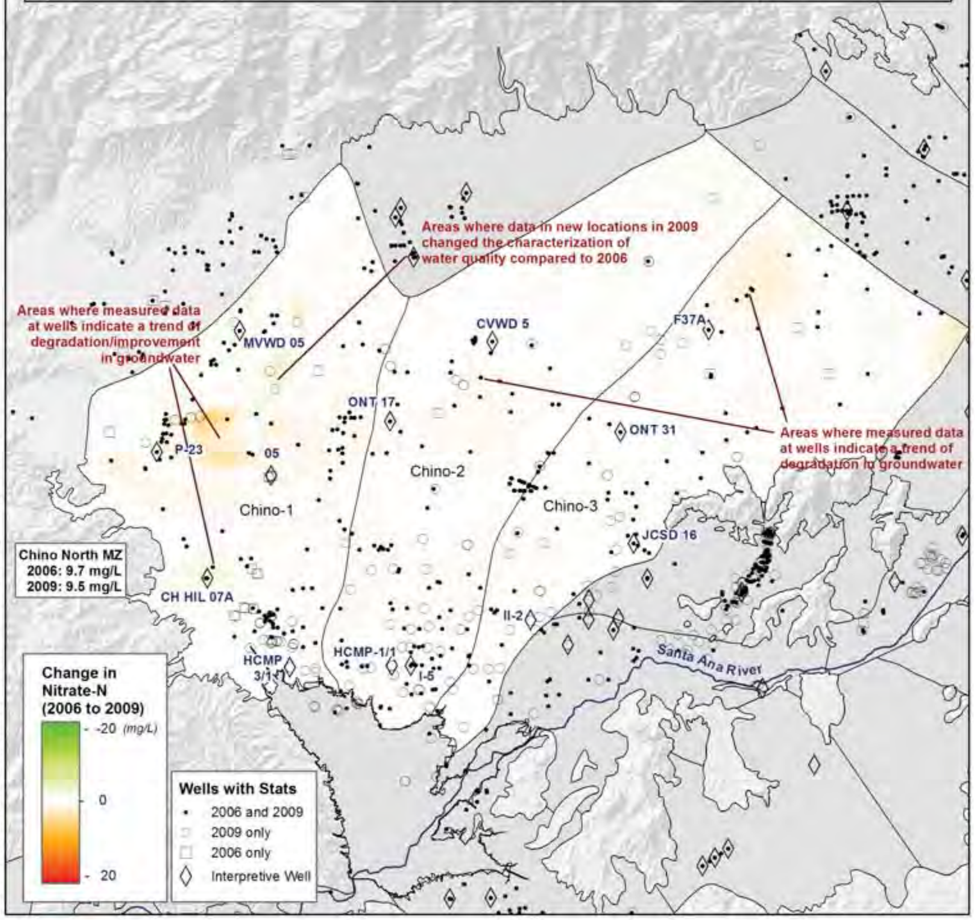
Change Maps of Nitrate-N and TDS

Chino North Management Zone - 2006 to 2009
Layer 2

Figure 4-8

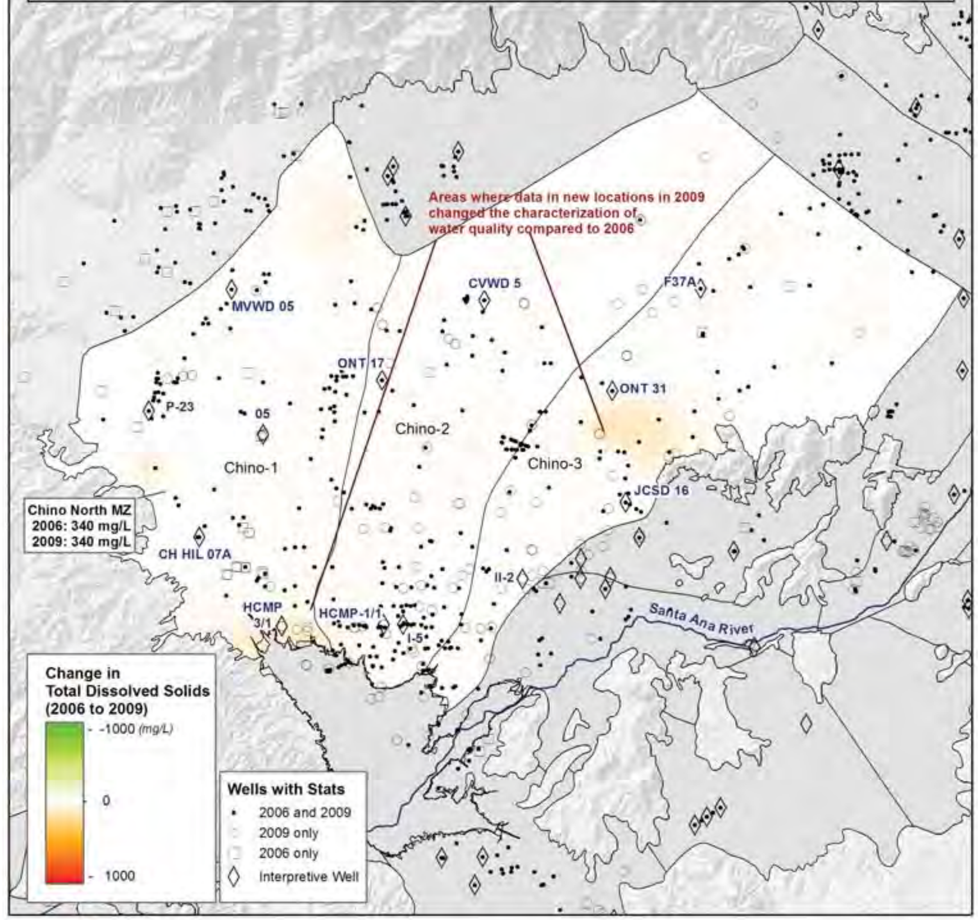
Results and Interpretations
The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009 for the third layer of the aquifer system.

The ambient nitrate-nitrogen concentrations decreased in the Chino-North Management Zone by 0.2 mg/L.
The mapping of regional nitrate-nitrogen concentrations in 2009 revealed areas of both increasing and decreasing concentration, compared to 2006. Some of these changes were driven by new data in areas where data were absent in 2006 (methodological factor), while other changes were driven by measured trends in water quality at wells.



Results and Interpretations
The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009 for the third layer of the aquifer system.

The ambient TDS concentrations did not change in the Chino-North Management Zone. This is because there is a good spatial distribution of ambient water quality statistics at wells across this management zone, and while there are areas shown below where concentrations changed due to new data from wells in areas where data were absent in 2006, the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional TDS concentrations in groundwater, compared to the 2006 analysis.



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0 2.5 5 7.5 Miles
0 2.5 5 7.5 10 12.5 KM

Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change Maps of Nitrate-N and TDS

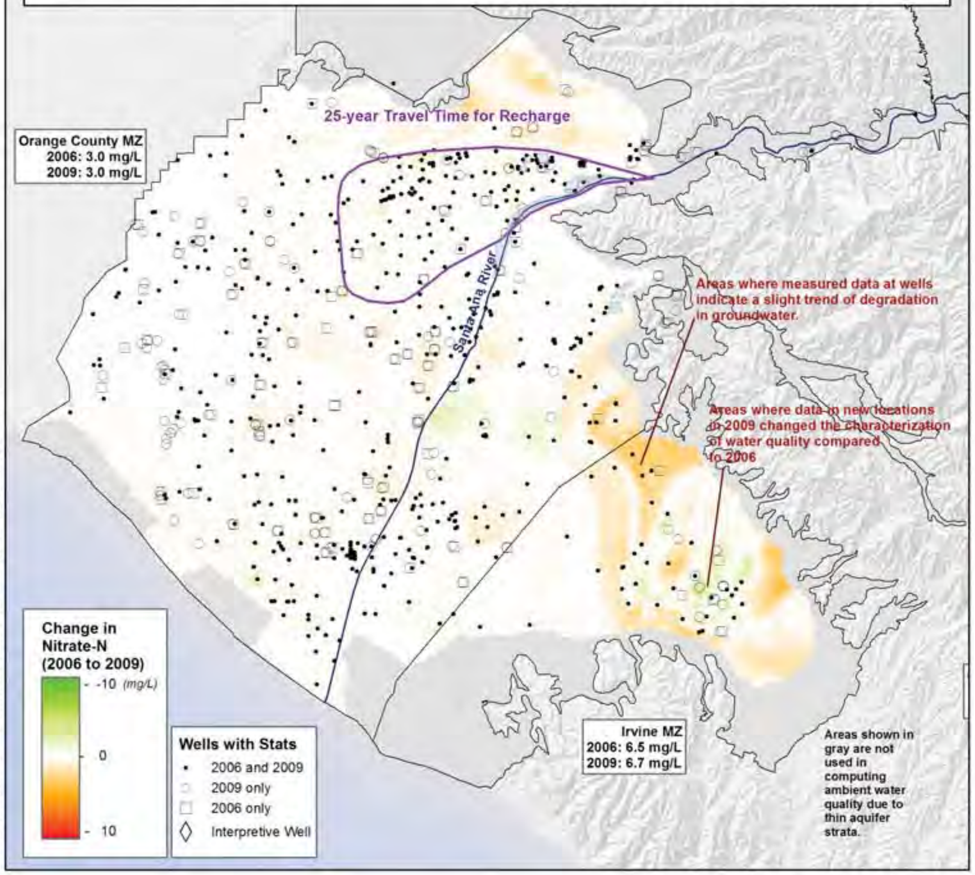
Chino North Management Zone - 2006 to 2009
Layer 3

Figure 4-9

Results and Interpretations
The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009 for the shallow aquifer system.

The ambient nitrate-nitrogen concentration did not change in the Orange County Management Zone from 2006 to 2009. This is because there is a good spatial distribution of ambient water quality statistics at wells across this management zone, and the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional nitrate-nitrogen concentrations in groundwater, compared to the 2006 analysis.

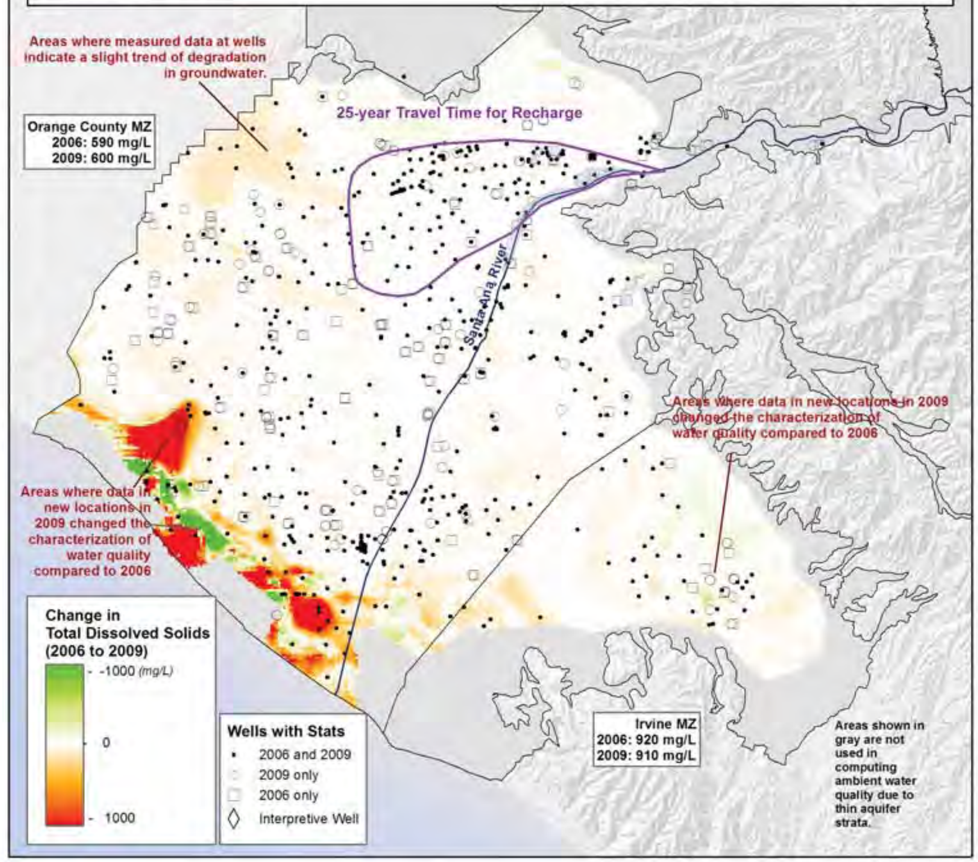
The ambient nitrate-nitrogen concentration increased in the Irvine Management Zone by 0.2 mg/L. This increase was mainly driven by new data from wells in areas where data were absent in 2006 (methodological factor).



Results and Interpretations
The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009 for the shallow aquifer system.

The ambient TDS concentration increased in the Orange County Management Zone by 10 mg/L. This increase was mainly driven by new data from wells in areas where data were absent in 2006 (methodological factor). This methodological factor is most evident in the southwestern portion of the management zone where increased monitoring of seawater intrusion is taking place. There is a good spatial distribution of statistics at wells across the rest of the management zone.

The ambient TDS concentration decreased in the Irvine Management Zone by 10 mg/L. The water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional nitrate-nitrogen concentrations in groundwater, compared to the 2006 analysis.



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0 3 6 9 Miles
0 3 6 9 12 15 KM

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Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Change Maps of Nitrate-N and TDS

Orange County & Irvine - 2006 to 2009

Layer 1

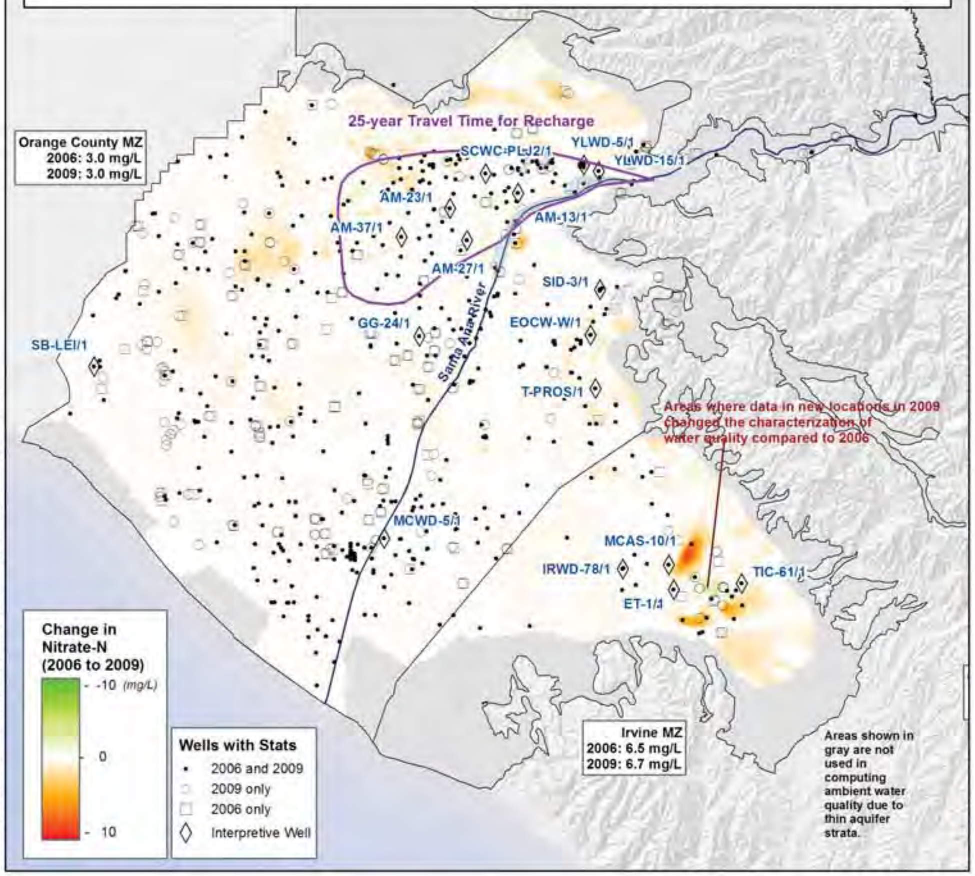
Figure 4-10

Results and Interpretations

The map below shows changes in regional nitrate-nitrogen concentrations in groundwater from 2006 to 2009 for the principal aquifer system.

The ambient nitrate-nitrogen concentration did not change in the Orange County Management Zone from 2006 to 2009. This is because there is a good spatial distribution of ambient water quality statistics at wells across this management zone, and the water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional nitrate-nitrogen concentrations in groundwater, compared to the 2006 analysis.

The ambient nitrate-nitrogen concentration increased in the Irvine Management Zone by 0.2 mg/L. This increase was mainly driven by new data from wells in areas where data were absent in 2006 (methodological factor).

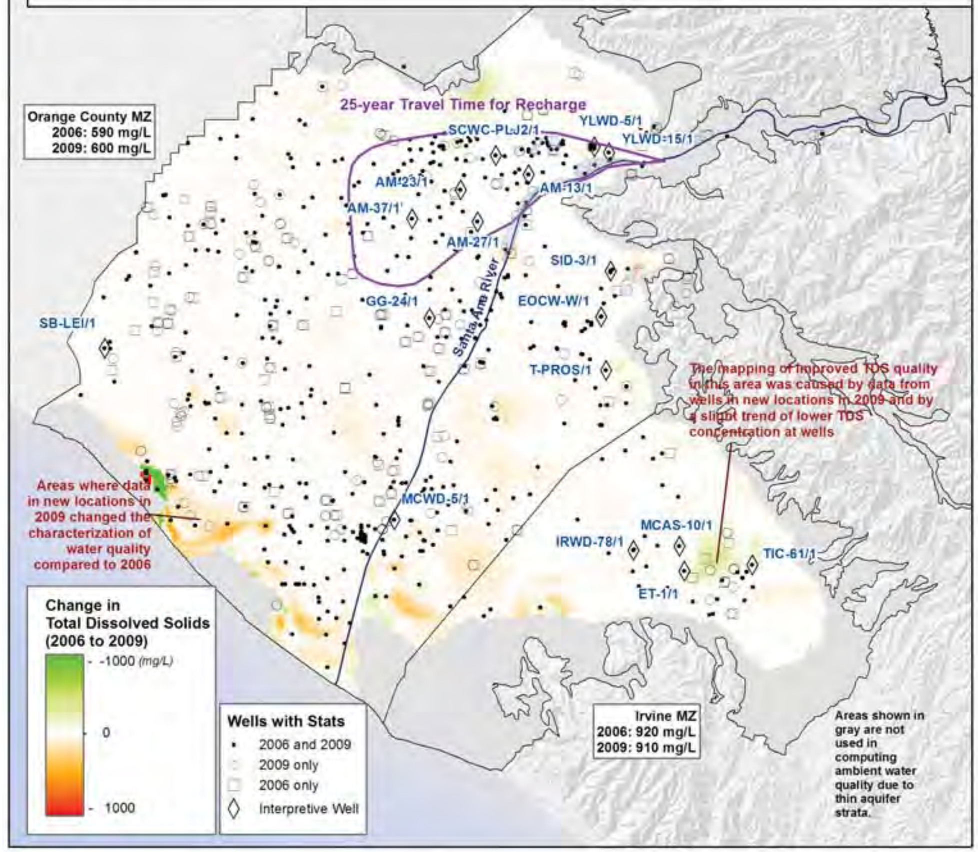


Results and Interpretations

The map below shows changes in regional TDS concentrations in groundwater from 2006 to 2009 for the shallow aquifer system.

The ambient TDS concentration increased in the Orange County Management Zone by 10 mg/L. This increase was mainly driven by new data from wells in areas where data were absent in 2006 (methodological factor). This methodological factor is most evident in the southwestern portion of the management zone where increased monitoring of seawater intrusion is taking place. There is a good spatial distribution of statistics at wells across the rest of the management zone.

The ambient TDS concentration decreased in the Irvine Management Zone by 10 mg/L. The water quality data added to (2007-09) and subtracted from (1987-89) the analysis did not cause significant changes in the characterization of regional nitrate-nitrogen concentrations in groundwater, compared to the 2006 analysis.



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0 3 6 9 Miles
0 3 6 9 12 15 KM

Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

Change Maps of Nitrate-N and TDS

Orange County & Irvine - 2006 to 2009
Layer 2

Figure 4-11

Figure 4-12: TDS at Interpretive Wells - Beaumont

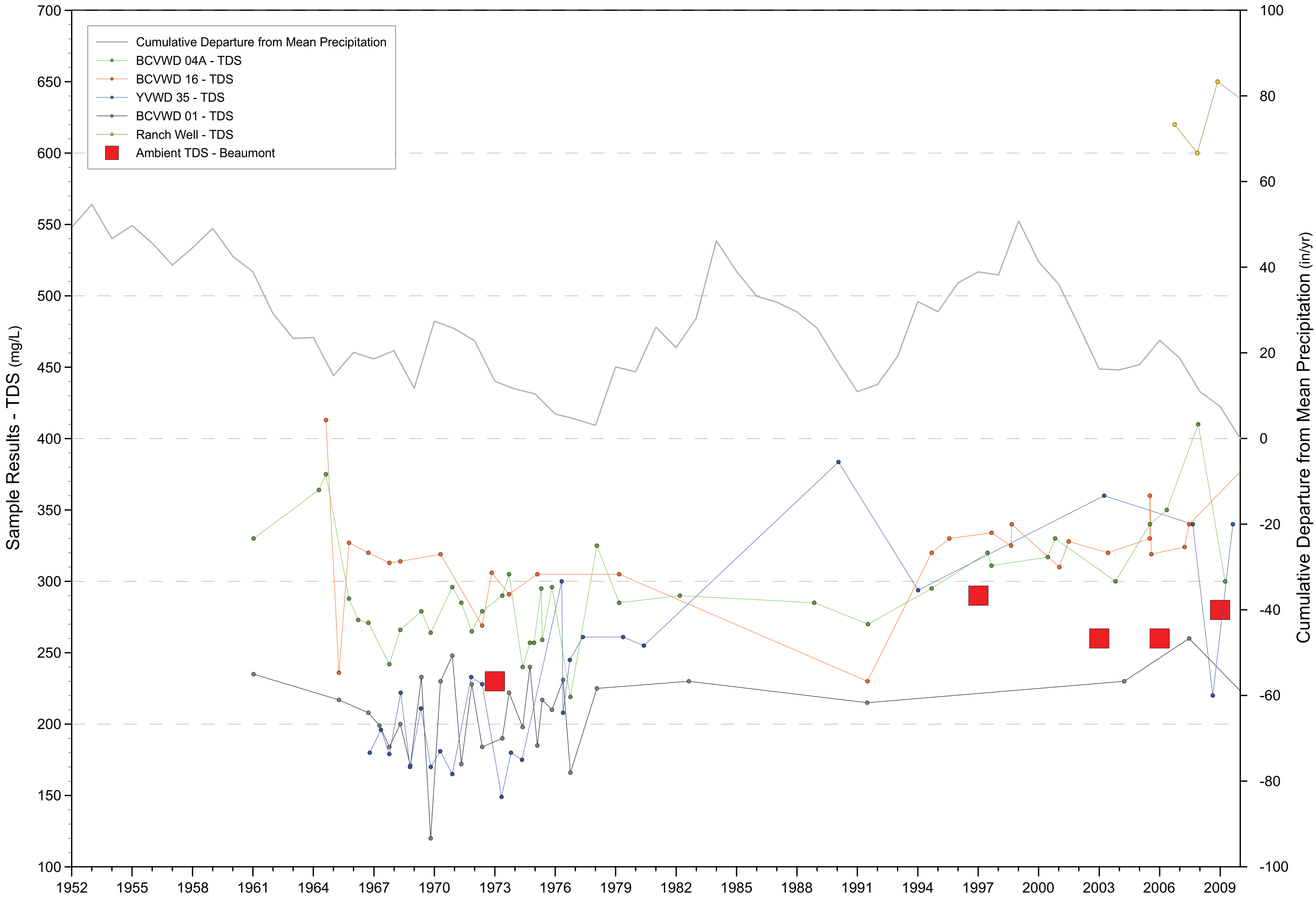

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Figure 4-13: Nitrate-N at Interpretive Wells - Beaumont

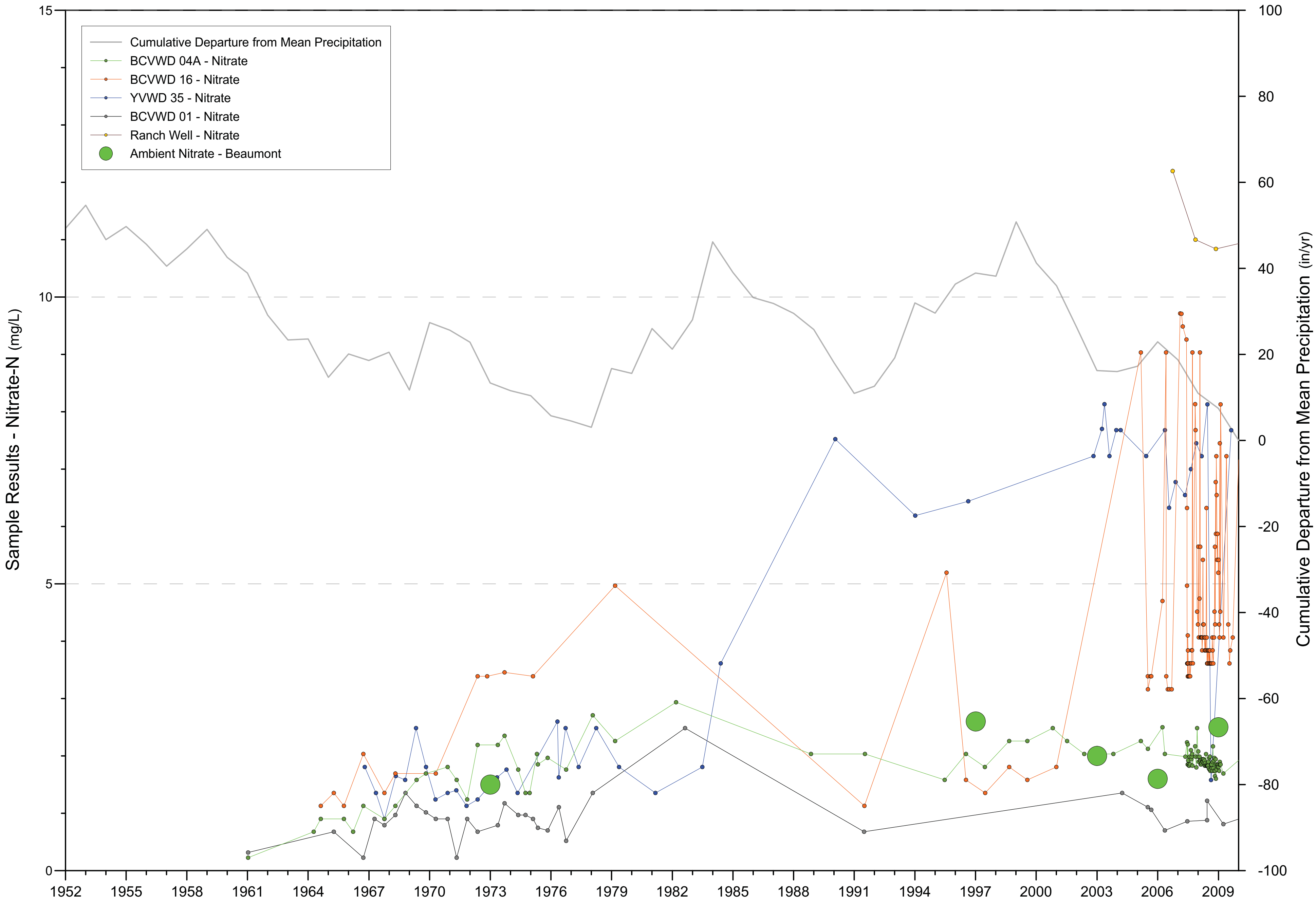
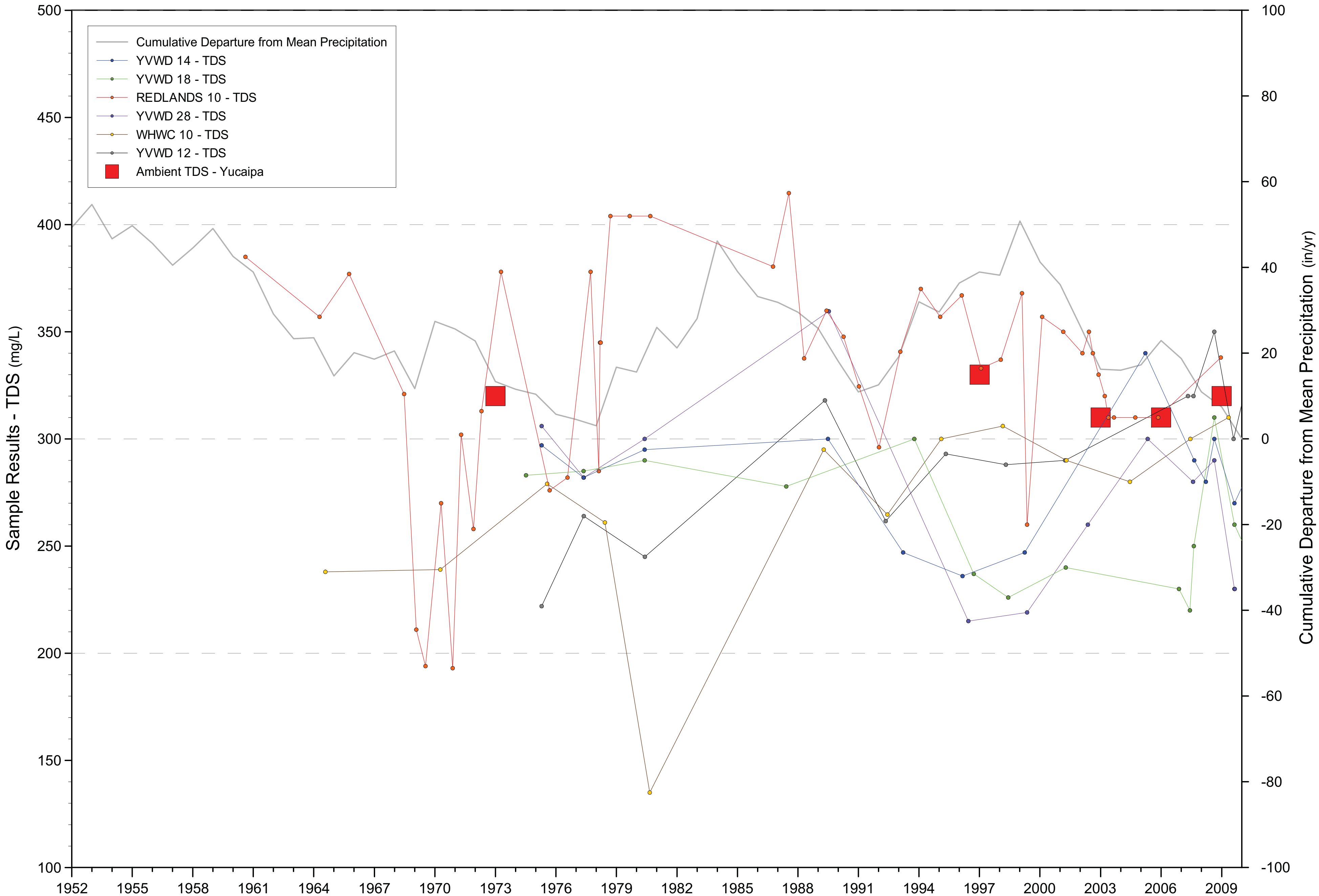


Figure 4-14: TDS at Interpretive Wells - Yucaipa



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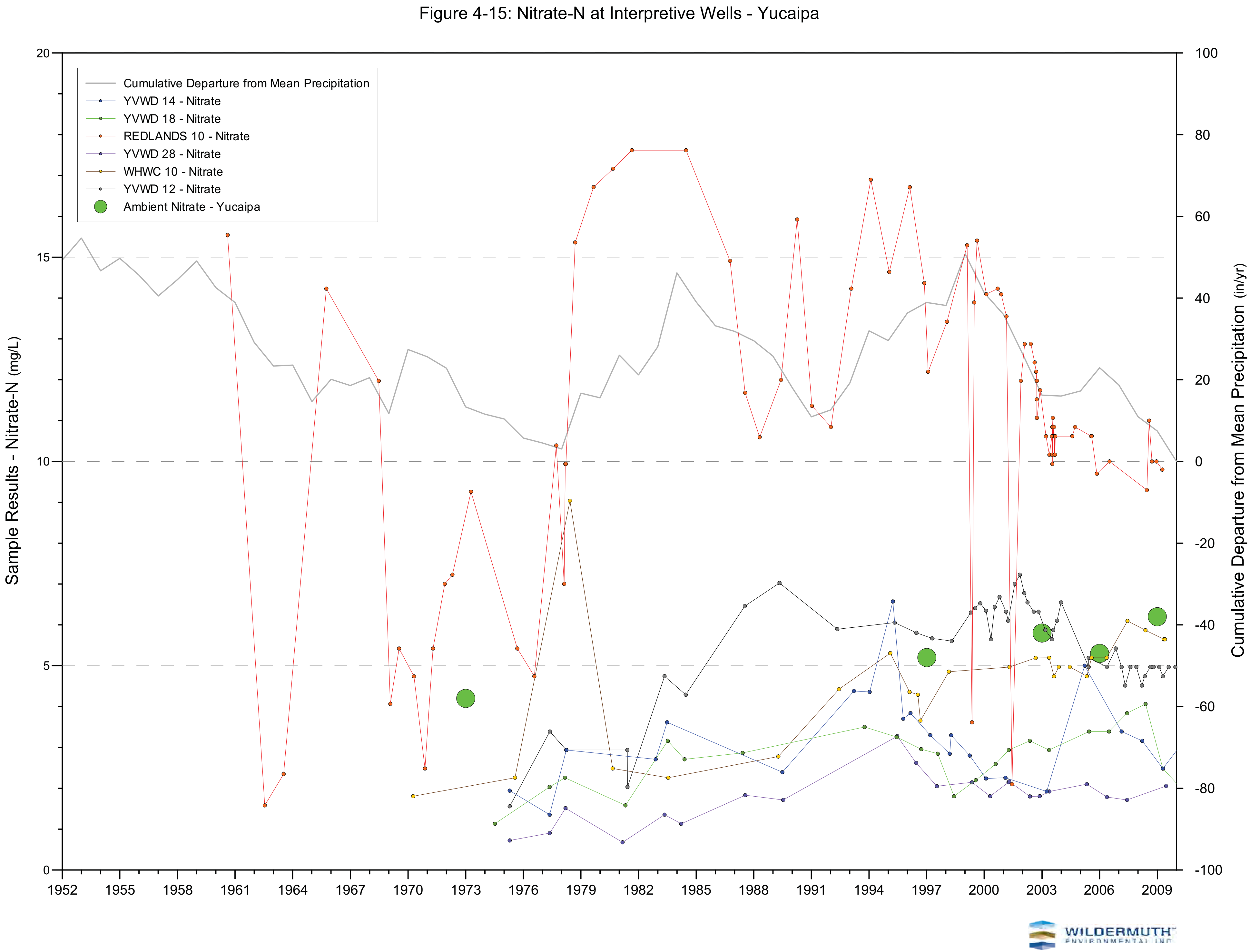
Figure 4-15: Nitrate-N at Interpretive Wells - Yucaipa
Cumulative Departure from Mean Precipitation
YVWD 14 - Nitrate
YVWD 18 - Nitrate
REDLANDS 10 - Nitrate
YVWD 28 - Nitrate
WHWC 10 - Nitrate
YVWD 12 - Nitrate
Ambient Nitrate - Yucaipa
Sample Results - Nitrate-N (mg/L)
Cumulative Departure from Mean Precipitation (in/yr)
20
15
10
5
0
100
80
60
40
20
0
-20
-40
-60
-80
-100
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
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Figure 4-16: TDS at Interpretive Wells - Bunker Hill A

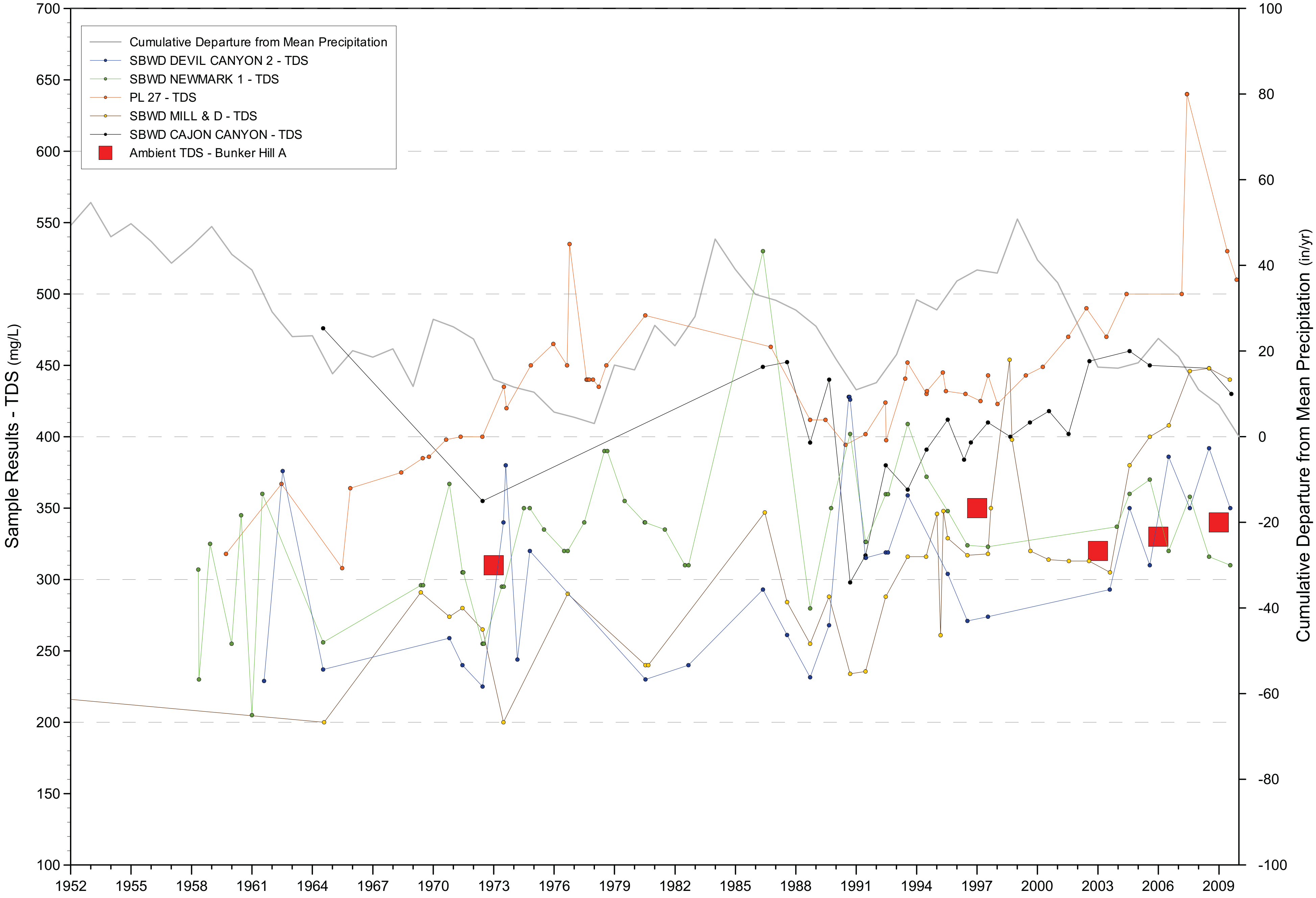

Figure 4-17: Nitrate-N at Interpretive Wells - Bunker Hill A

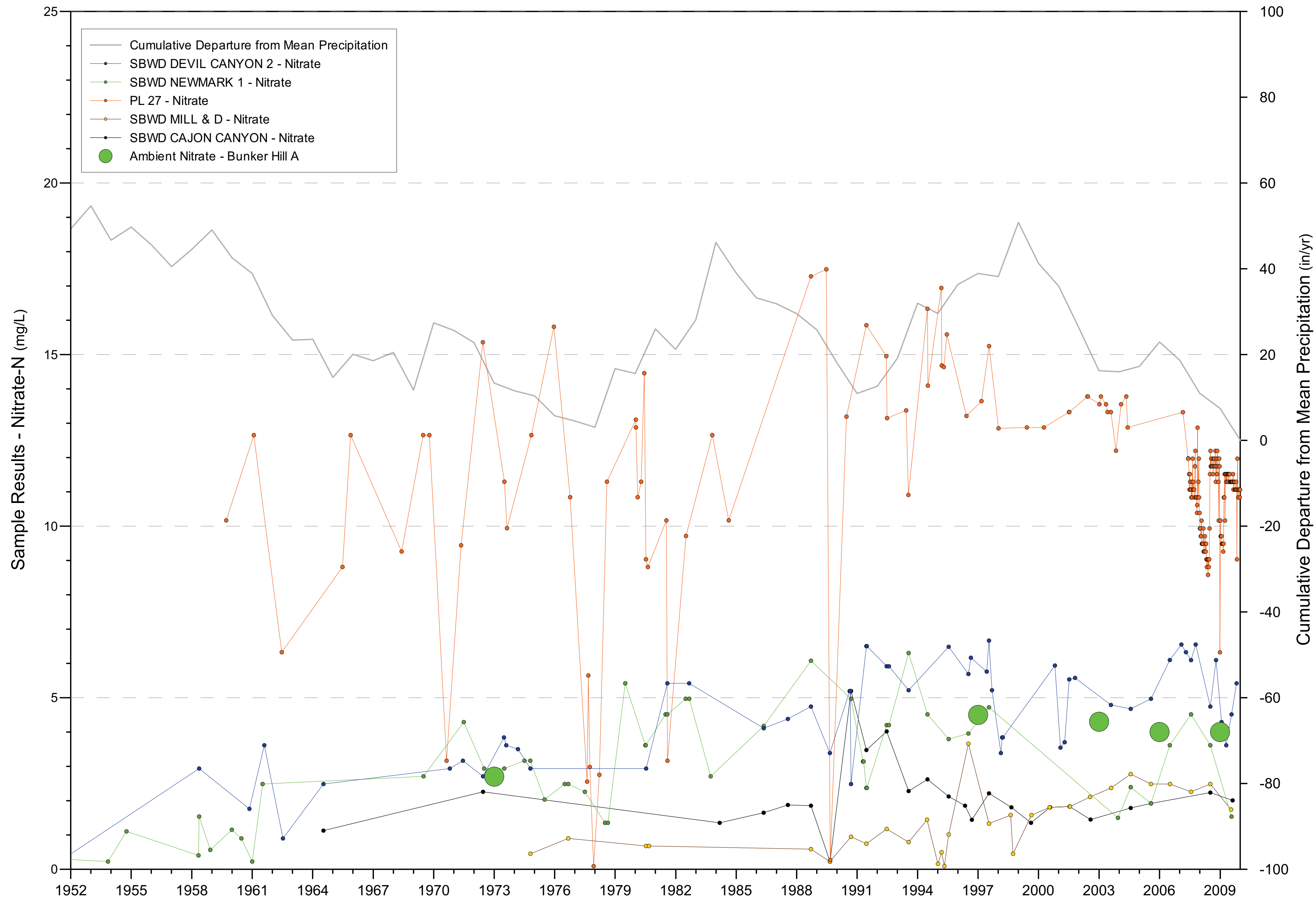

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Figure 4-18: TDS at Interpretive Wells - Bunker Hill B

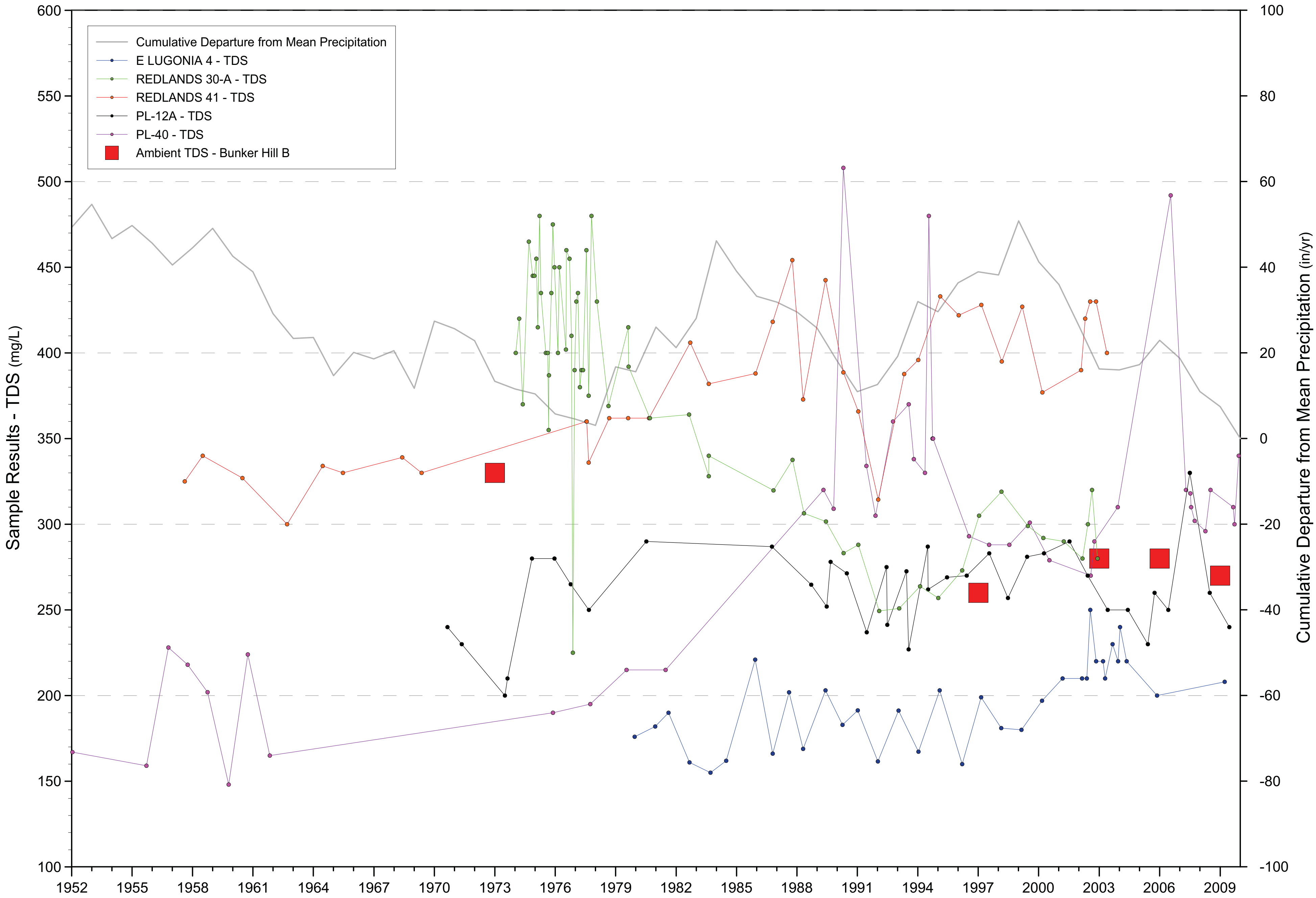

Figure 4-19: Nitrate-N at Interpretive Wells - Bunker Hill B

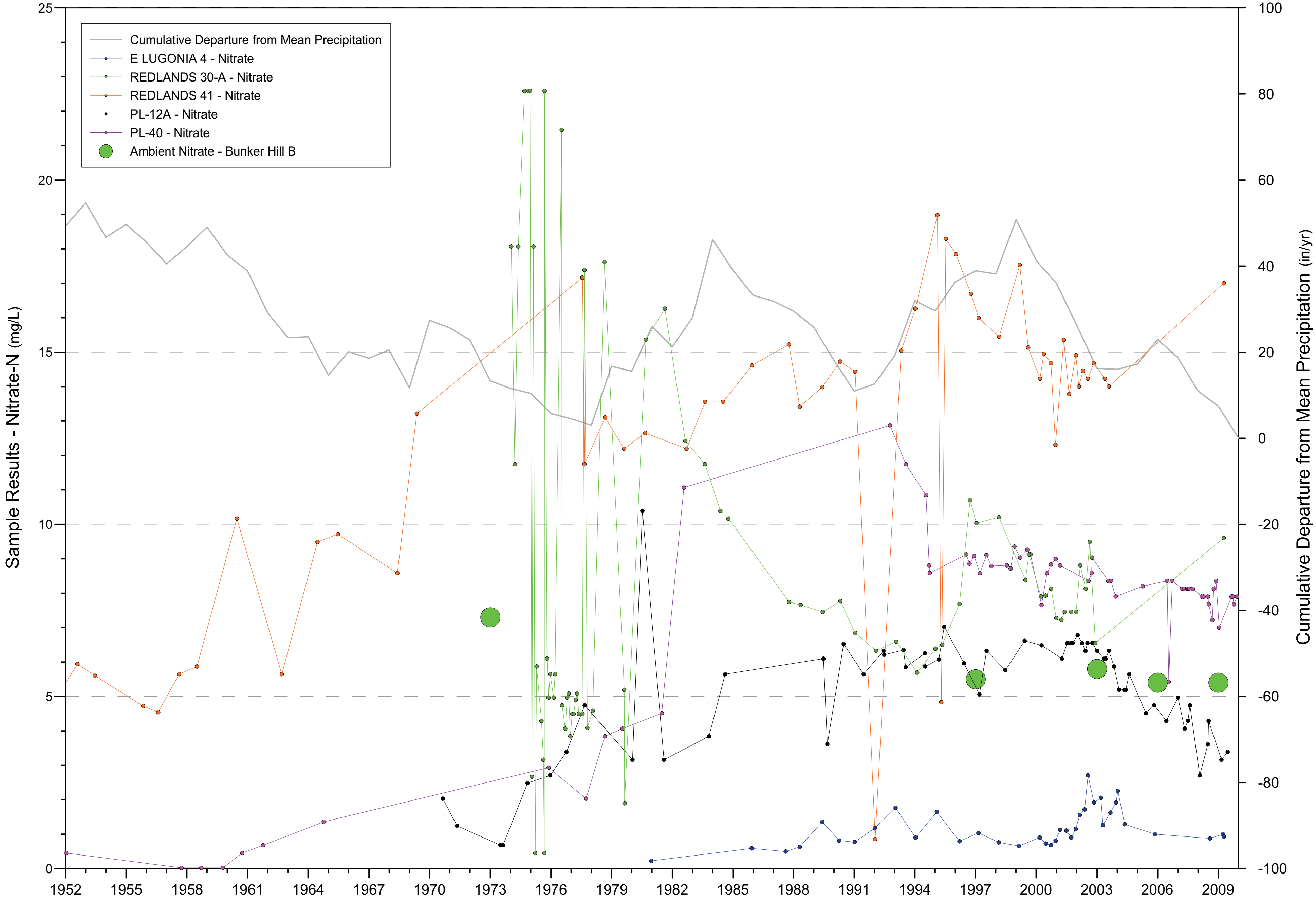

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Figure 4-20: TDS at Interpretive Wells - Colton

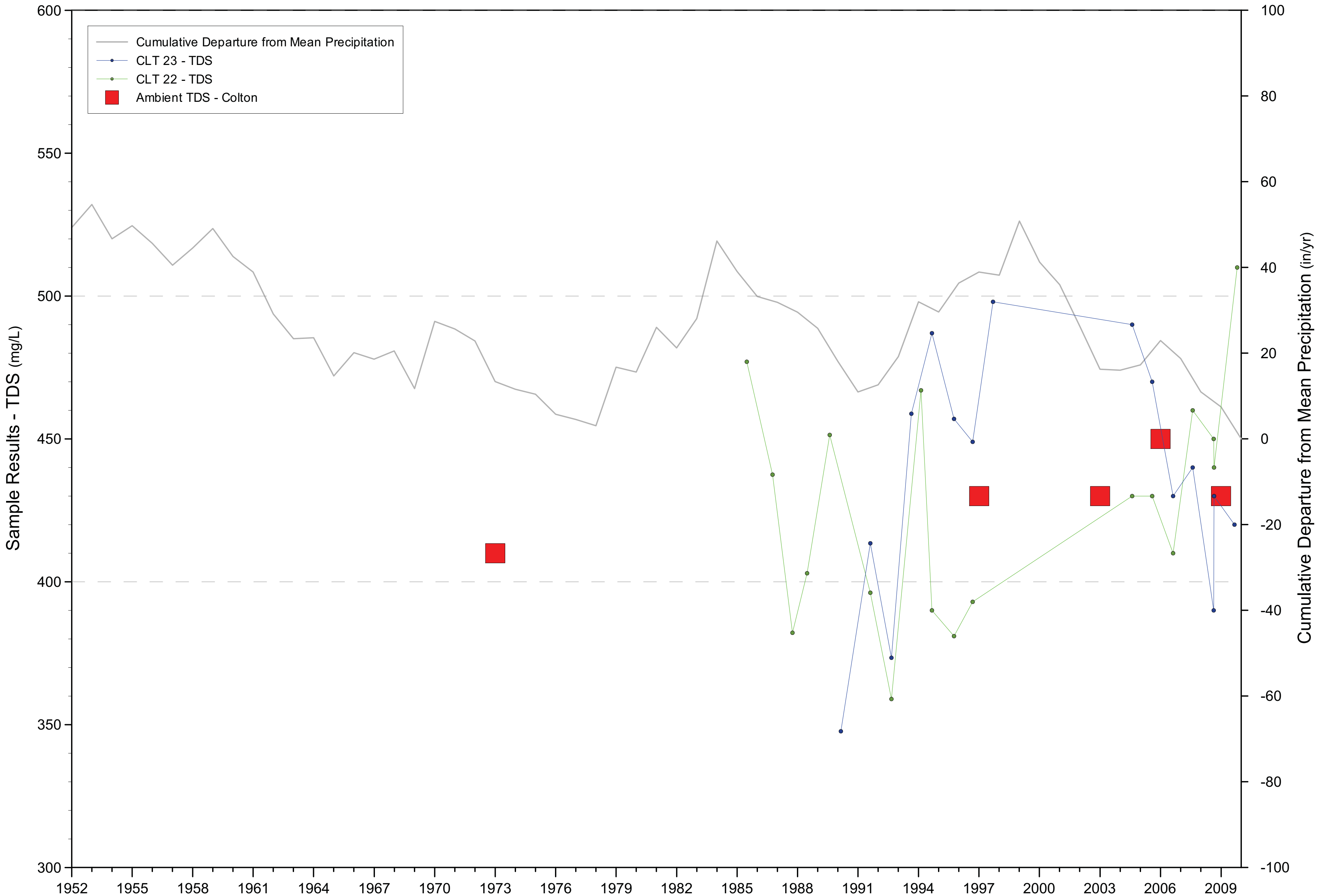

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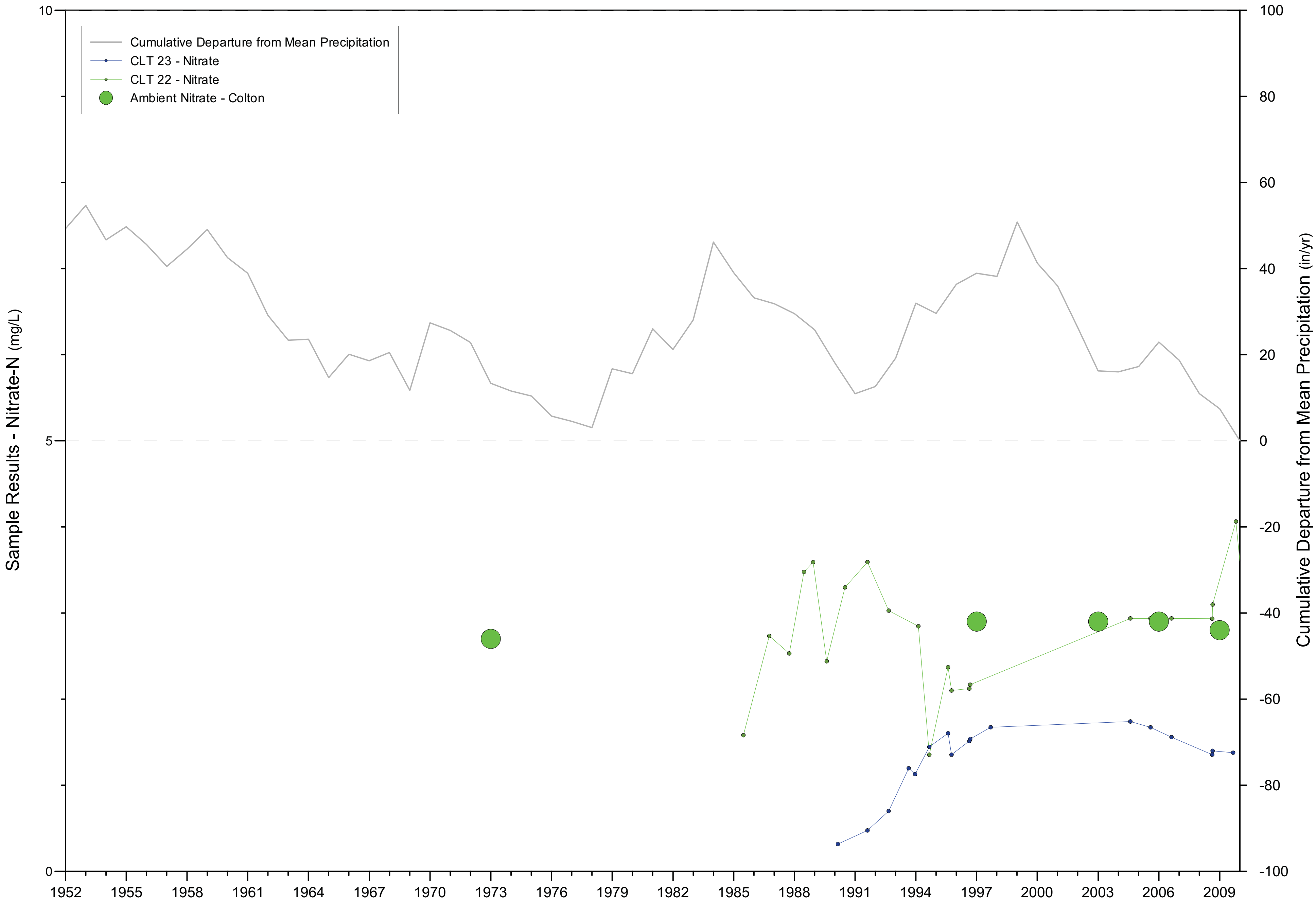
Figure 4-21: Nitrate-N at Interpretive Wells - Colton



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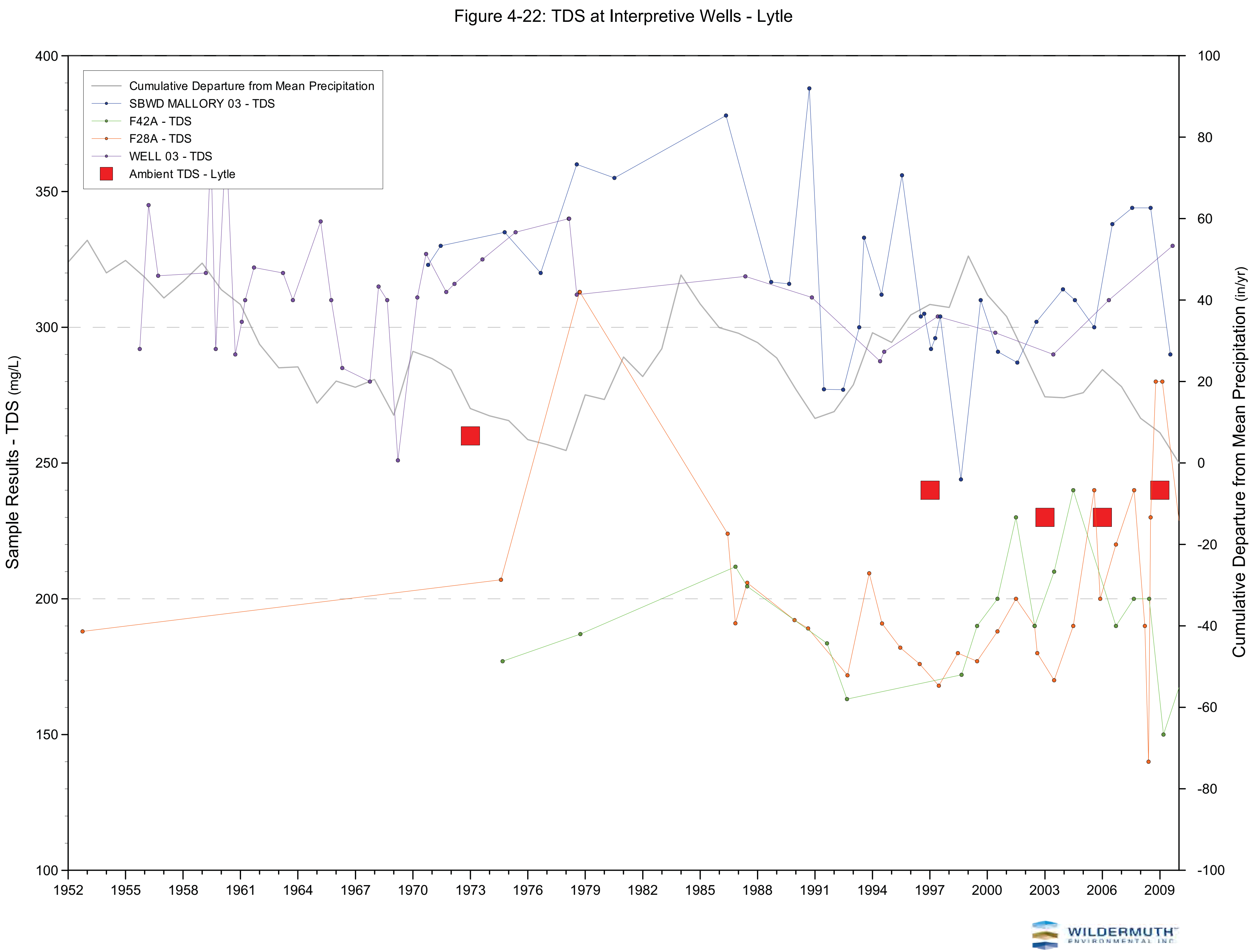

Figure 4-22: TDS at Interpretive Wells - Lytle
Cumulative Departure from Mean Precipitation
SBWD MALLORY 03 - TDS
F42A - TDS
F28A - TDS
WELL 03 - TDS
Ambient TDS - Lytle
Sample Results - TDS (mg/L)
Cumulative Departure from Mean Precipitation (in/yr)
400
350
300
250
200
150
100
100
80
60
40
20
0
-20
-40
-60
-80
-100
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
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Figure 4-23: Nitrate-N at Interpretive Wells - Lytle

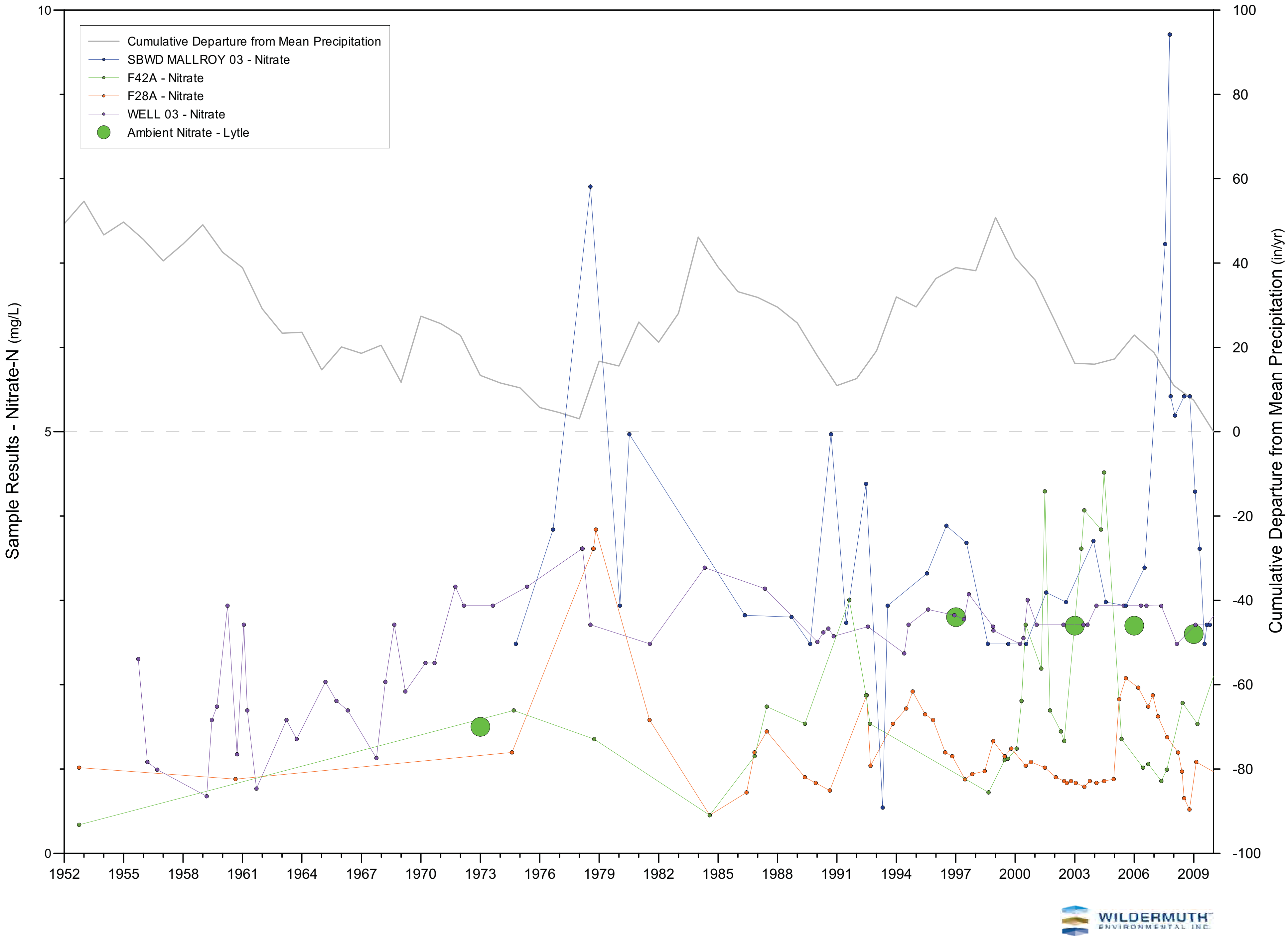

Figure 4-24: TDS at Interpretive Wells - Rialto

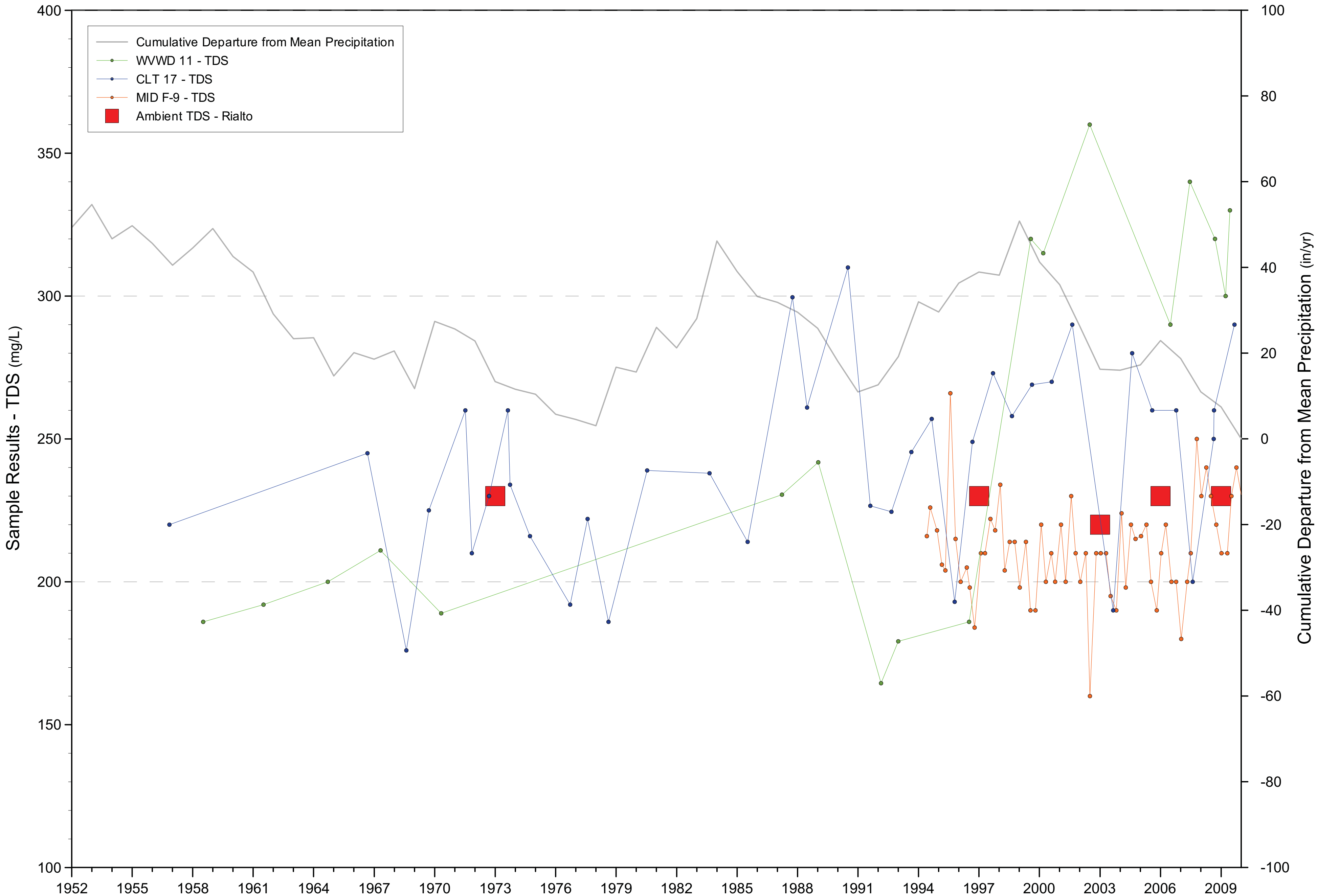

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Figure 4-25: Nitrate-N at Interpretive Wells - Rialto

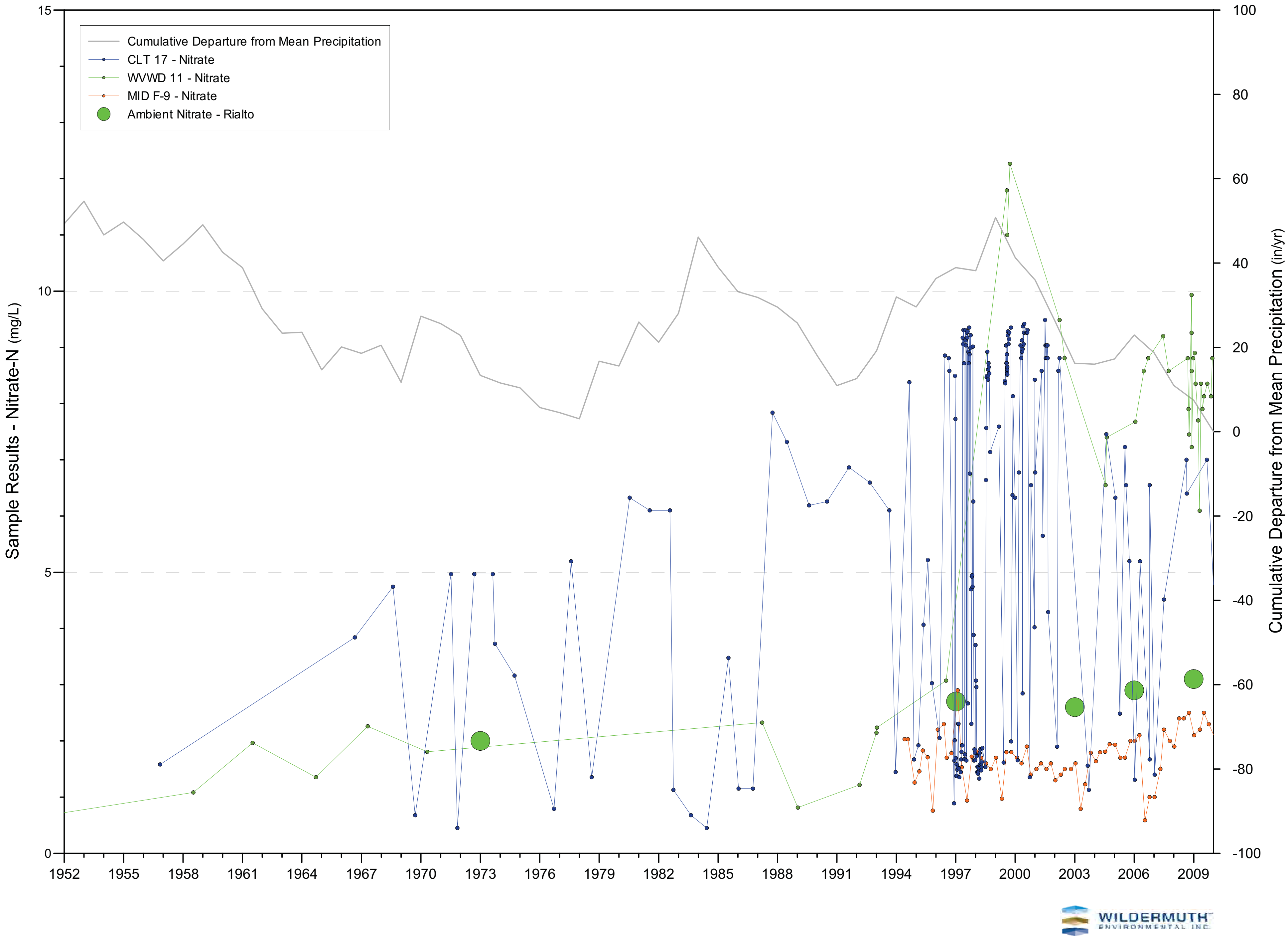

Figure 4-26: TDS at Interpretive Wells - Riverside A

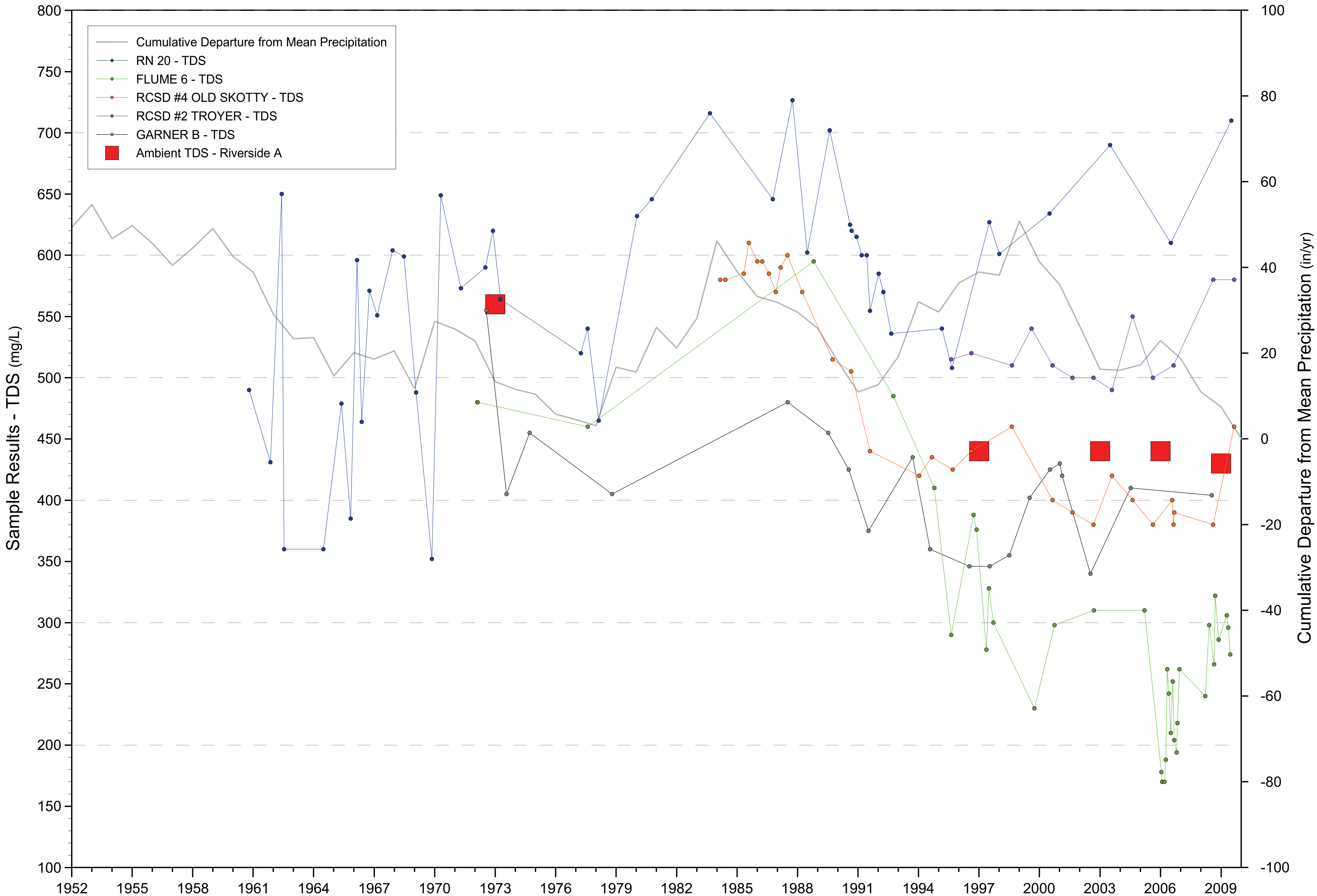

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Figure 4-27: Nitrate-N at Interpretive Wells - Riverside A

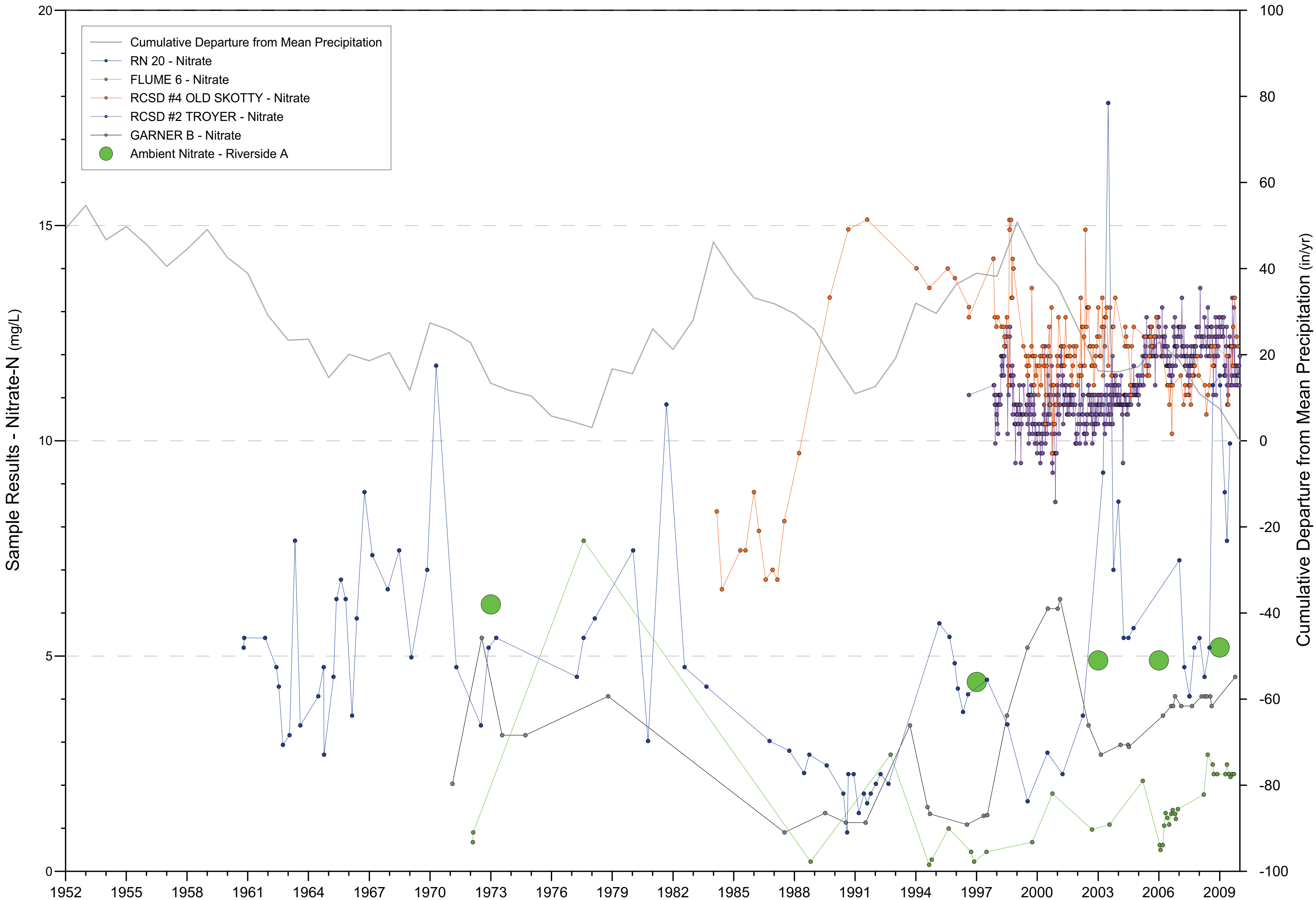


Figure 4-28: TDS at Interpretive Wells - Riverside B

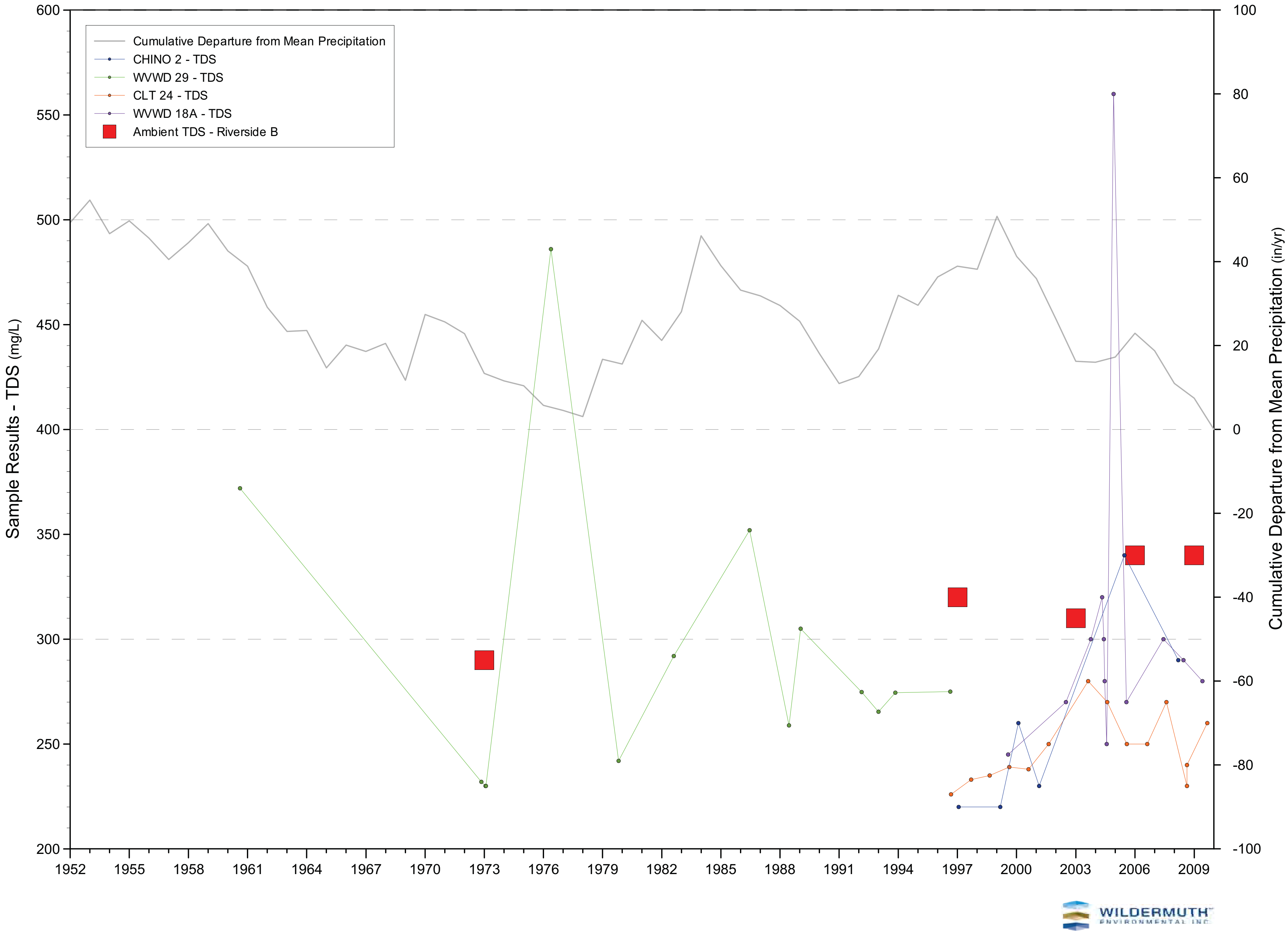
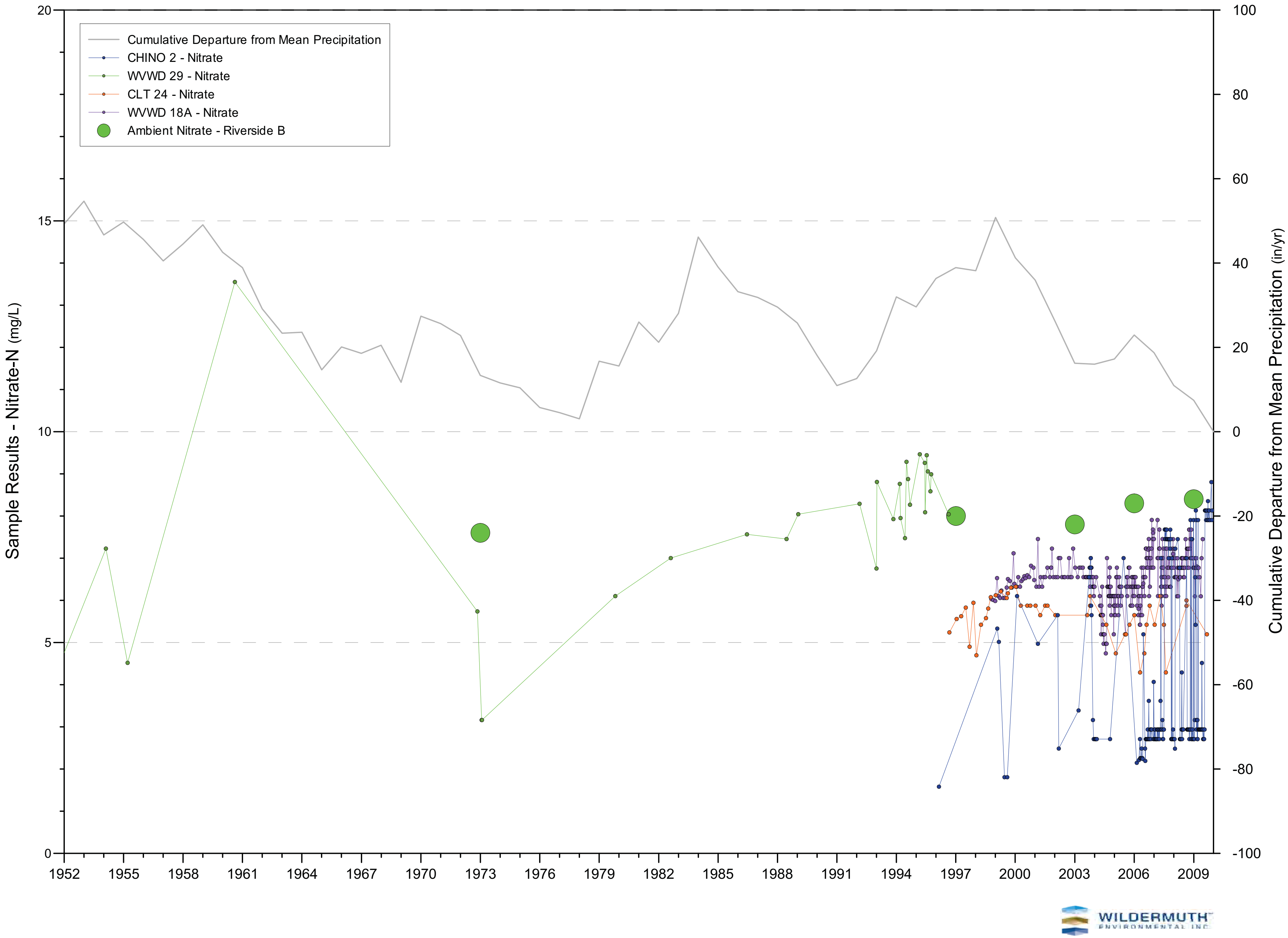


Figure 4-29: Nitrate-N at Interpretive Wells - Riverside B



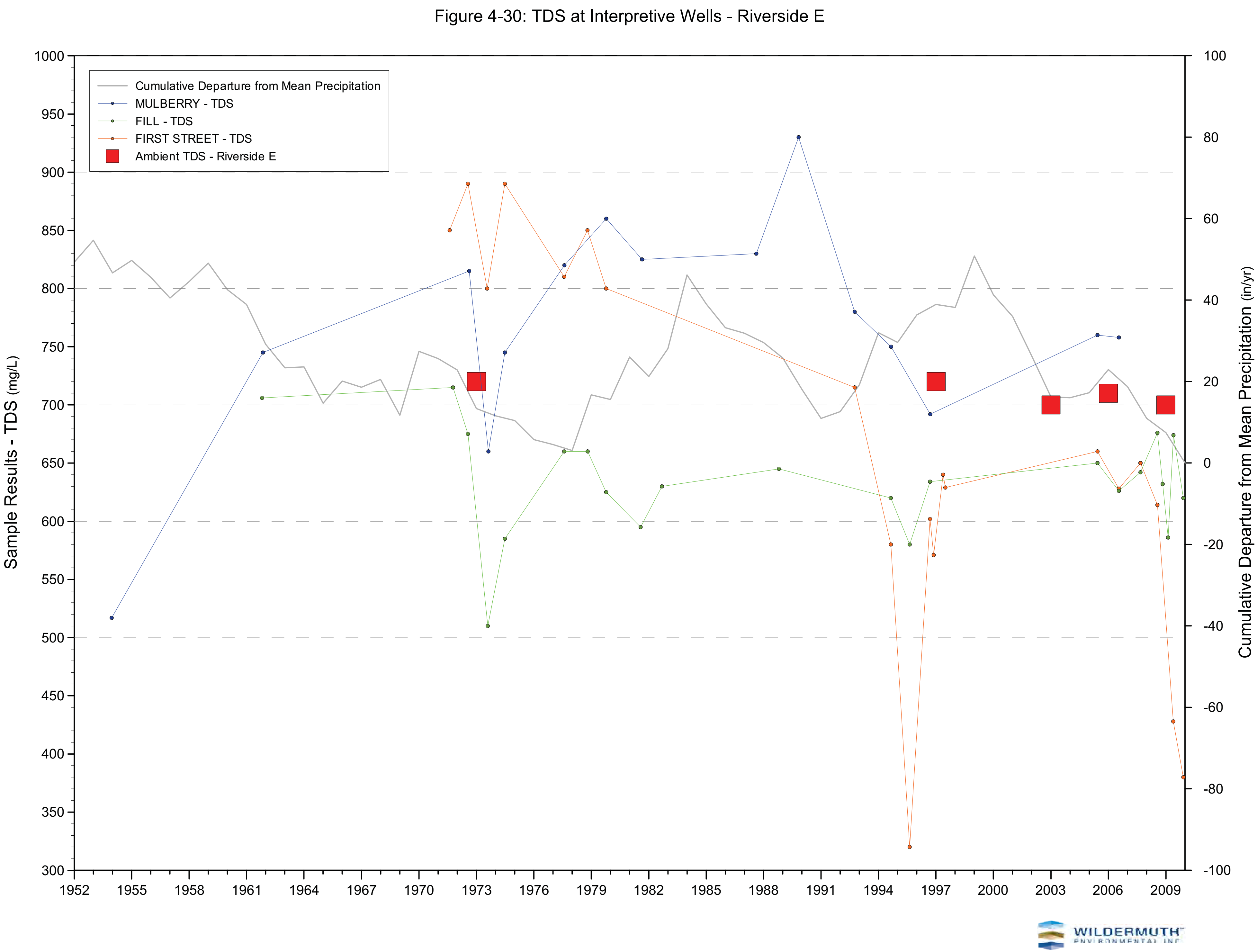


Figure 4-30: TDS at Interpretive Wells - Riverside E
Cumulative Departure from Mean Precipitation
MULBERRY - TDS
FILL - TDS
FIRST STREET - TDS
Ambient TDS - Riverside E
Sample Results - TDS (mg/L)
Cumulative Departure from Mean Precipitation (in/yr)
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
100
80
60
40
20
0
-20
-40
-60
-80
-100
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
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Figure 4-31: Nitrate-N at Interpretive Wells - Riverside E

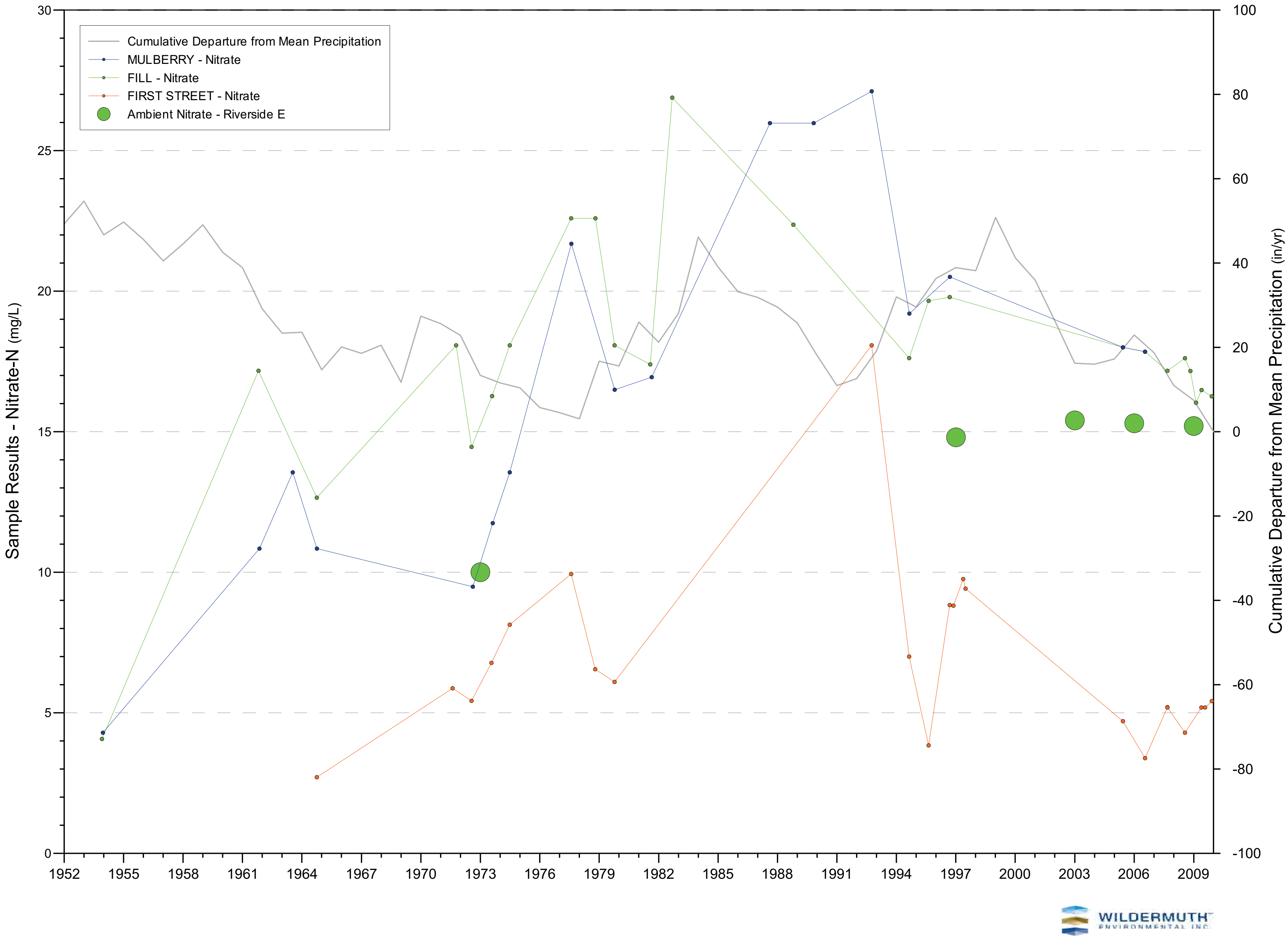

Figure 4-32: TDS at Interpretive Wells - Riverside F

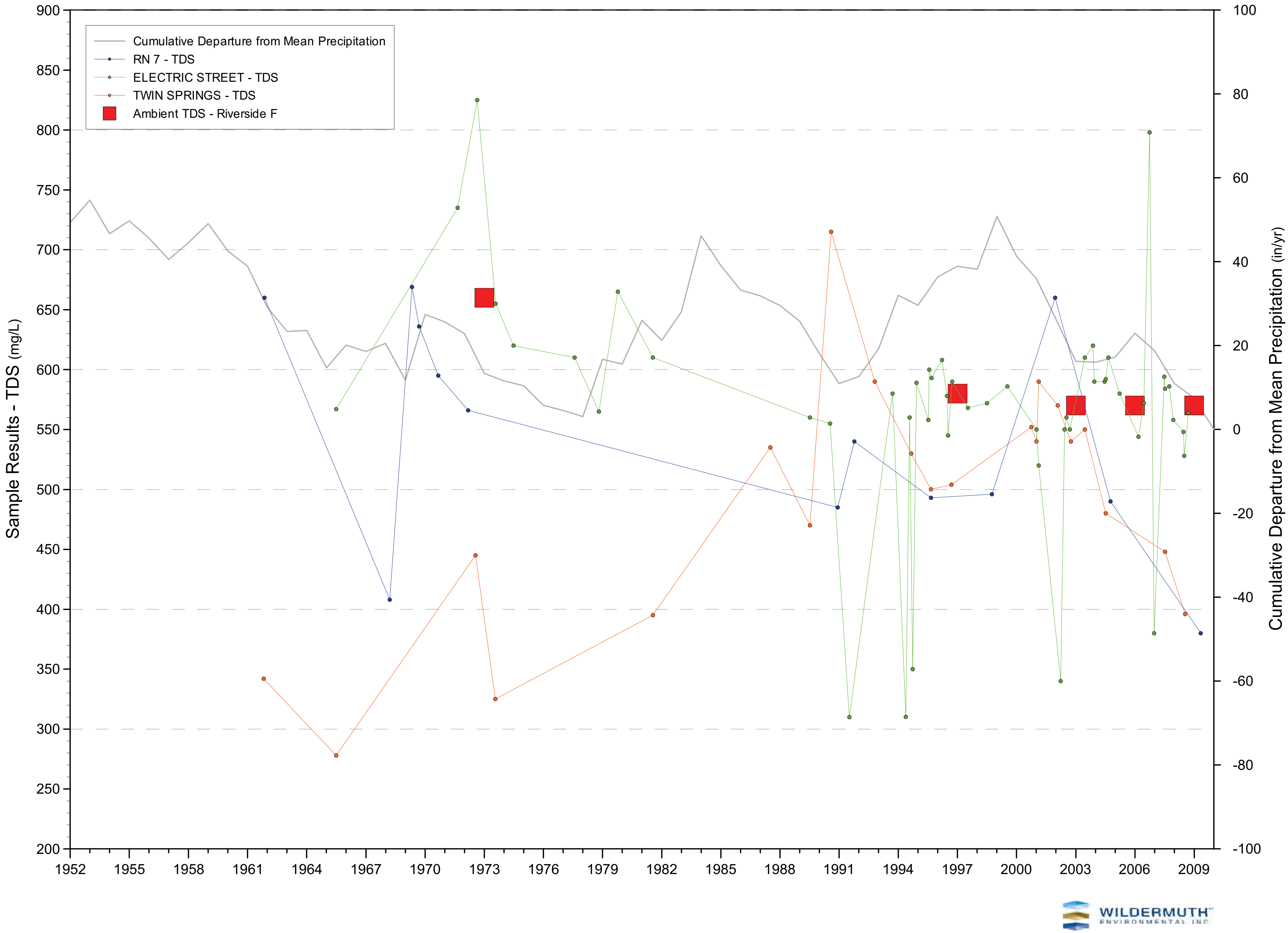

Figure 4-33: Nitrate-N at Interpretive Wells - Riverside F

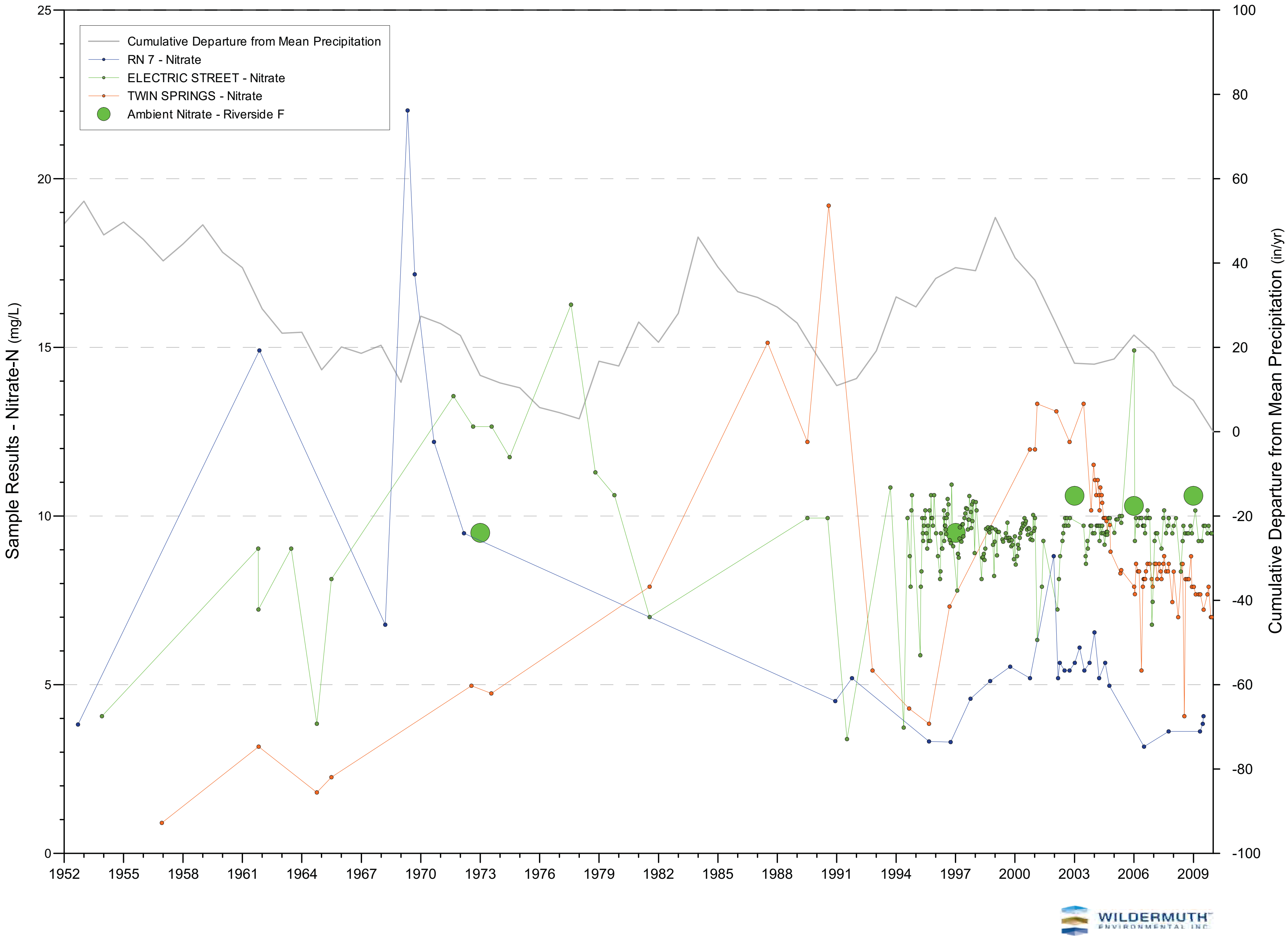

Figure 4-34: TDS at Interpretive Wells - Arlington

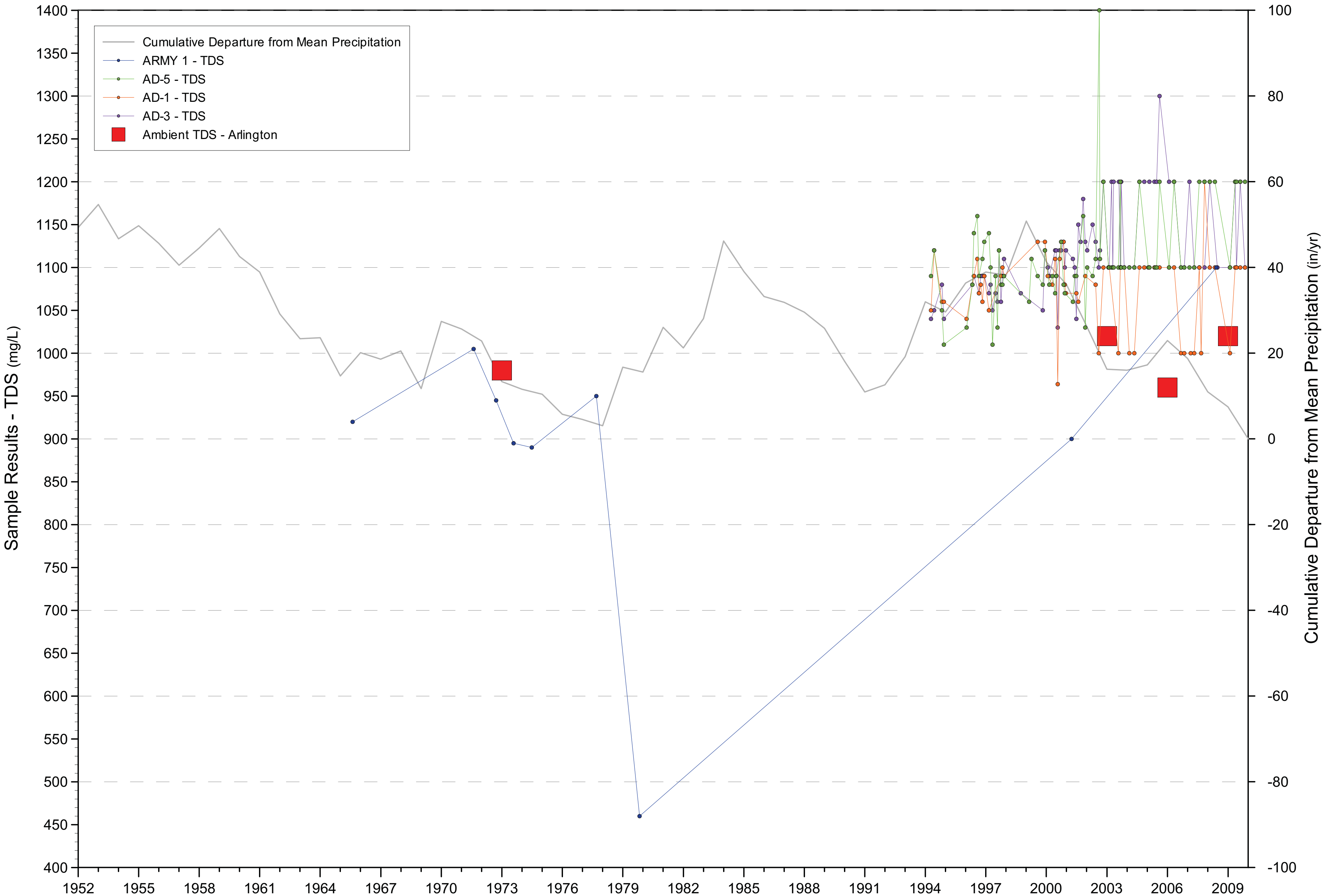

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Figure 4-35: Nitrate-N at Interpretive Wells - Arlington

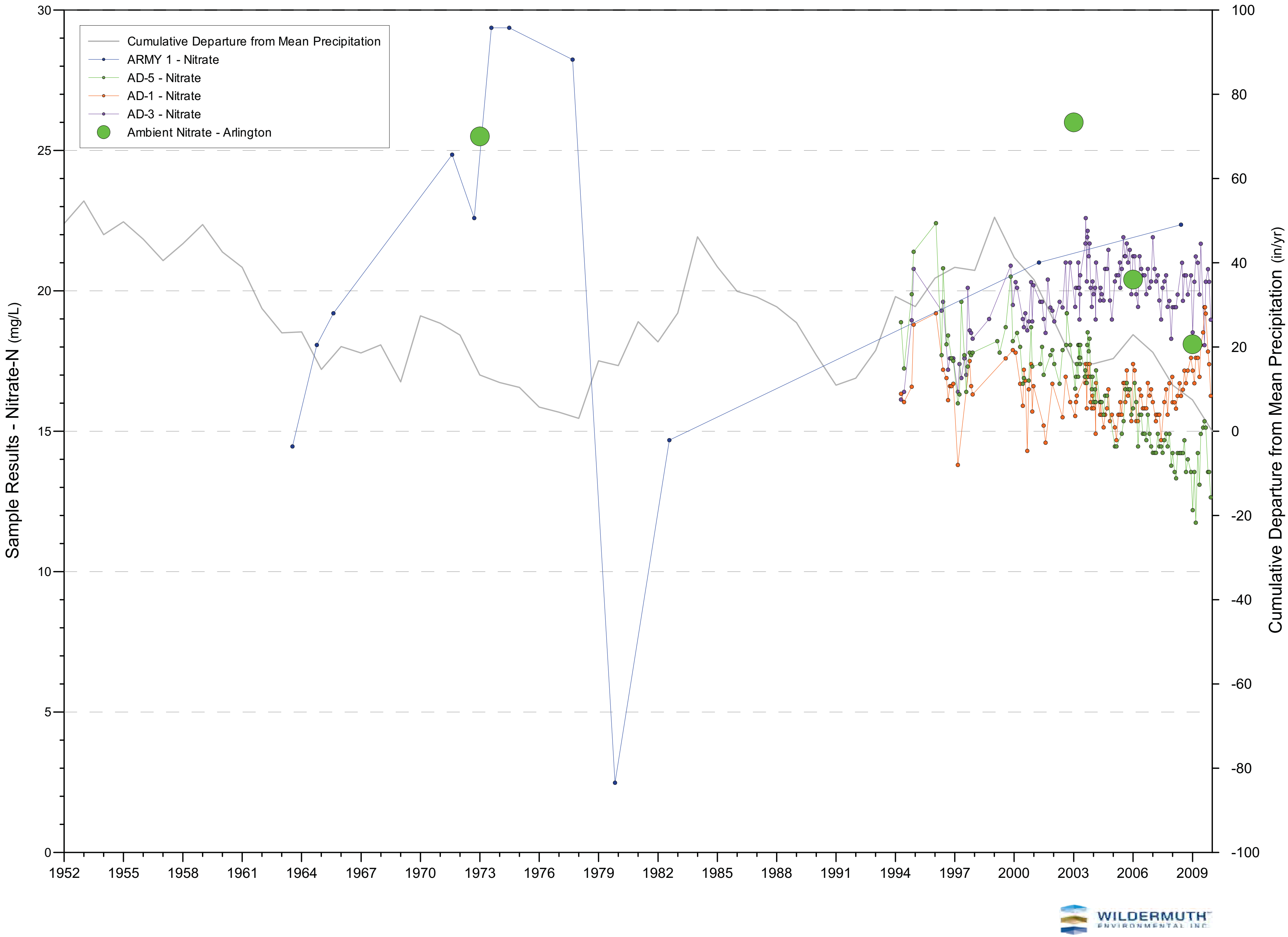

Figure 4-36: TDS at Interpretive Wells - Coldwater

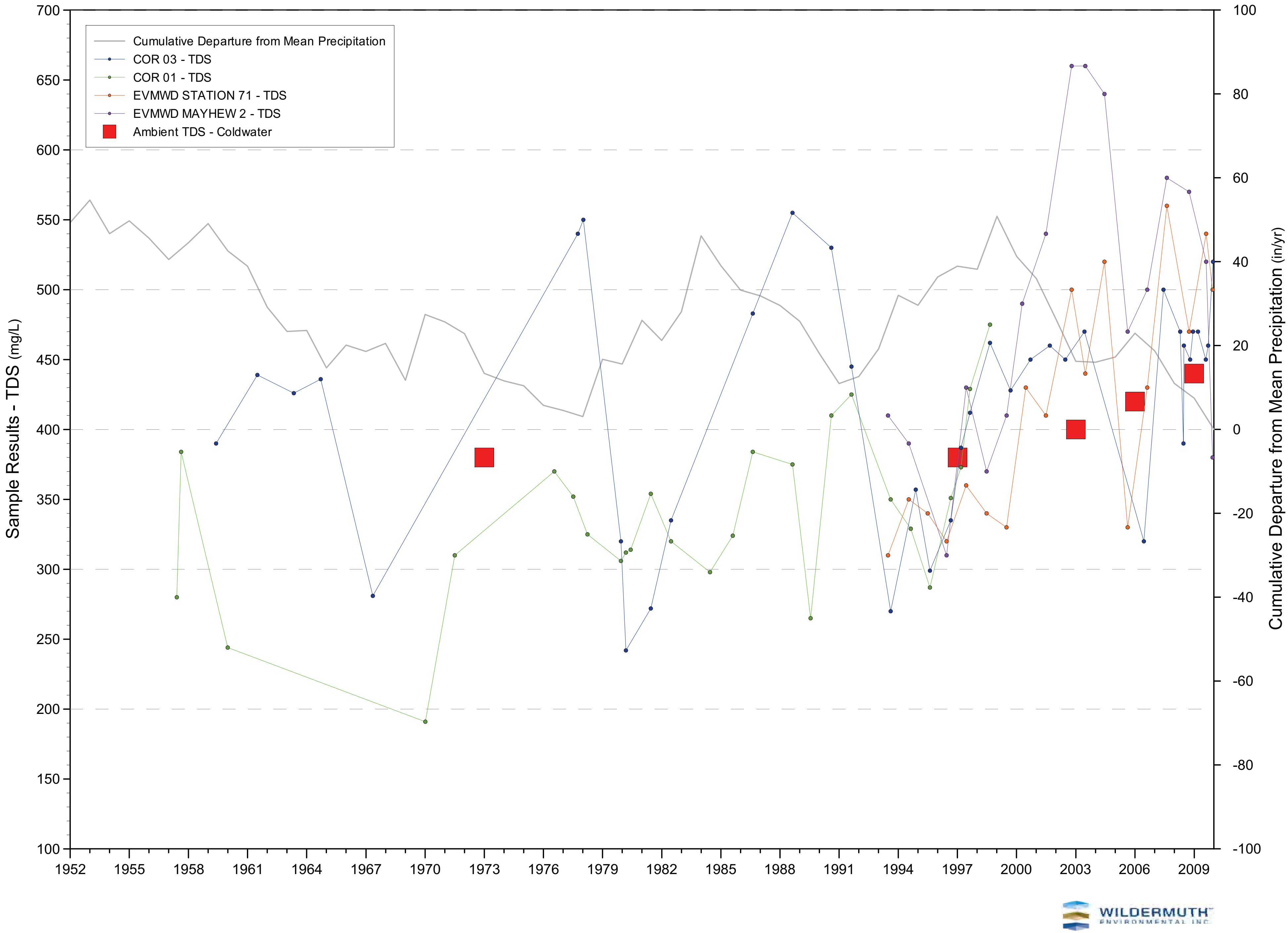

Figure 4-37: Nitrate-N at Interpretive Wells - Coldwater

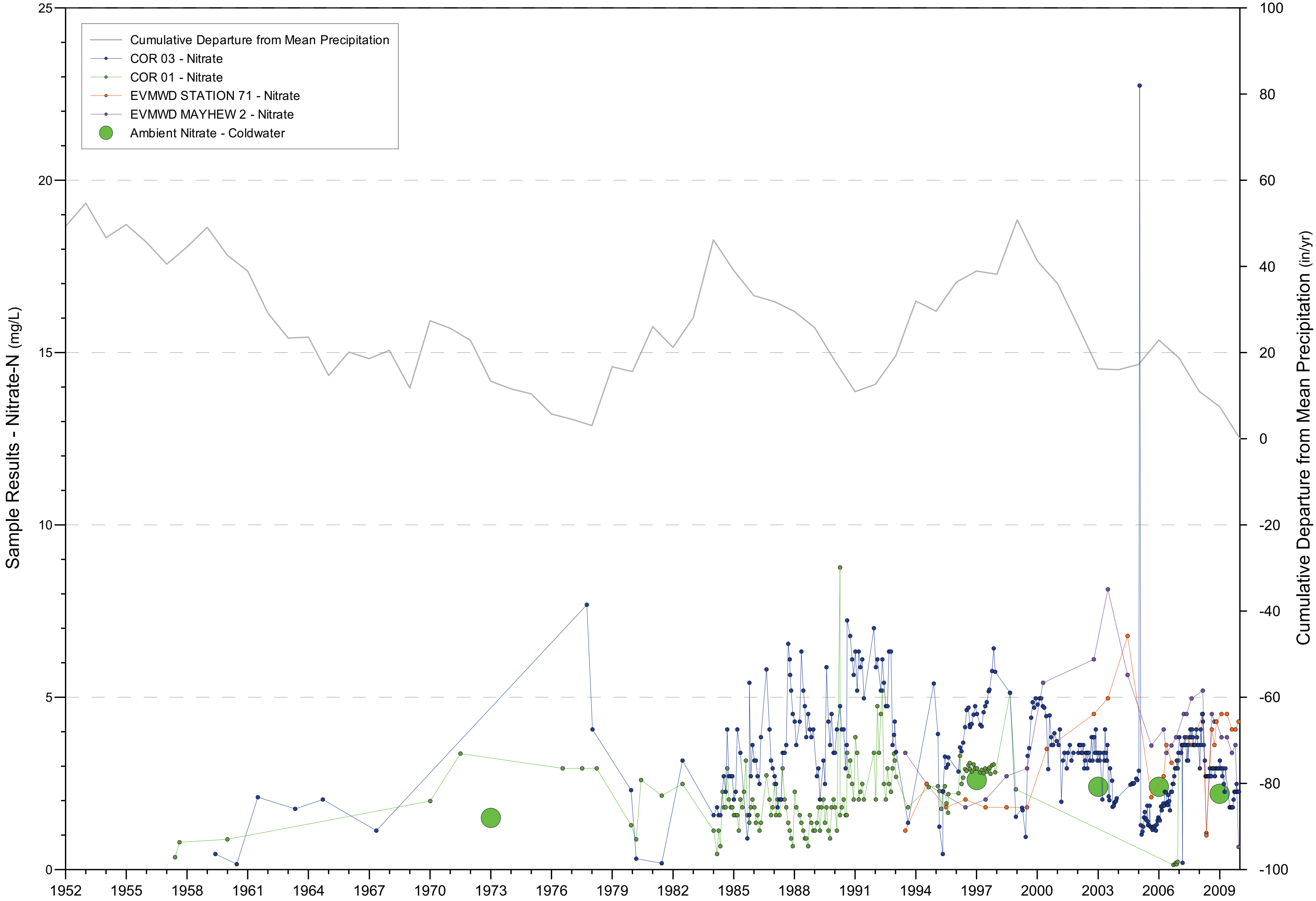

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Figure 4-38: TDS at Interpretive Wells - Elsinore

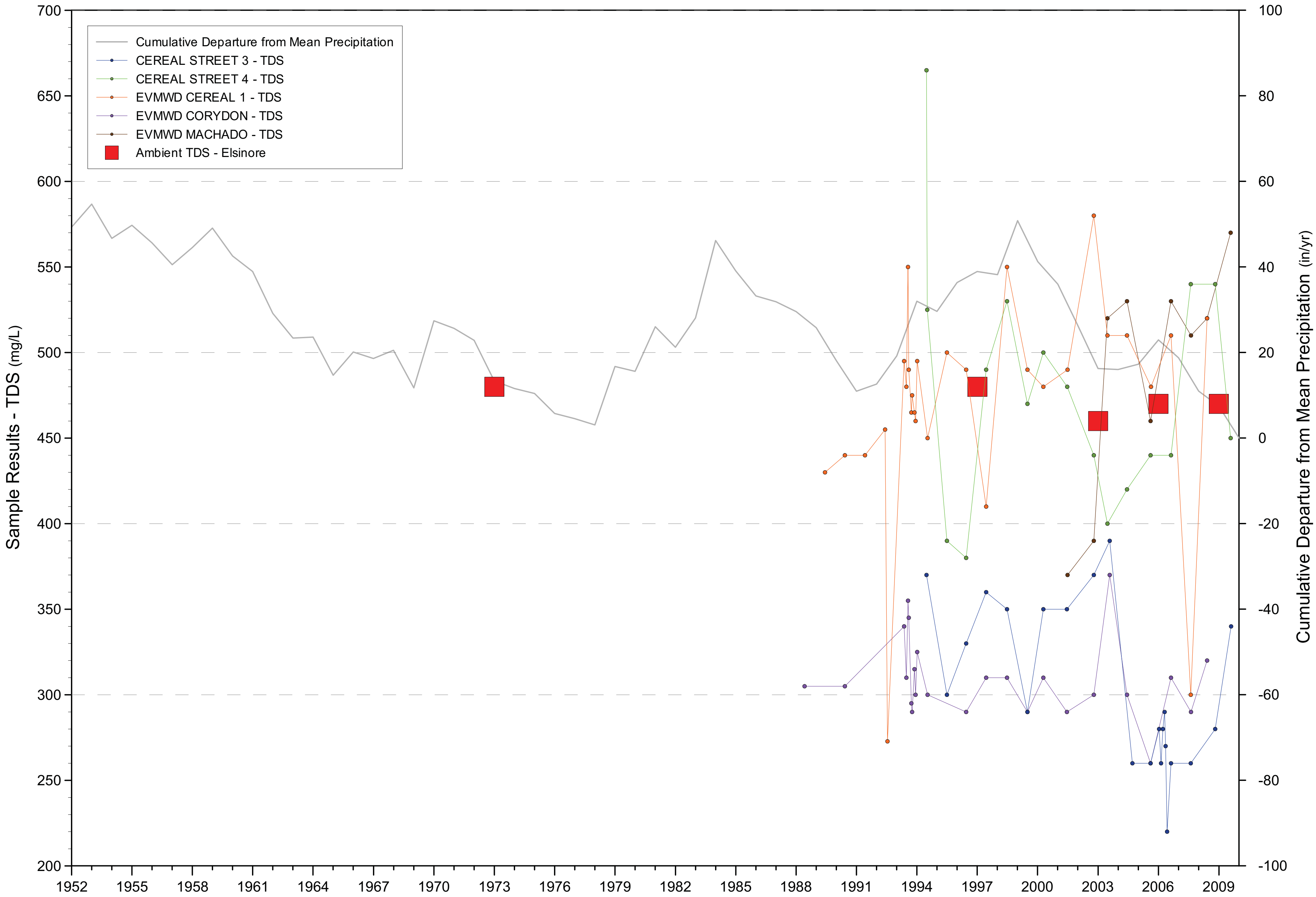

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Figure 4-39: Nitrate-N at Interpretive Wells - Elsinore

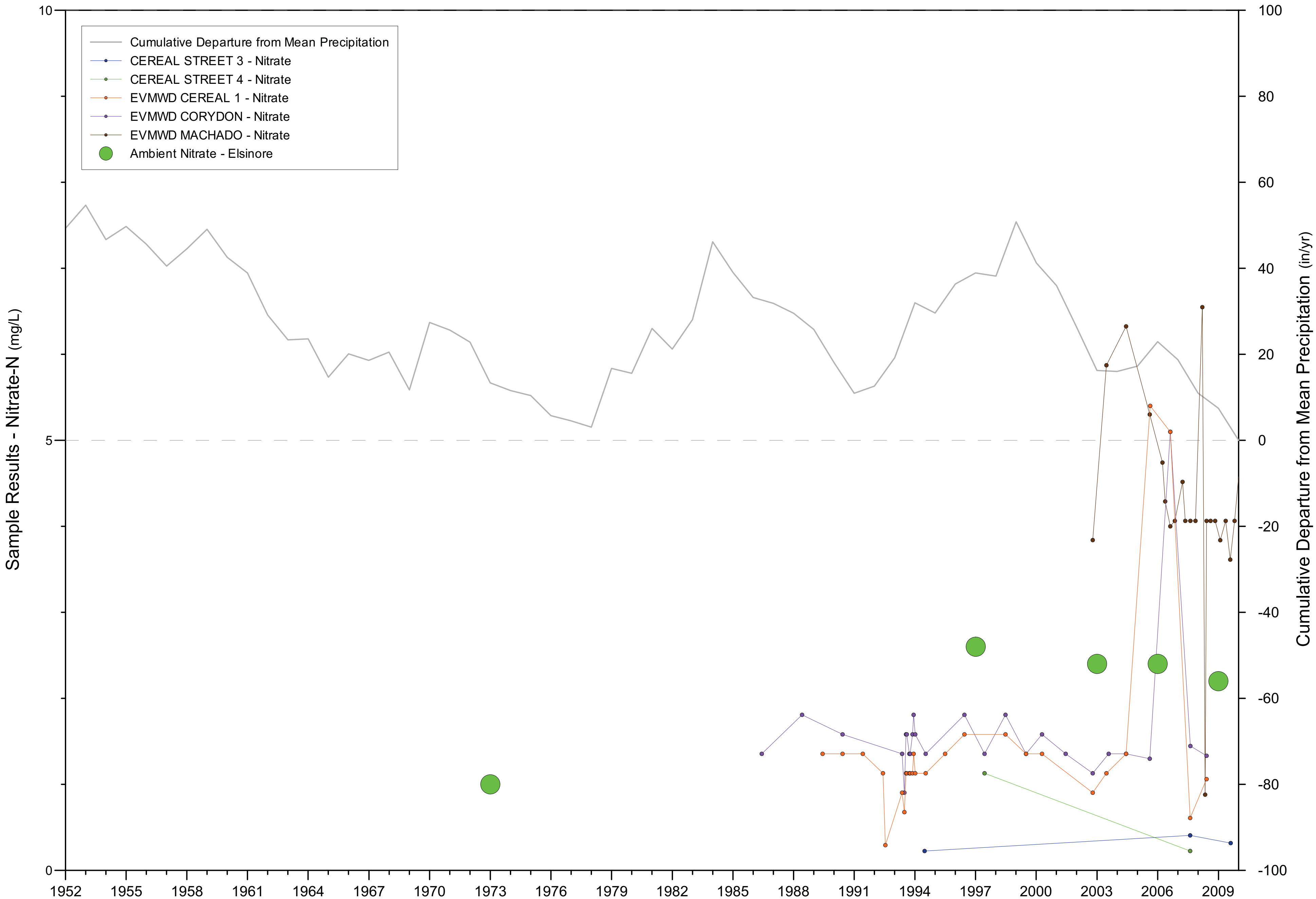

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Figure 4-40: TDS at Interpretive Wells - Temescal

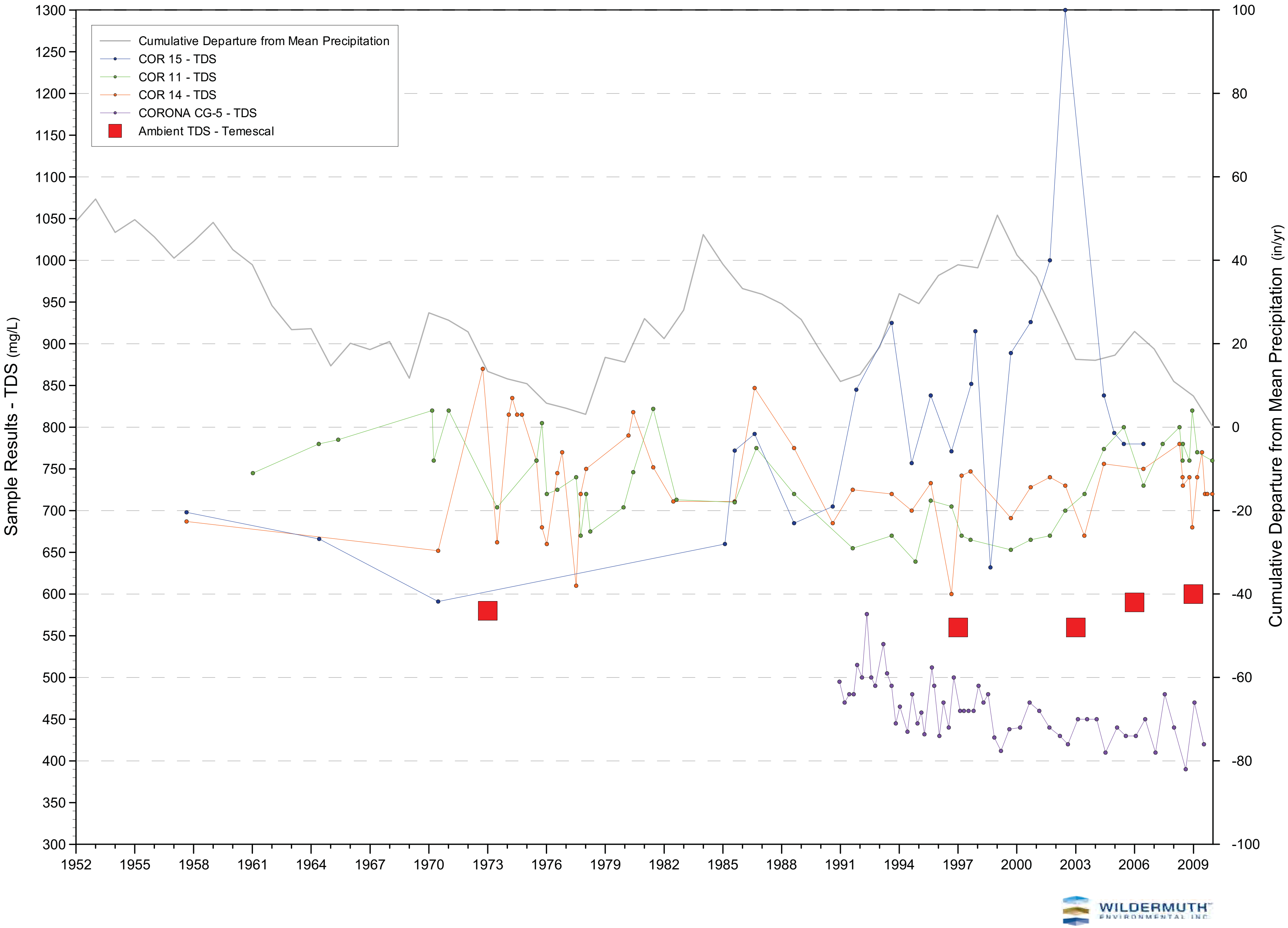

Figure 4-41: Nitrate-N at Interpretive Wells - Temescal

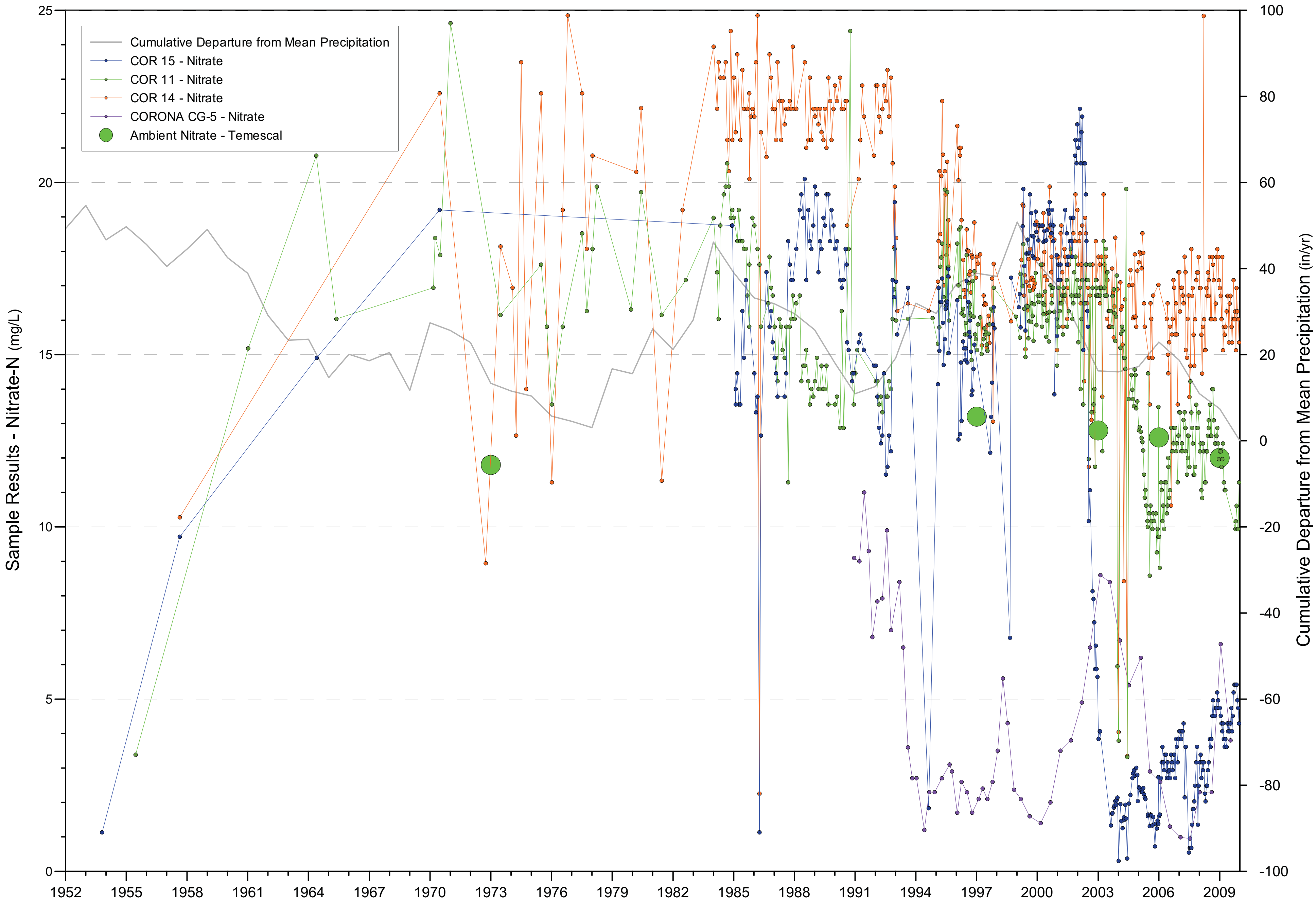

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Figure 4-42: TDS at Interpretive Wells - Hemet South

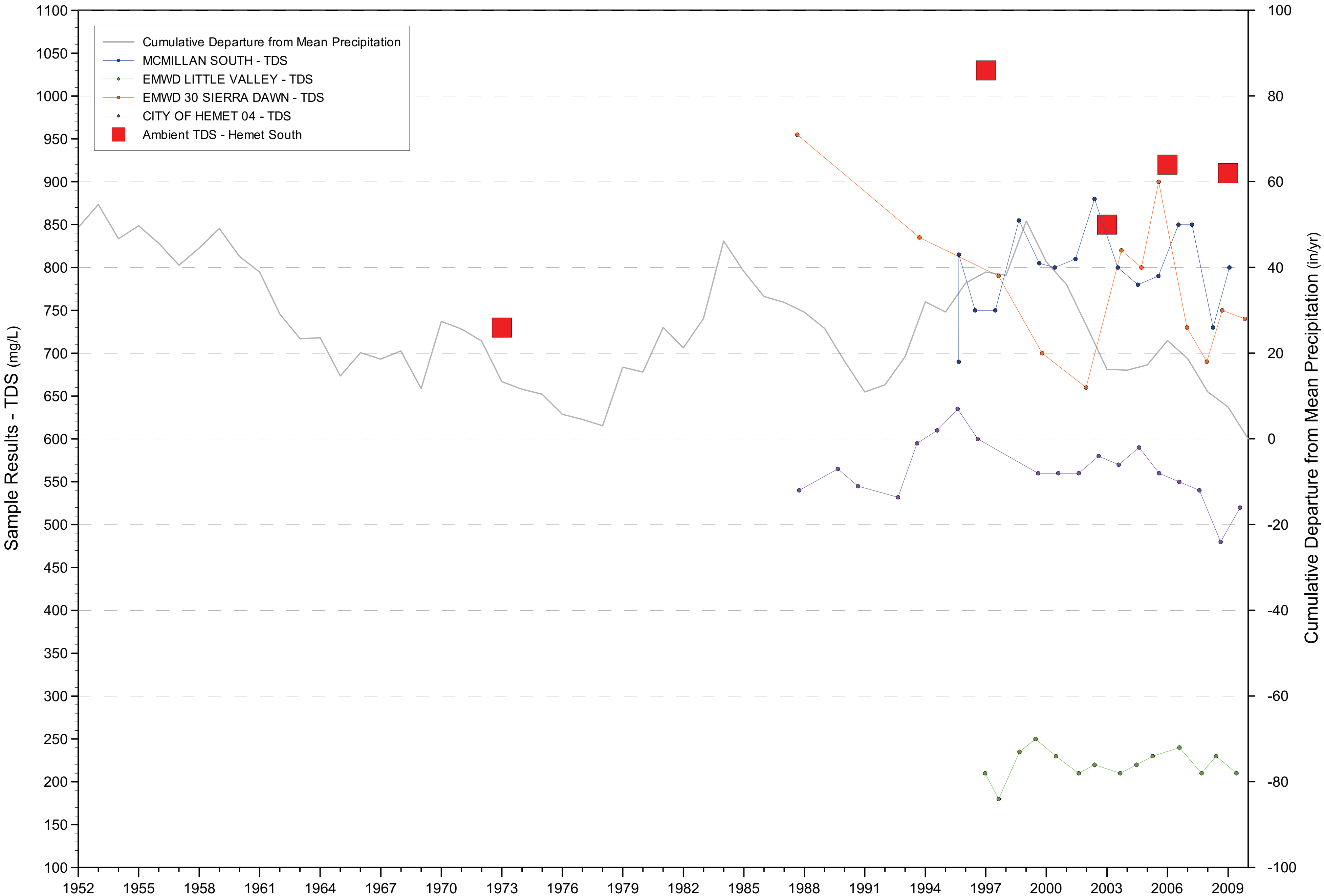

Figure 4-43: Nitrate-N at Interpretive Wells - Hemet South

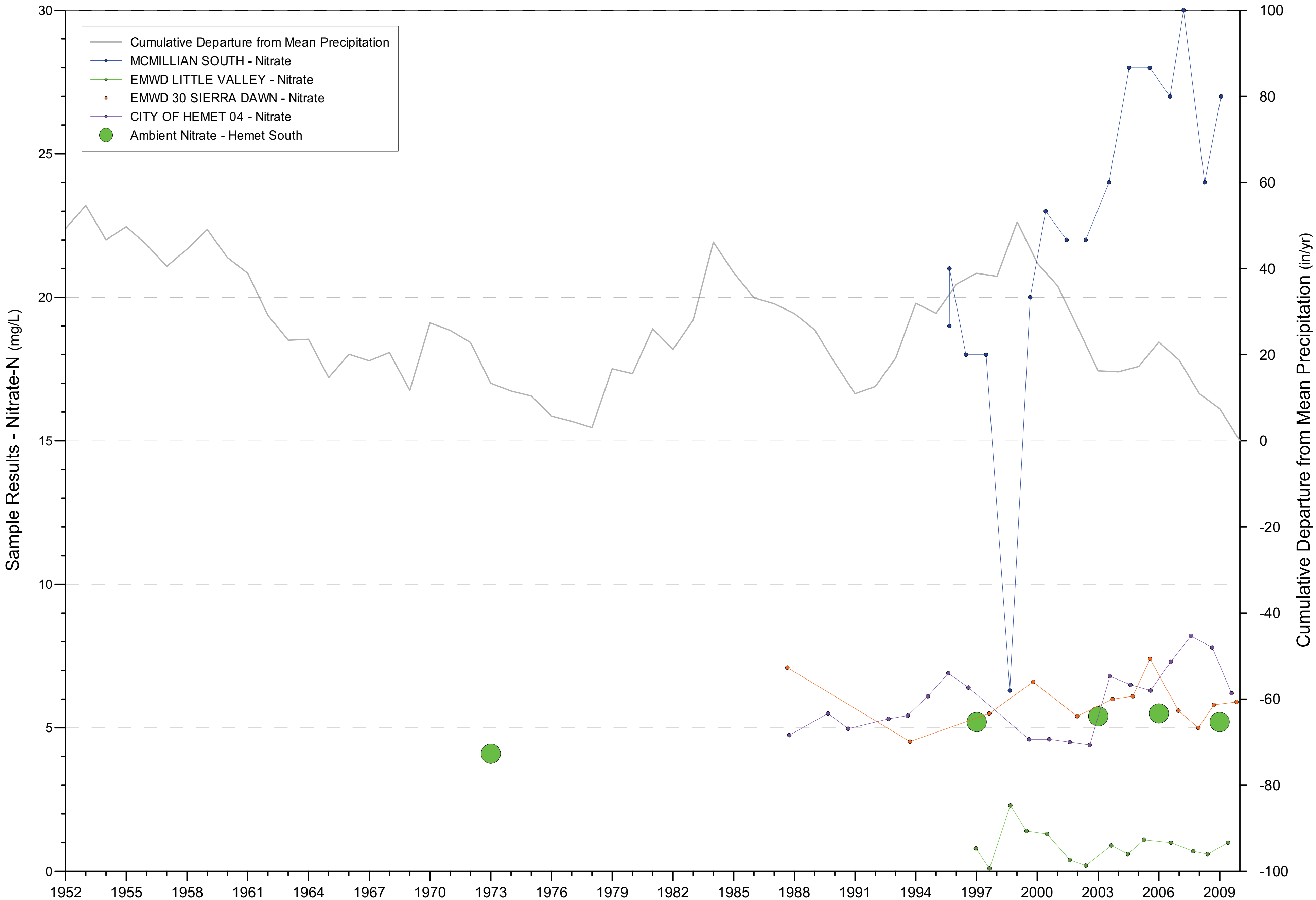

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Figure 4-44: TDS at Interpretive Wells - Lakeview/Hemet North

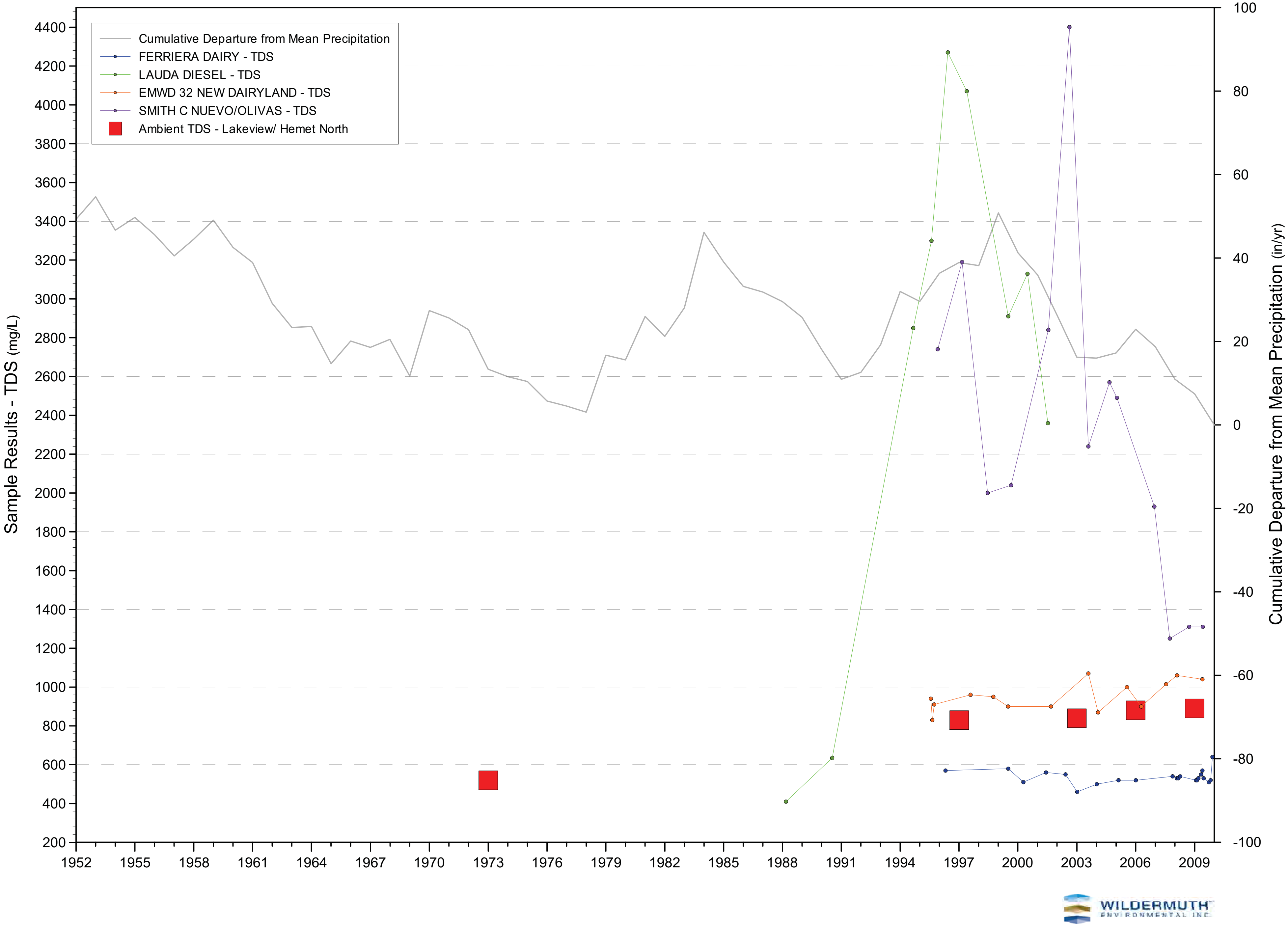

Figure 4-45: Nitrate-N at Interpretive Wells - Lakeview/Hemet North

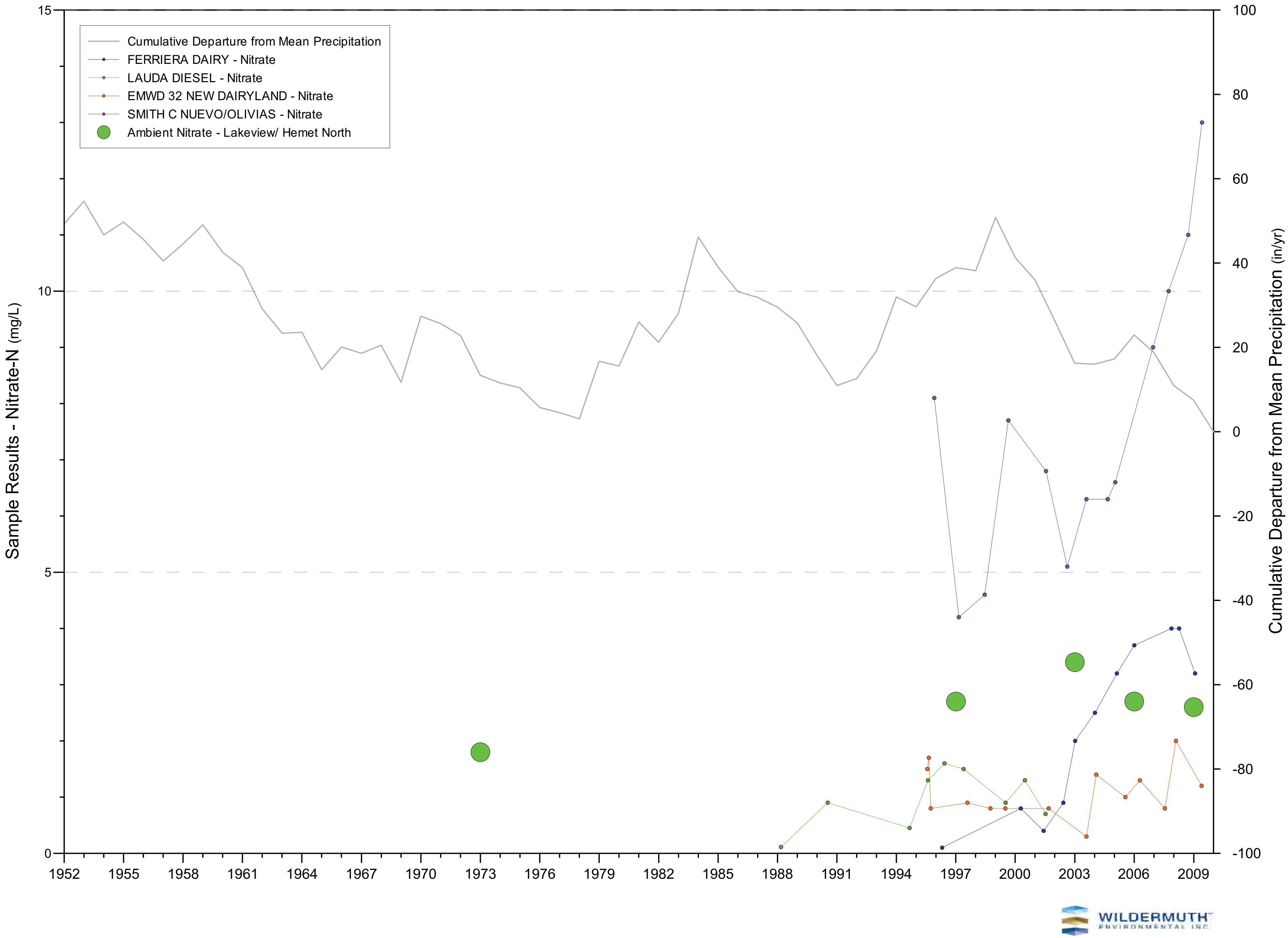

Figure 4-46: TDS at Interpretive Wells - Menifee

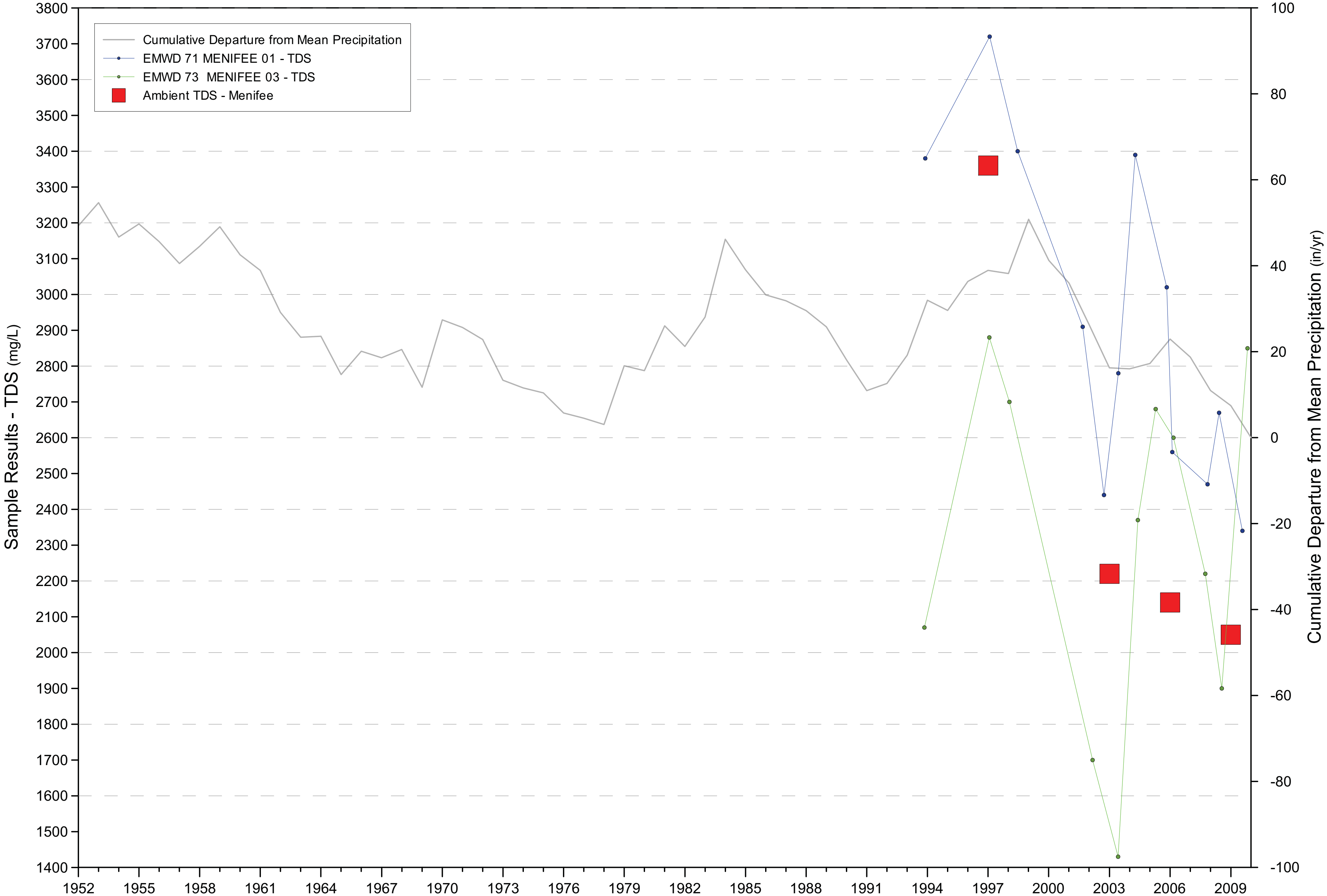

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Figure 4-47: NItrate-N at Interpretive Wells - Menifee

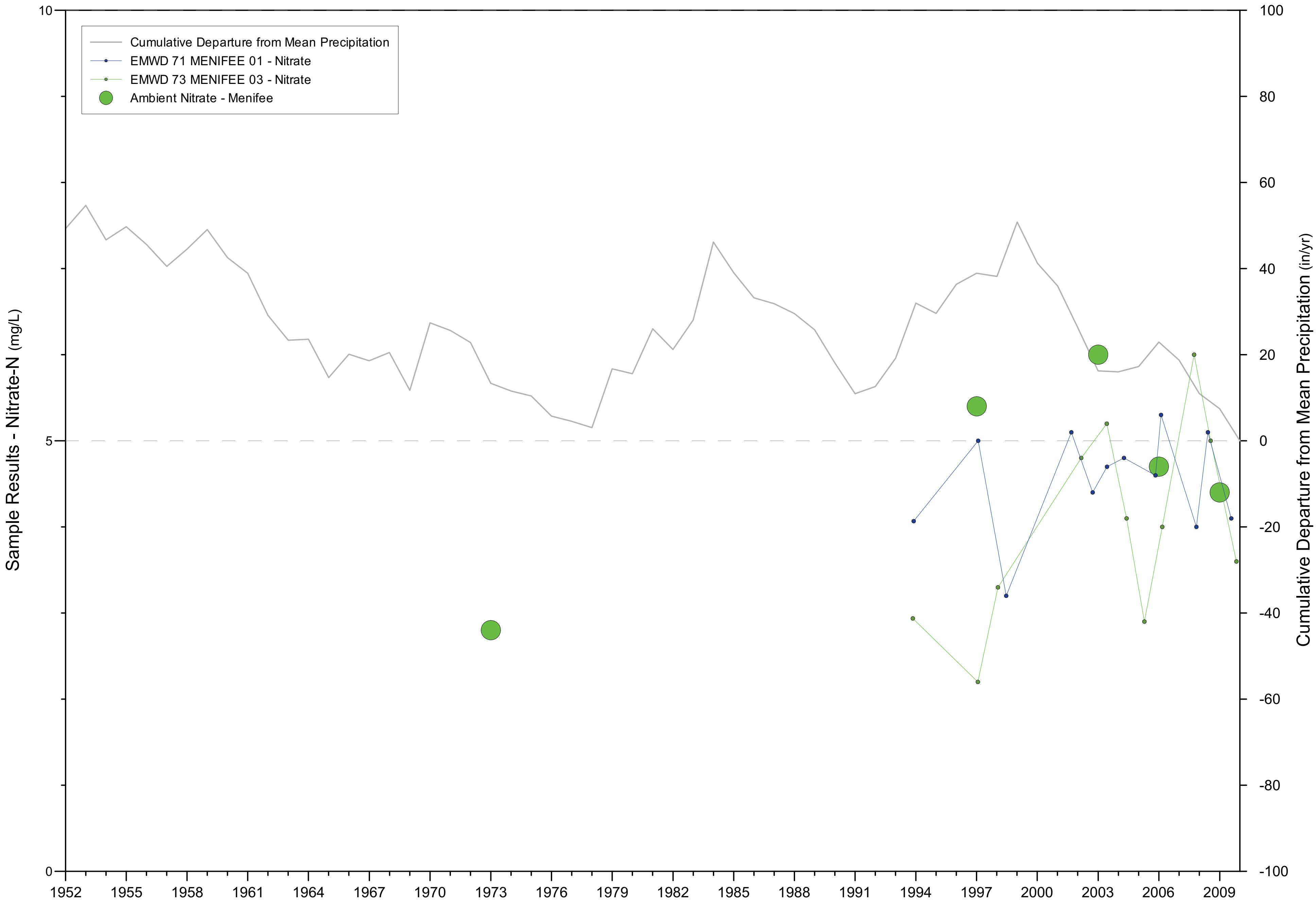

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Figure 4-48: TDS at Interpretive Wells - Perris North

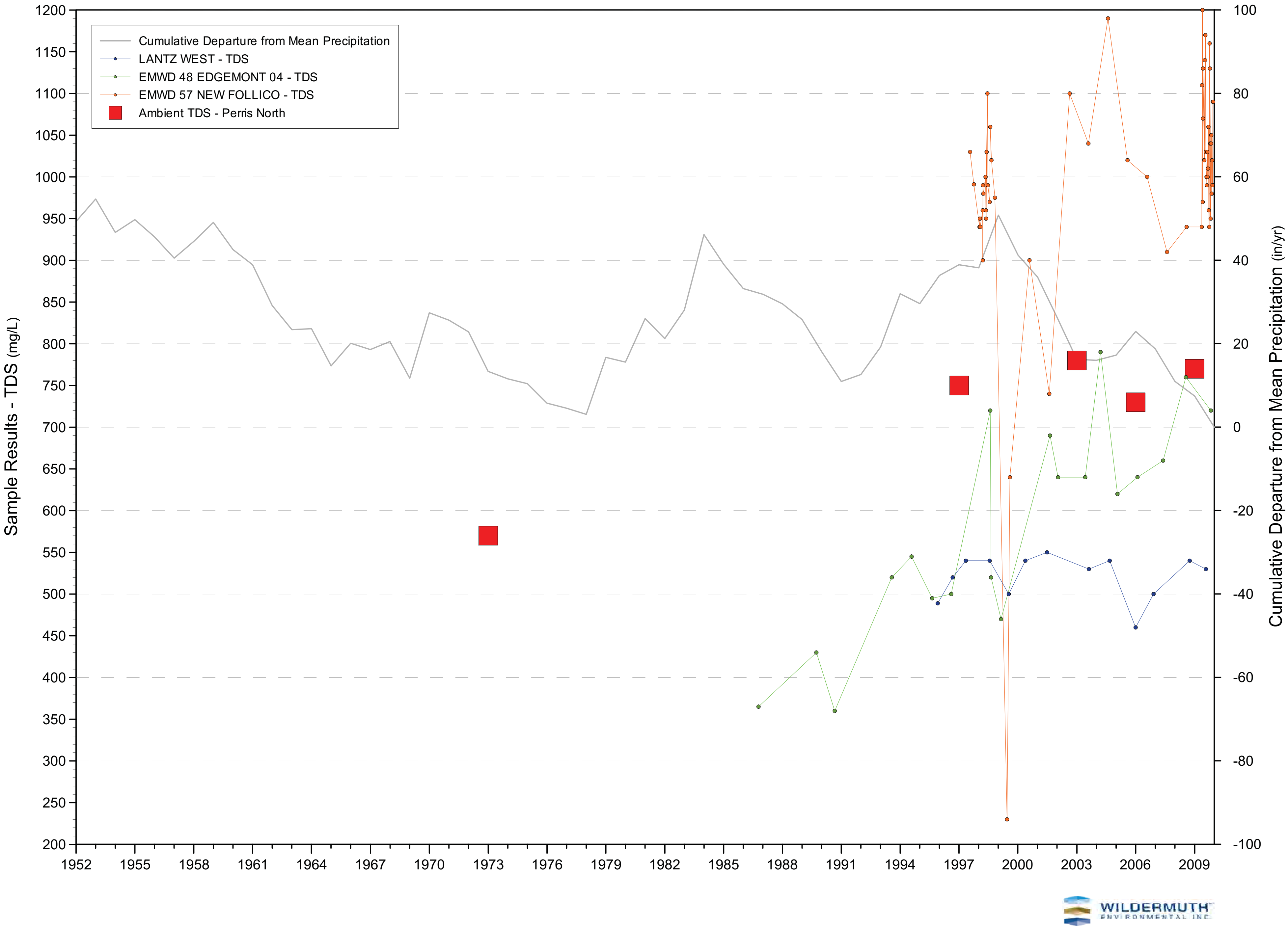

Figure 4-49: Nitrate-N at Interpretive Wells - Perris North

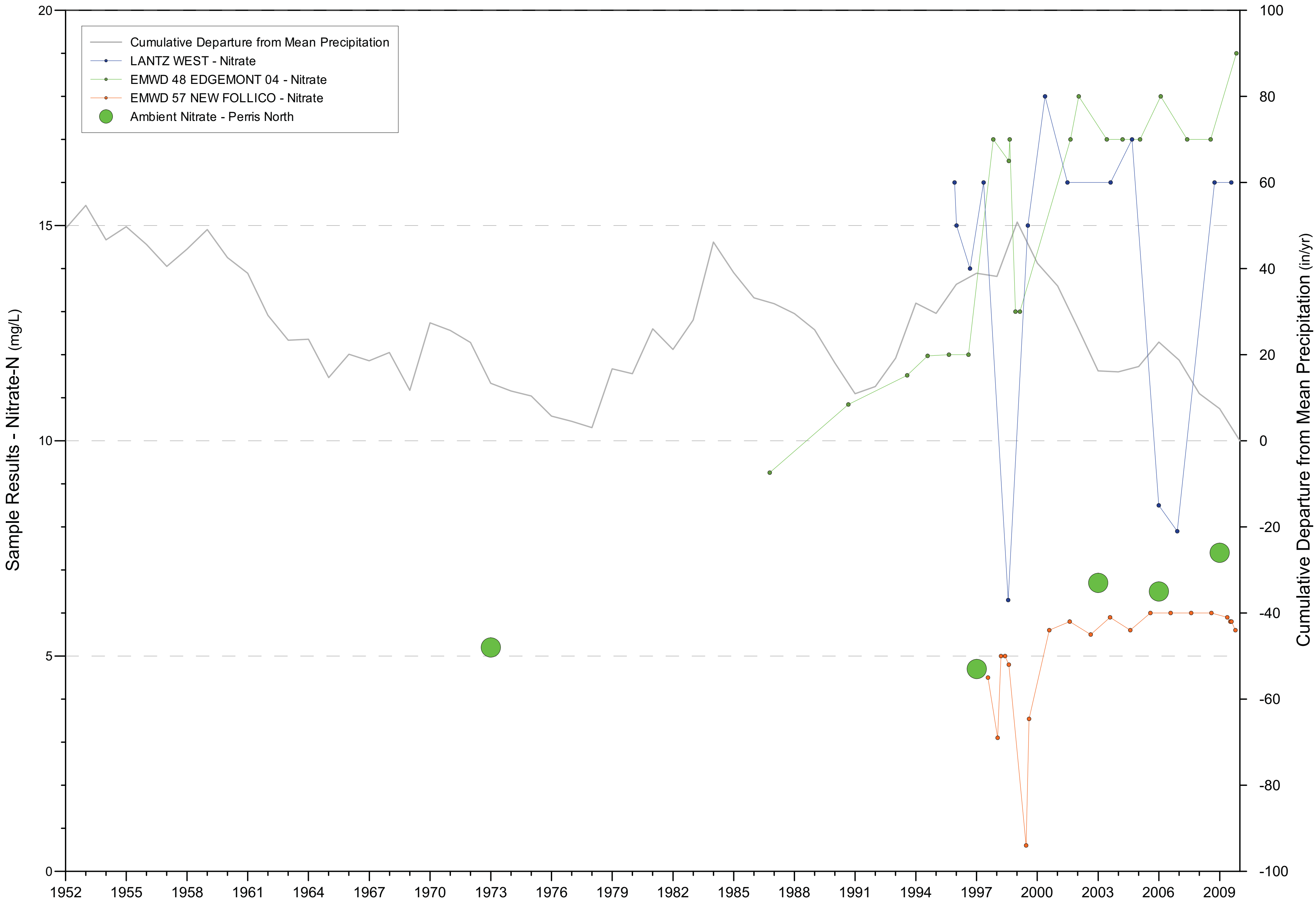

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Figure 4-50: TDS at Interpretive Wells - Perris South

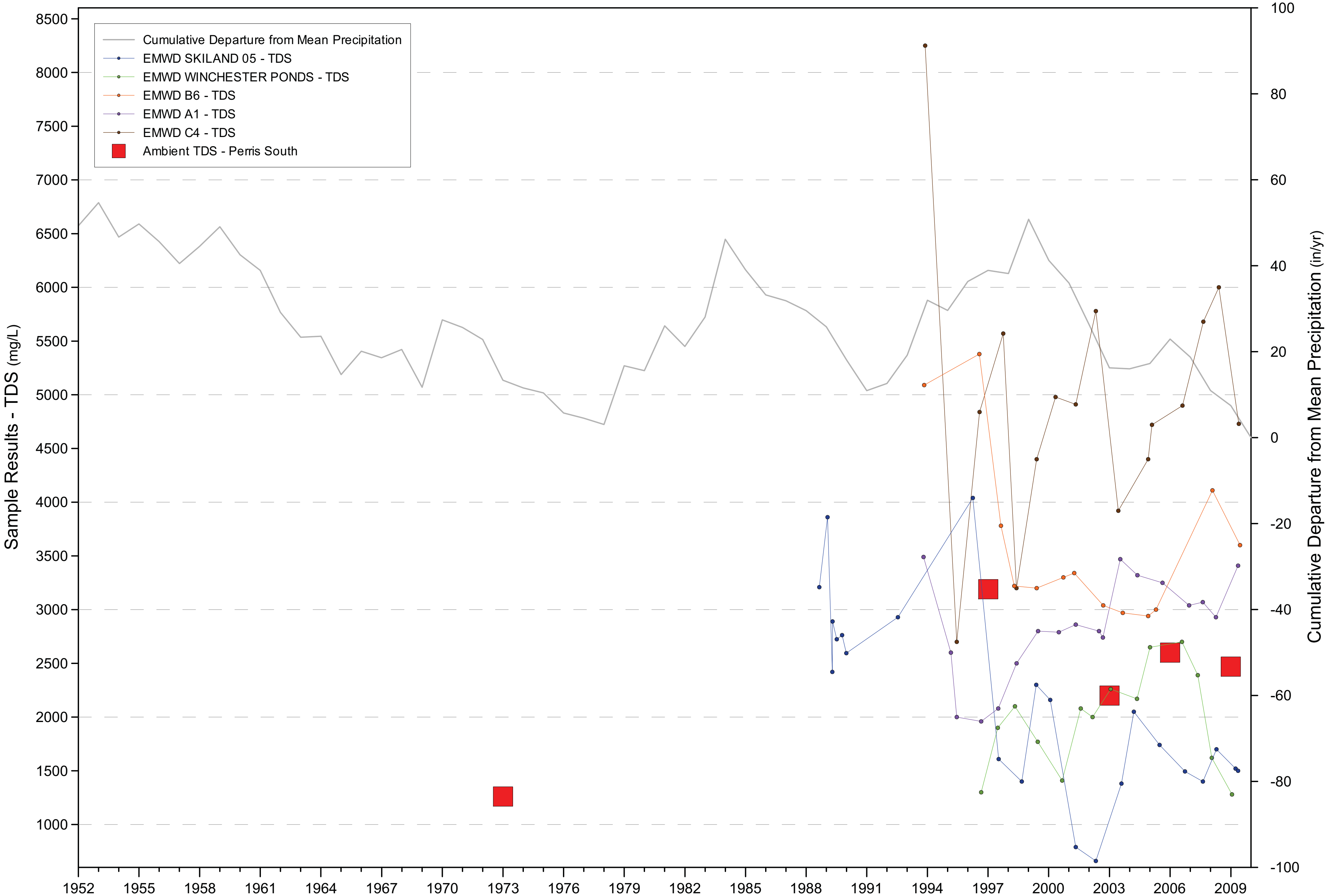

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Figure 4-51: Nitrate-N at Interpretive Wells - Perris South

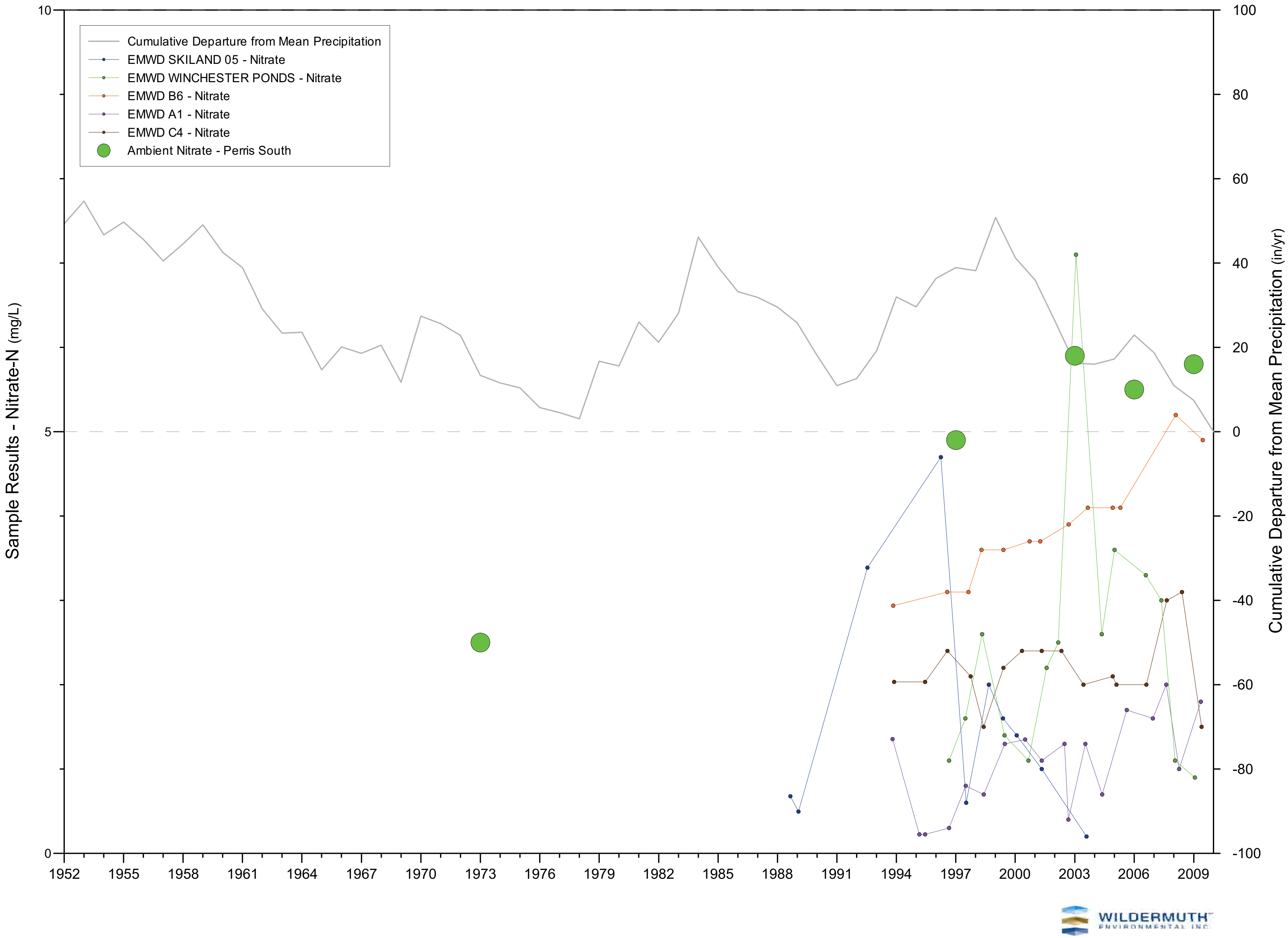

Figure 4-52: TDS at Interpretive Wells - San Jacinto Lower Pressure

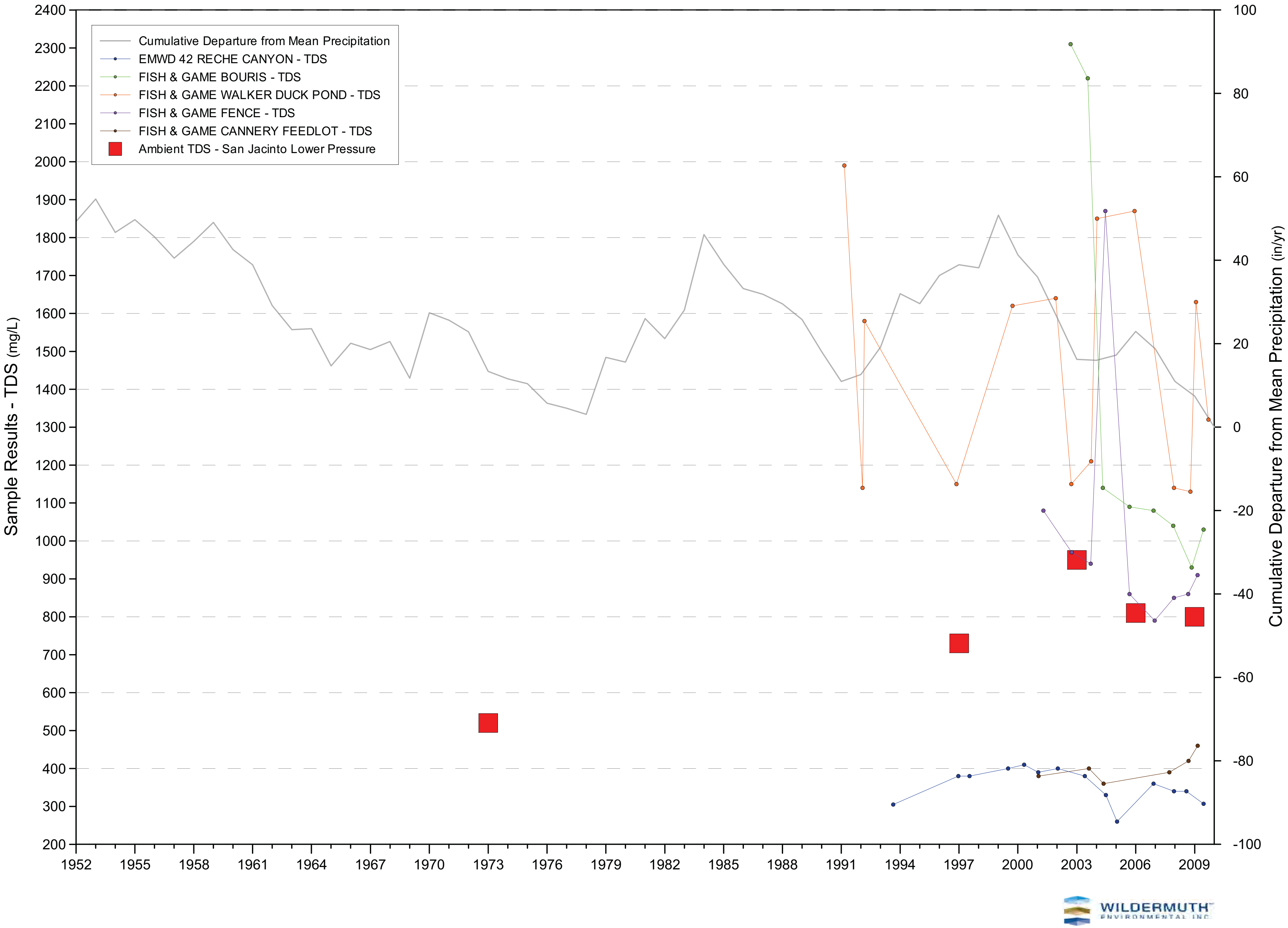

Figure 4-53: Nitrate-N at Interpretive Wells - San Jacinto Lower Pressure

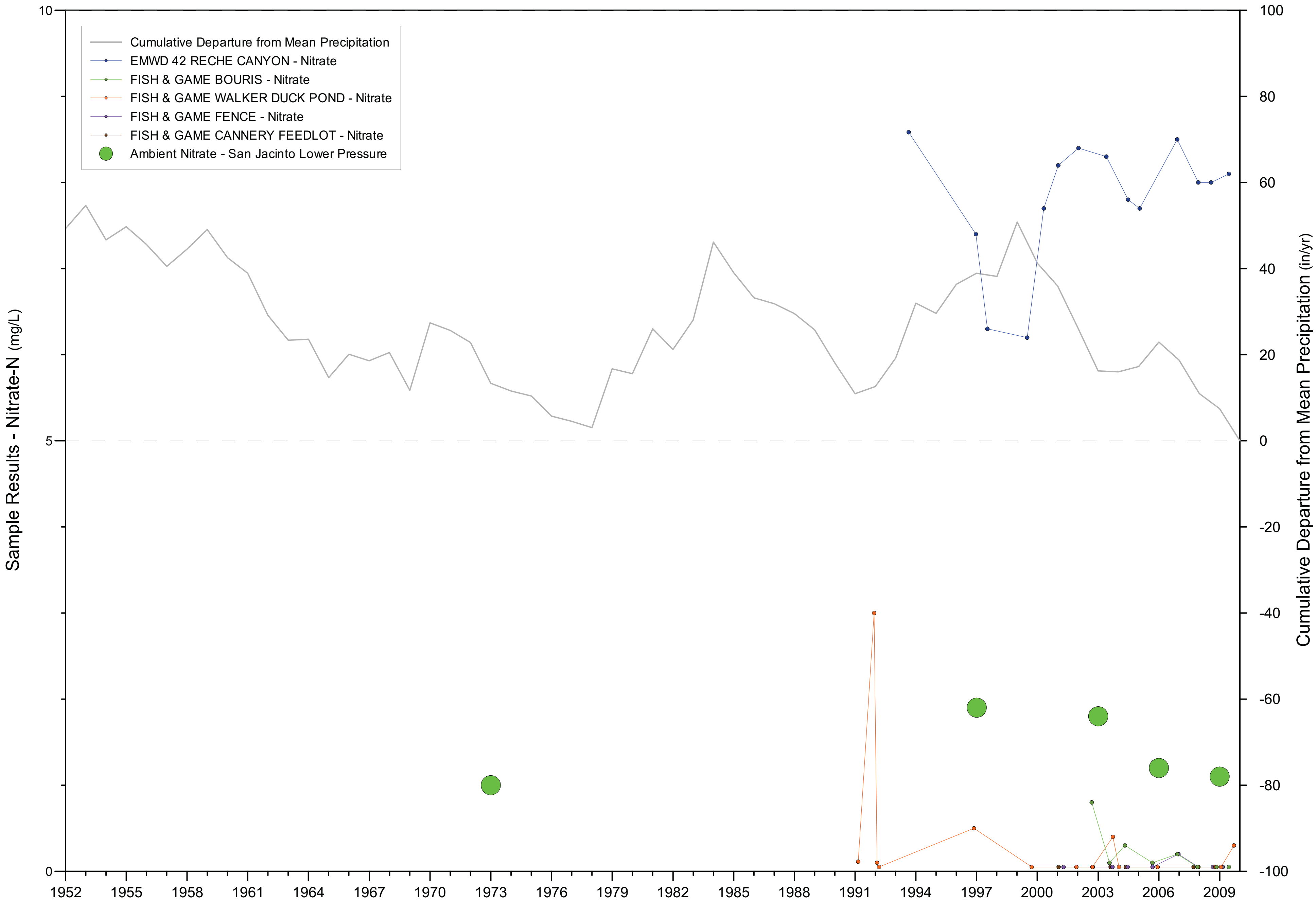

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Figure 4-54: TDS at Interpretive Wells - San Jacinto Upper Pressure

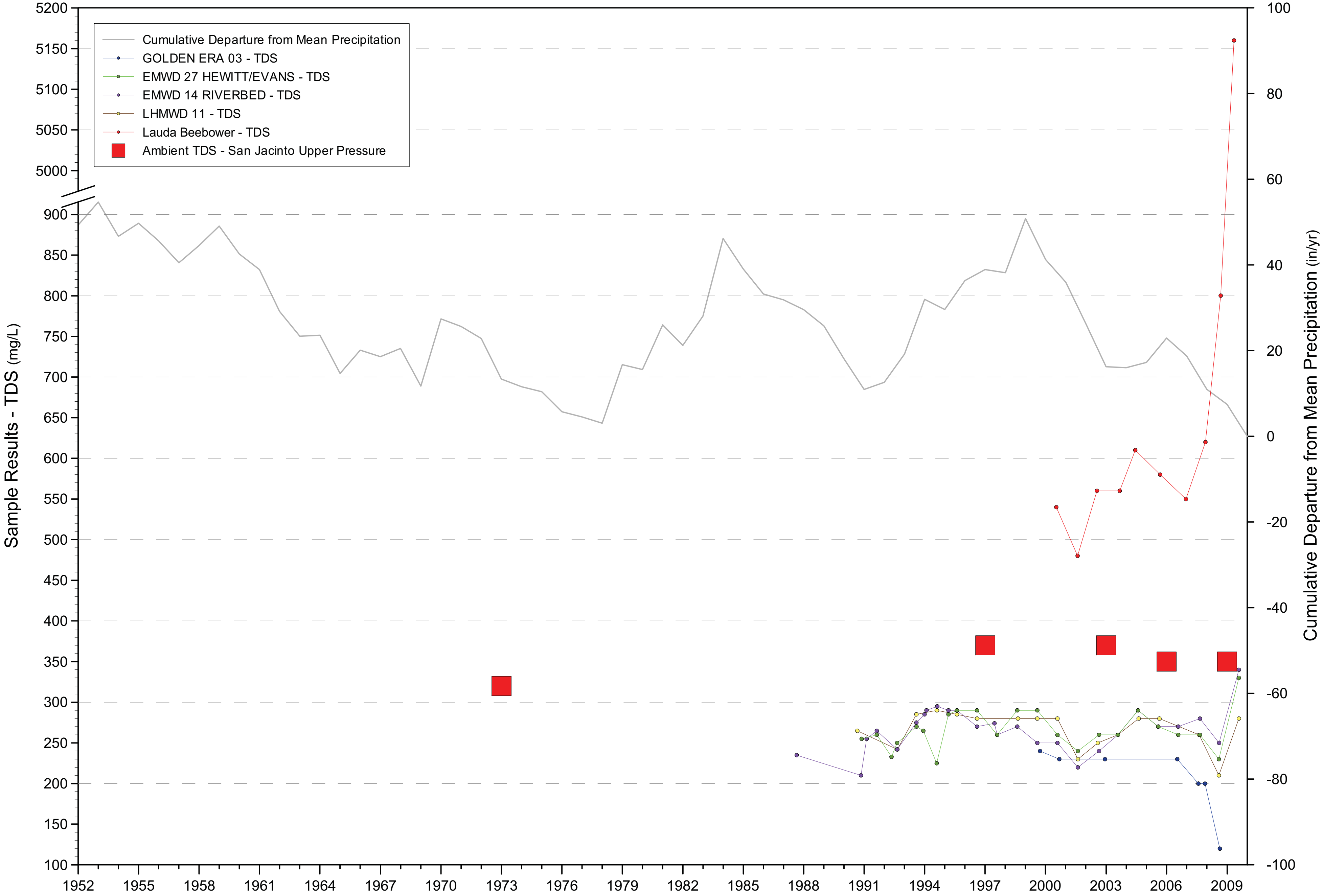


Figure 4-55: Nitrate-N at Interpretive Wells - San Jacinto Upper Pressure

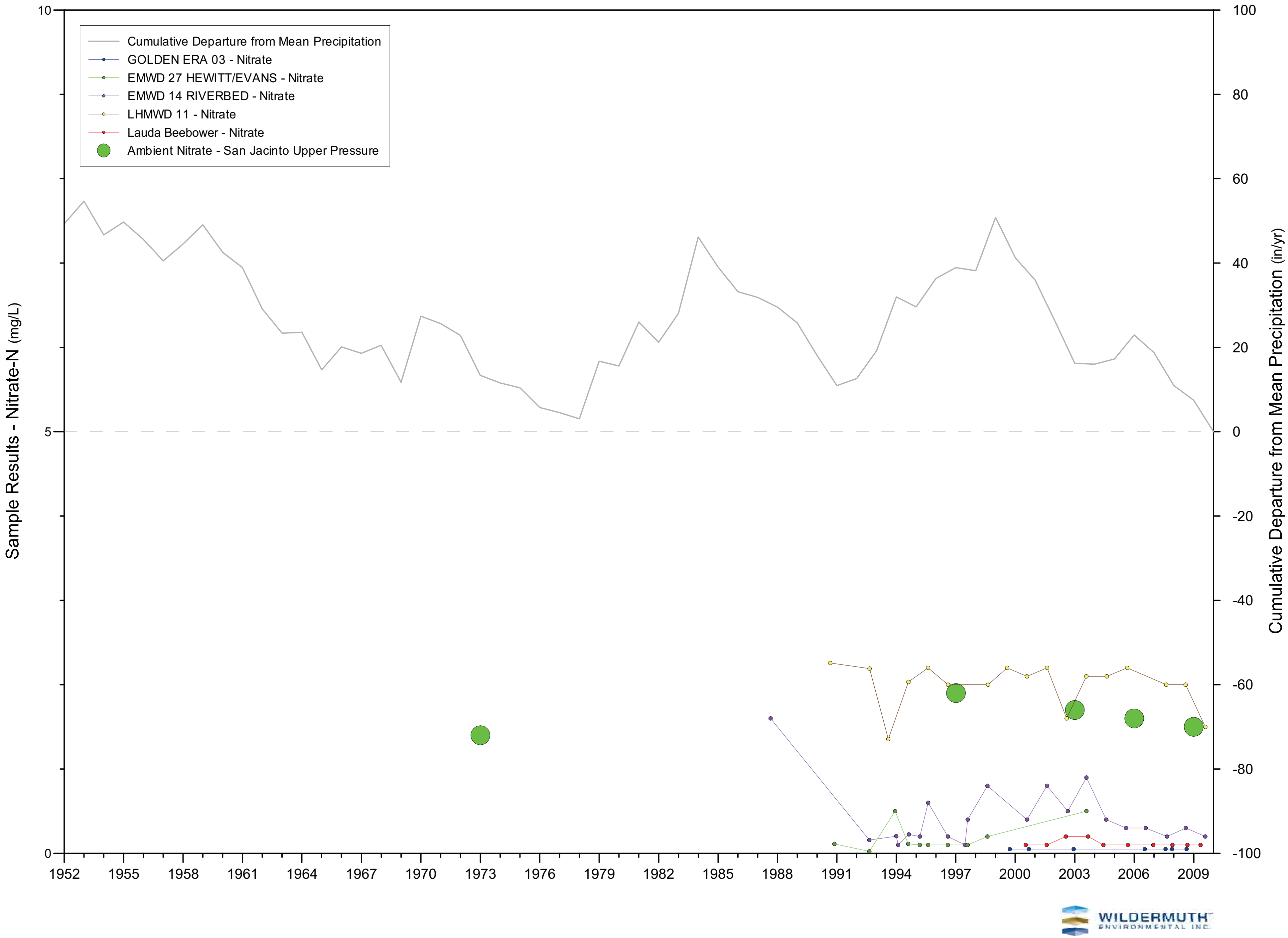


Figure 4-56: TDS at Interpretive Wells - Canyon

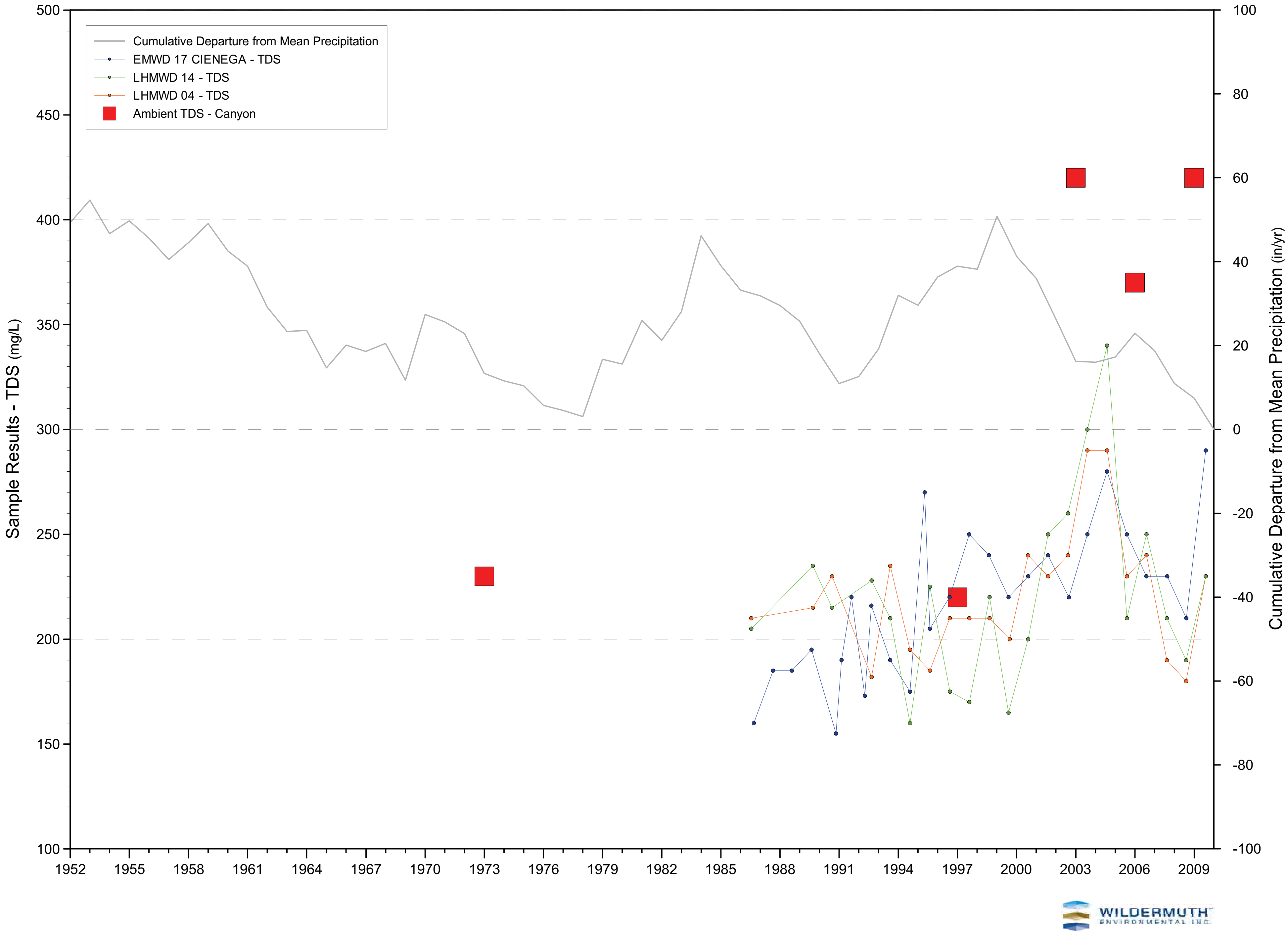


Figure 4-57: Nitrate-N at Interpretive Wells - Canyon

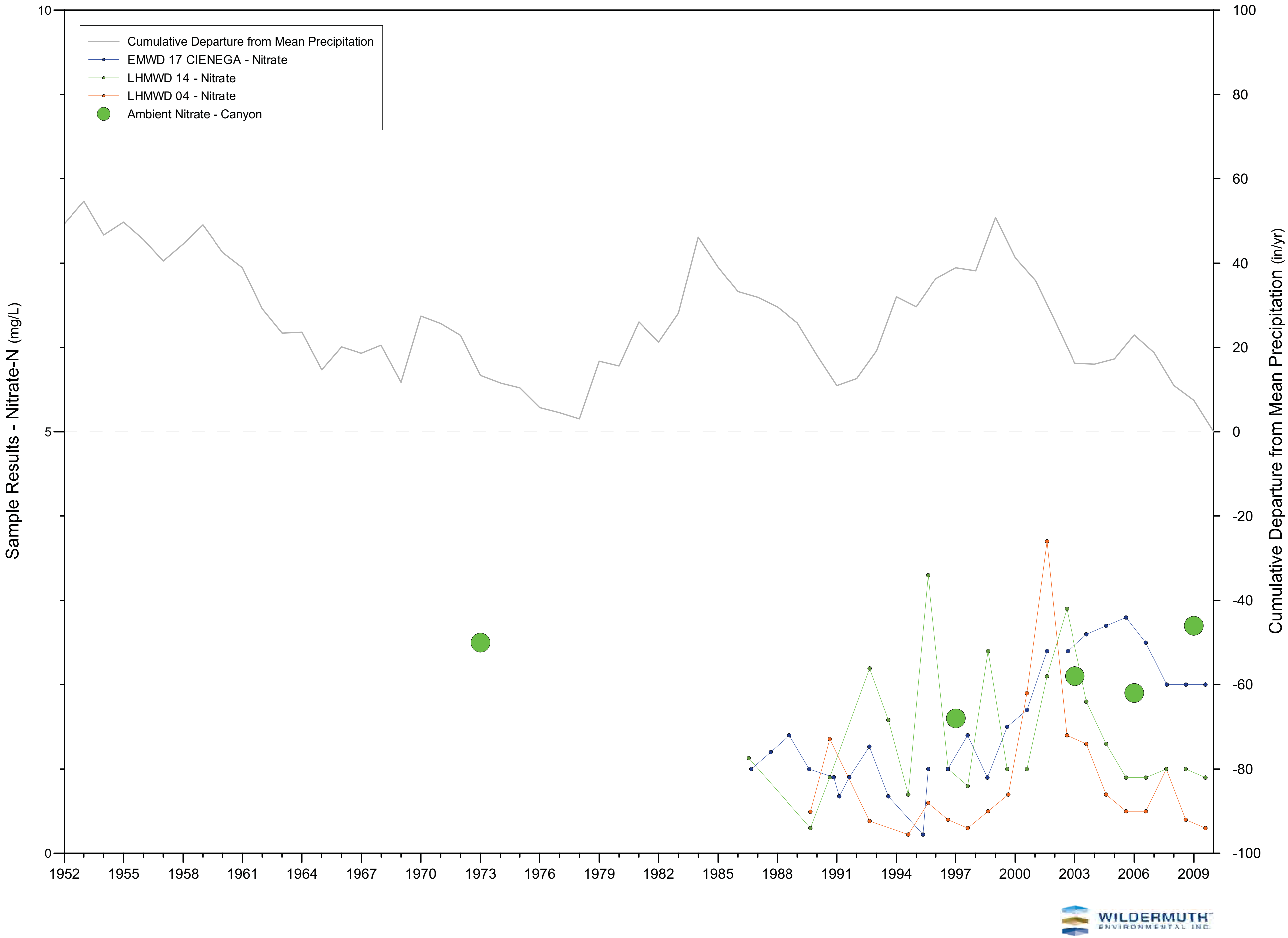


Figure 4-58: TDS at Interpretive Wells - Chino 1

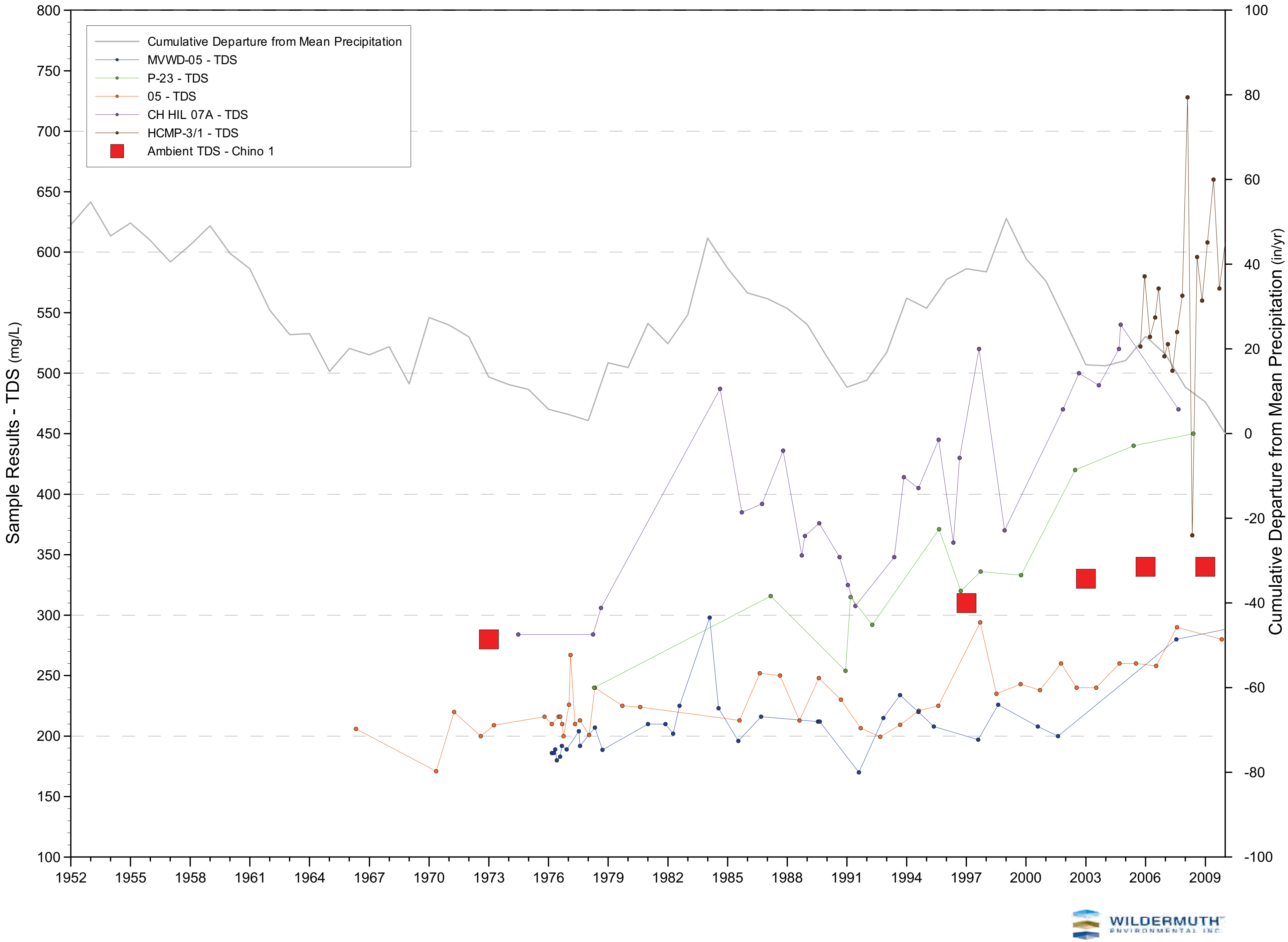
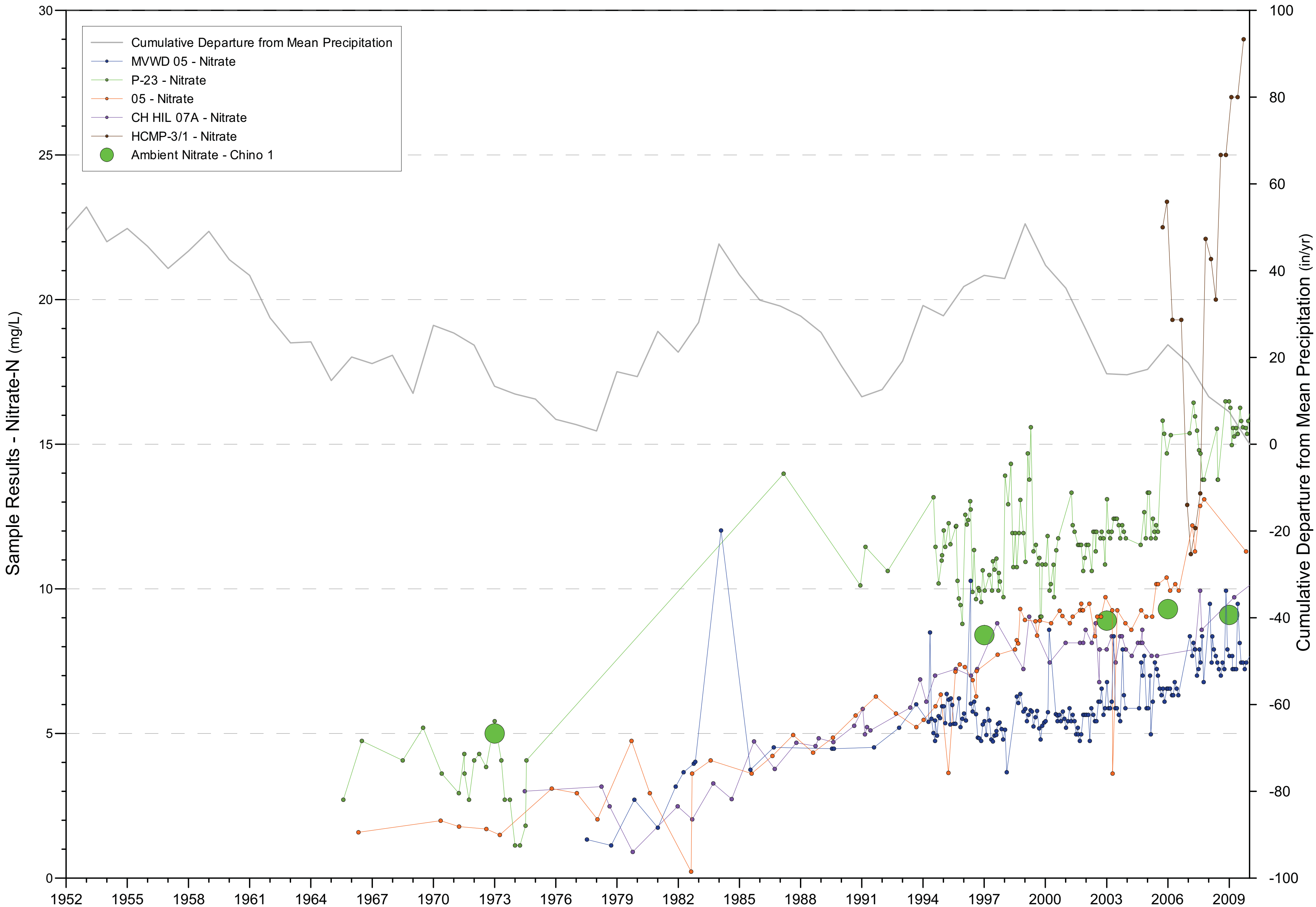


Figure 4-59: Nitrate-N at Interpretive Wells - Chino 1



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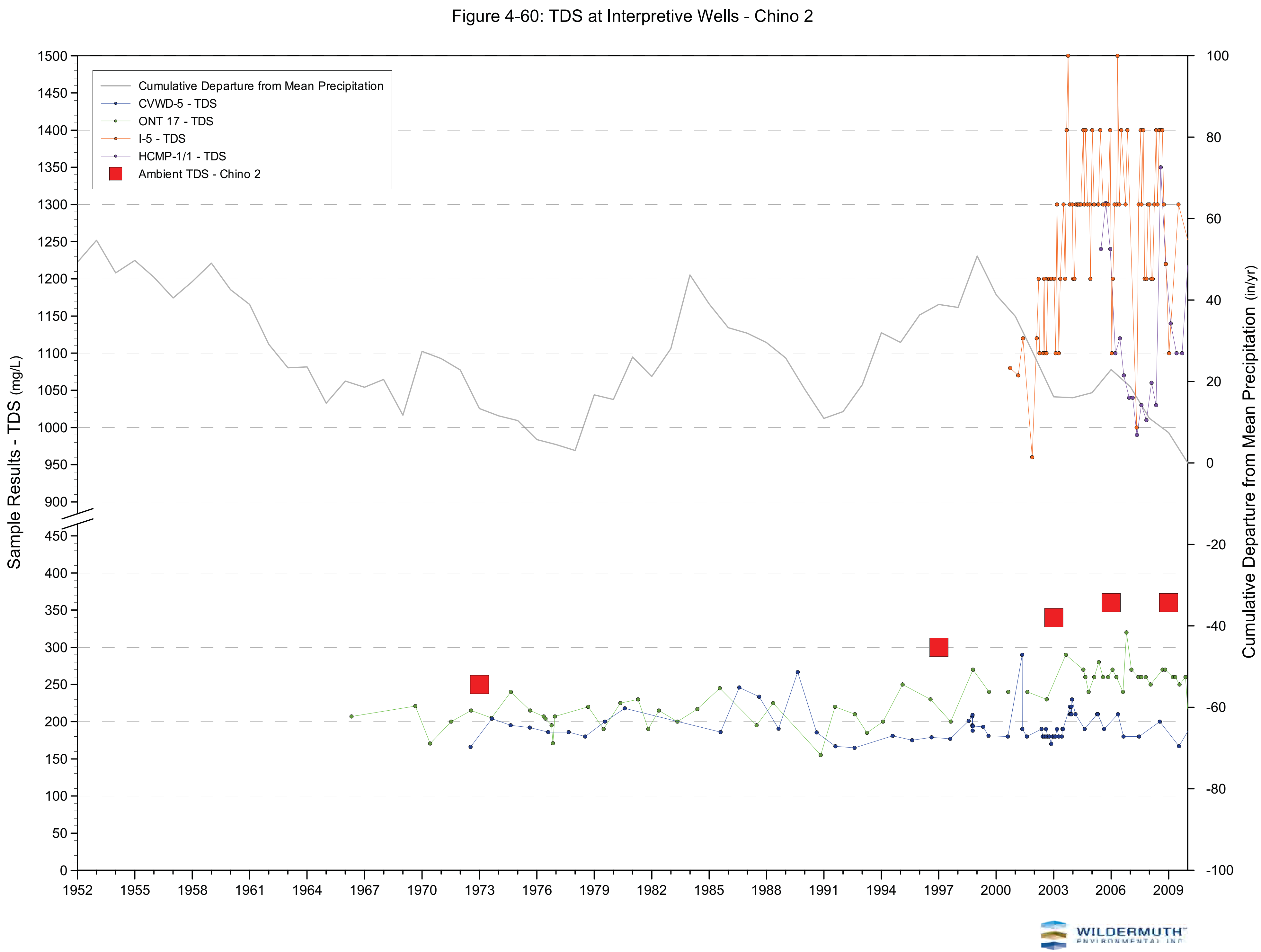

Figure 4-60: TDS at Interpretive Wells - Chino 2
Cumulative Departure from Mean Precipitation
CVWD-5 - TDS
ONT 17 - TDS
I-5 - TDS
HCMP-1/1 - TDS
Ambient TDS - Chino 2
Sample Results - TDS (mg/L)
Cumulative Departure from Mean Precipitation (in/yr)
1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
450
400
350
300
250
200
150
100
50
0
100
80
60
40
20
0
-20
-40
-60
-80
-100
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
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Figure 4-61: Nitrate-N at Interpretive Wells - Chino 2

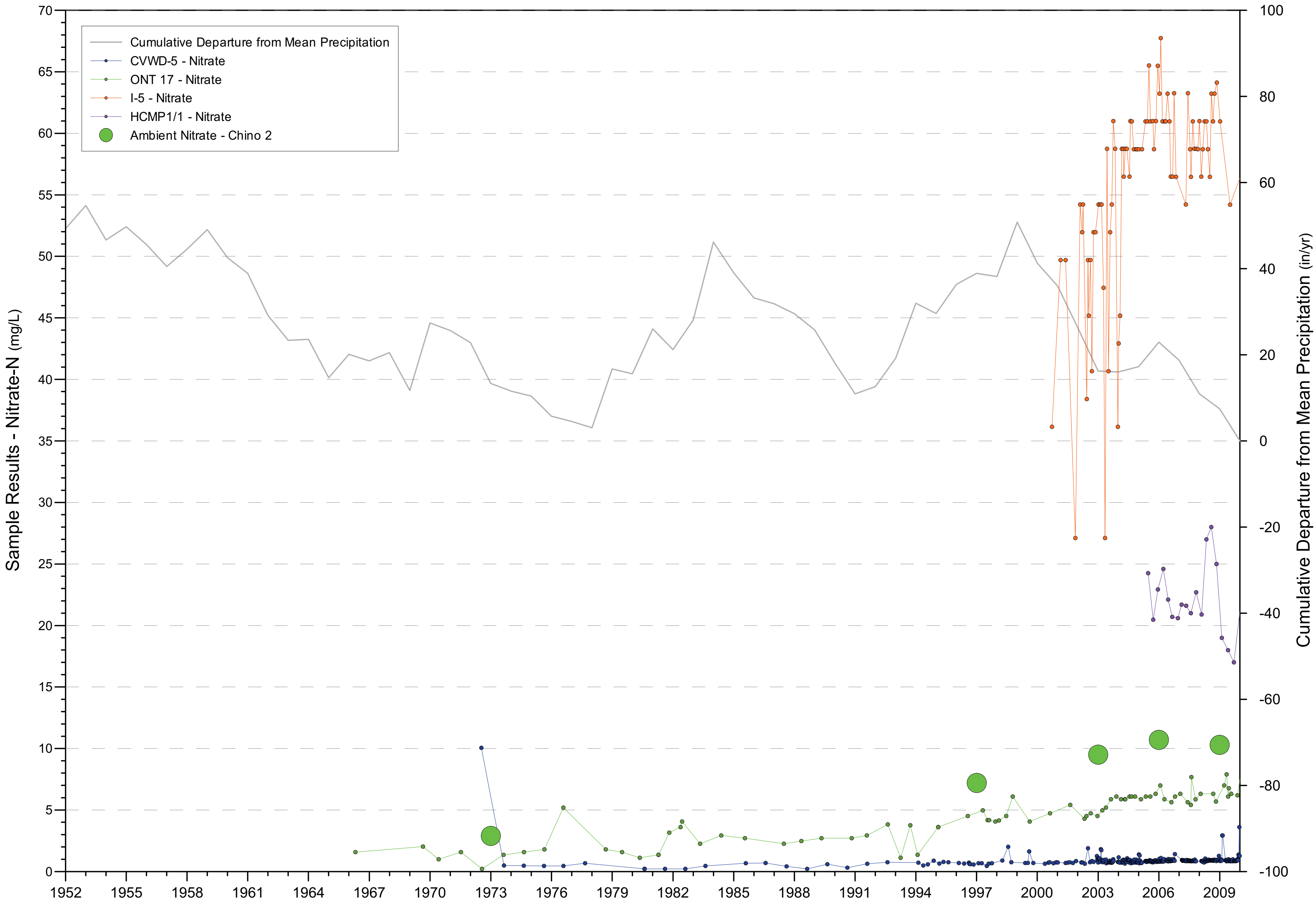

Figure 4-62: TDS at Interpretive Wells - Chino 3

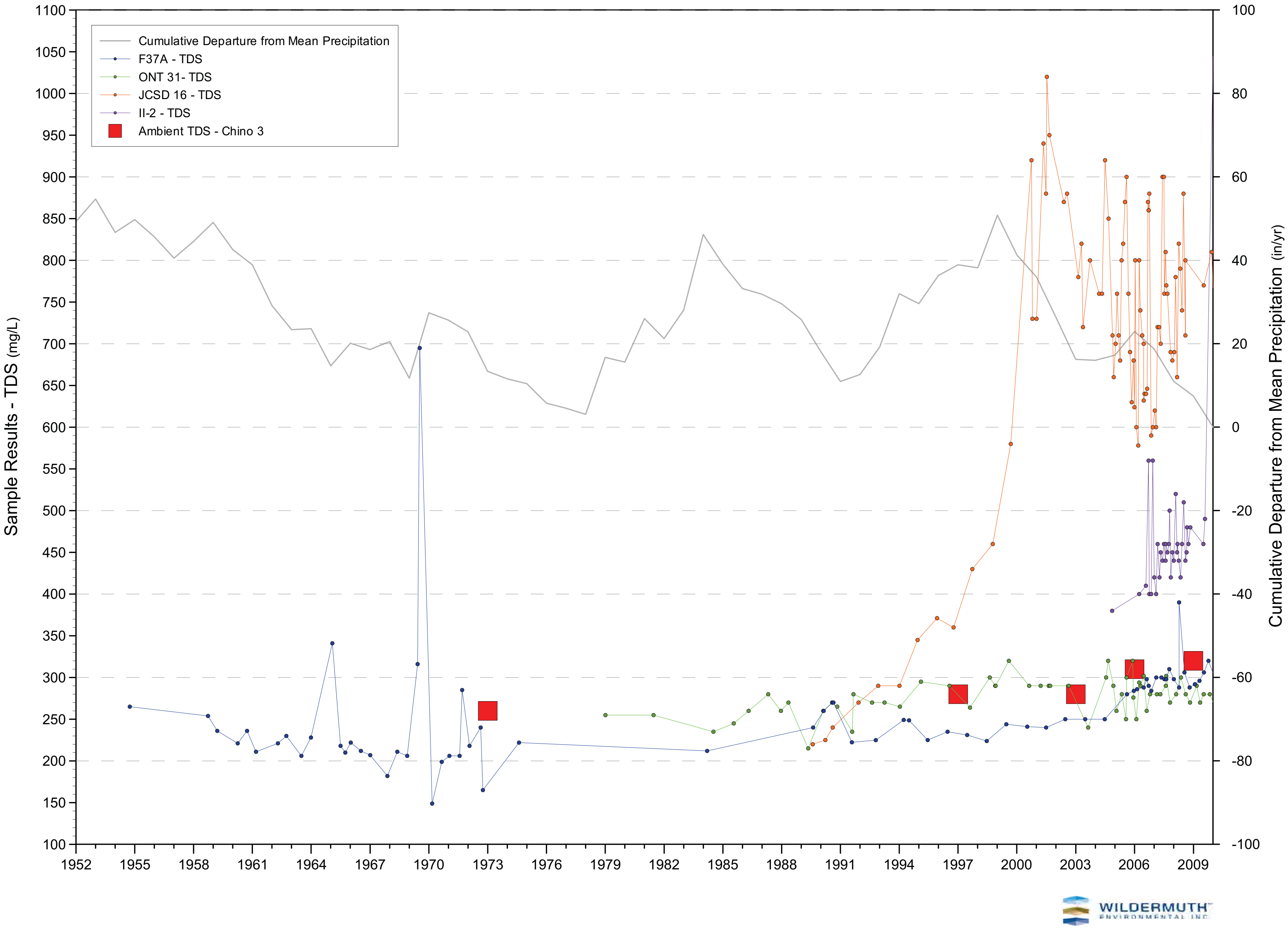

Figure 4-63: Nitrate-N at Interpretive Wells - Chino 3

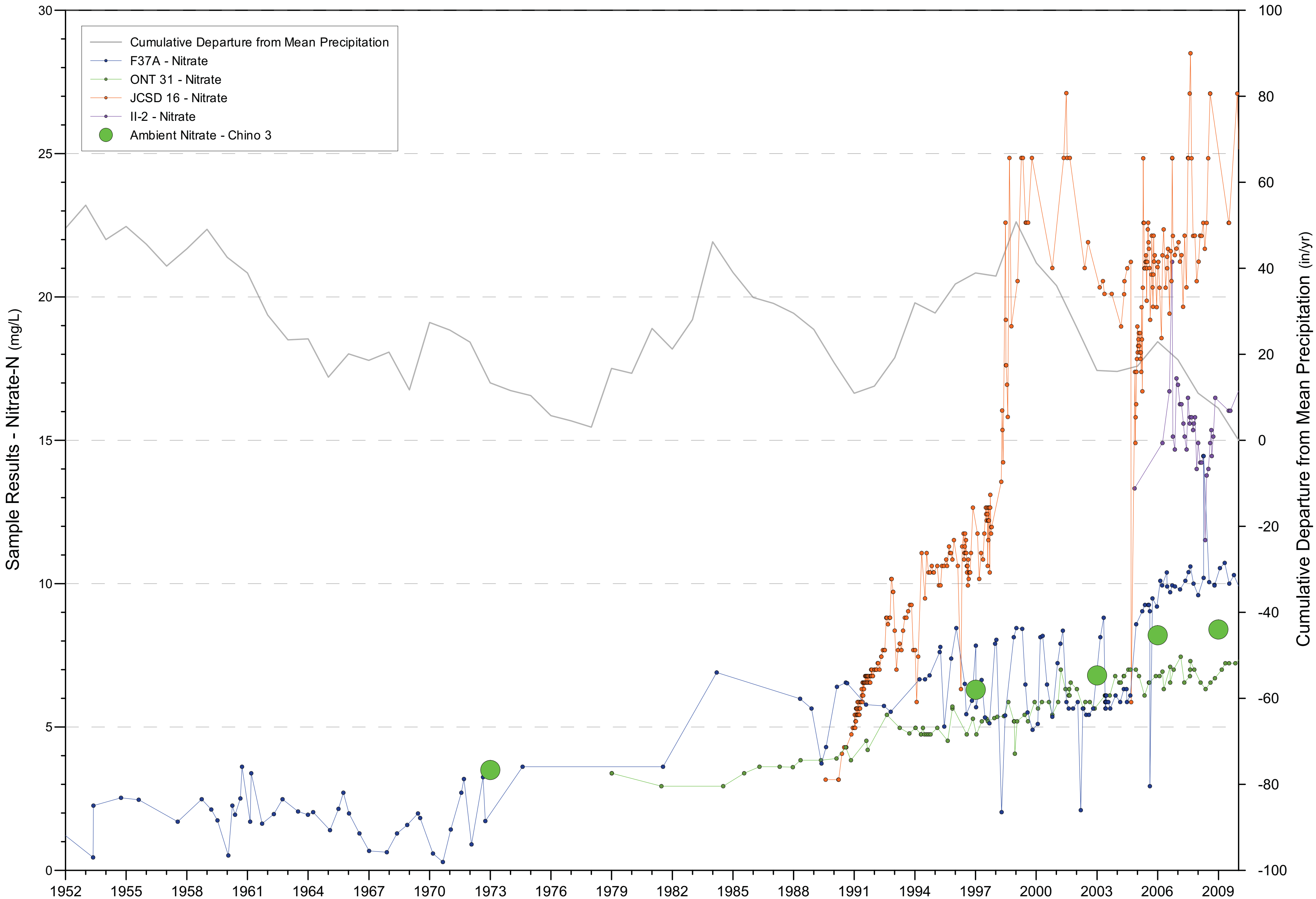

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Figure 4-64: TDS at Interpretive Wells - Chino East

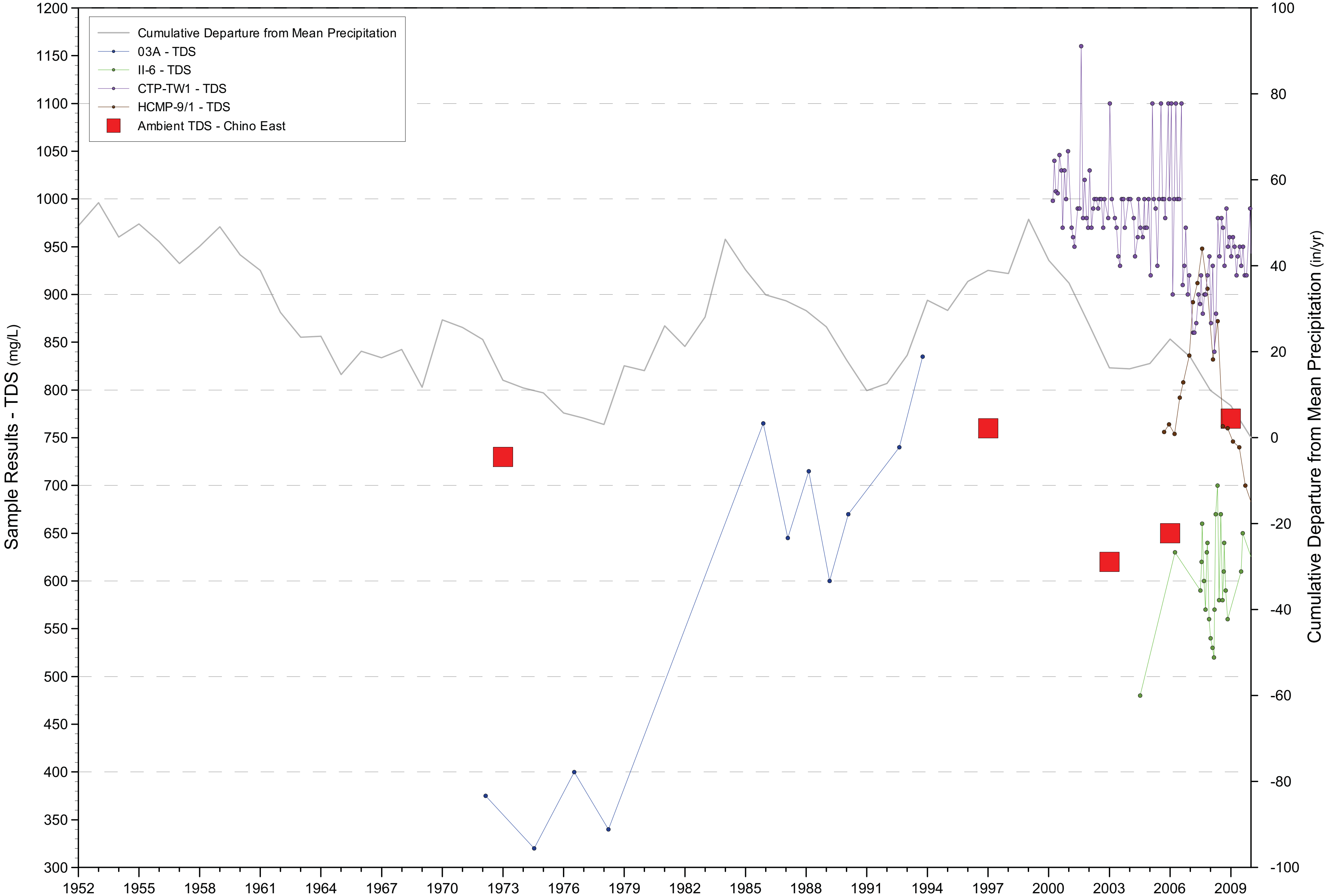

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Figure 4-65: Nitrate-N at Interpretive Wells - Chino East

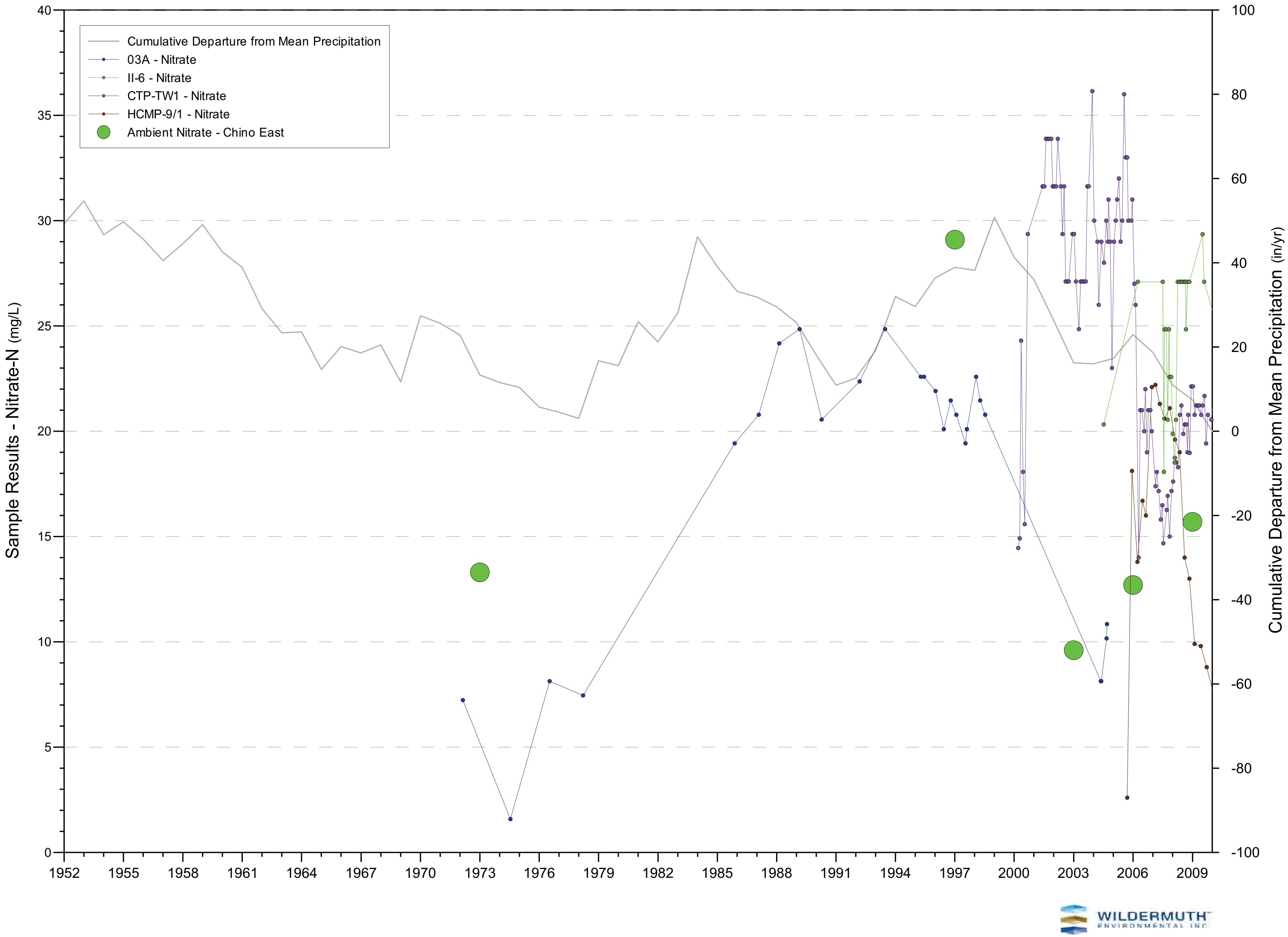

Figure 4-66: TDS at Interpretive Wells - Chino South

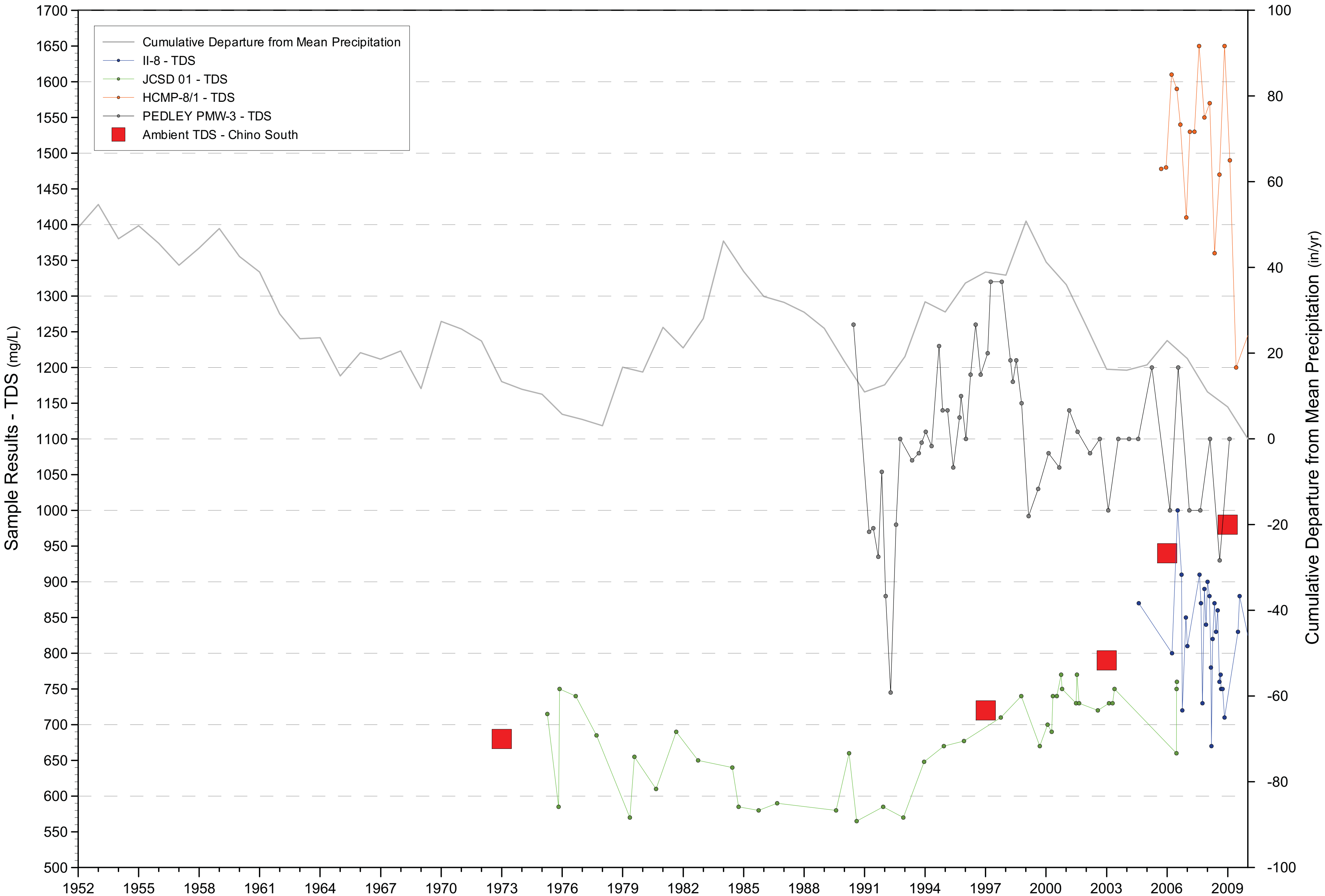

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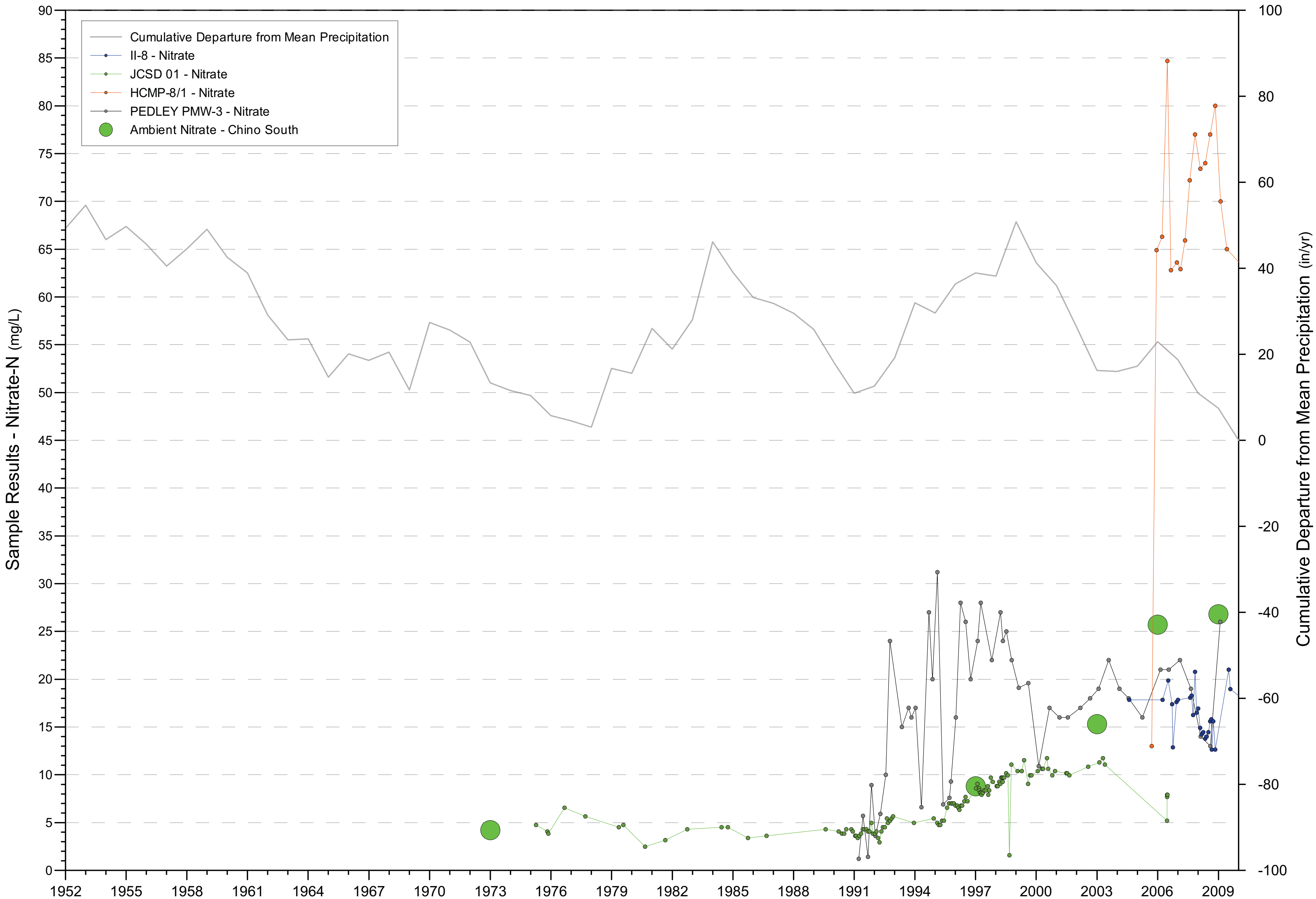
Figure 4-67: Nitrate-N at Interpretive Wells - Chino South



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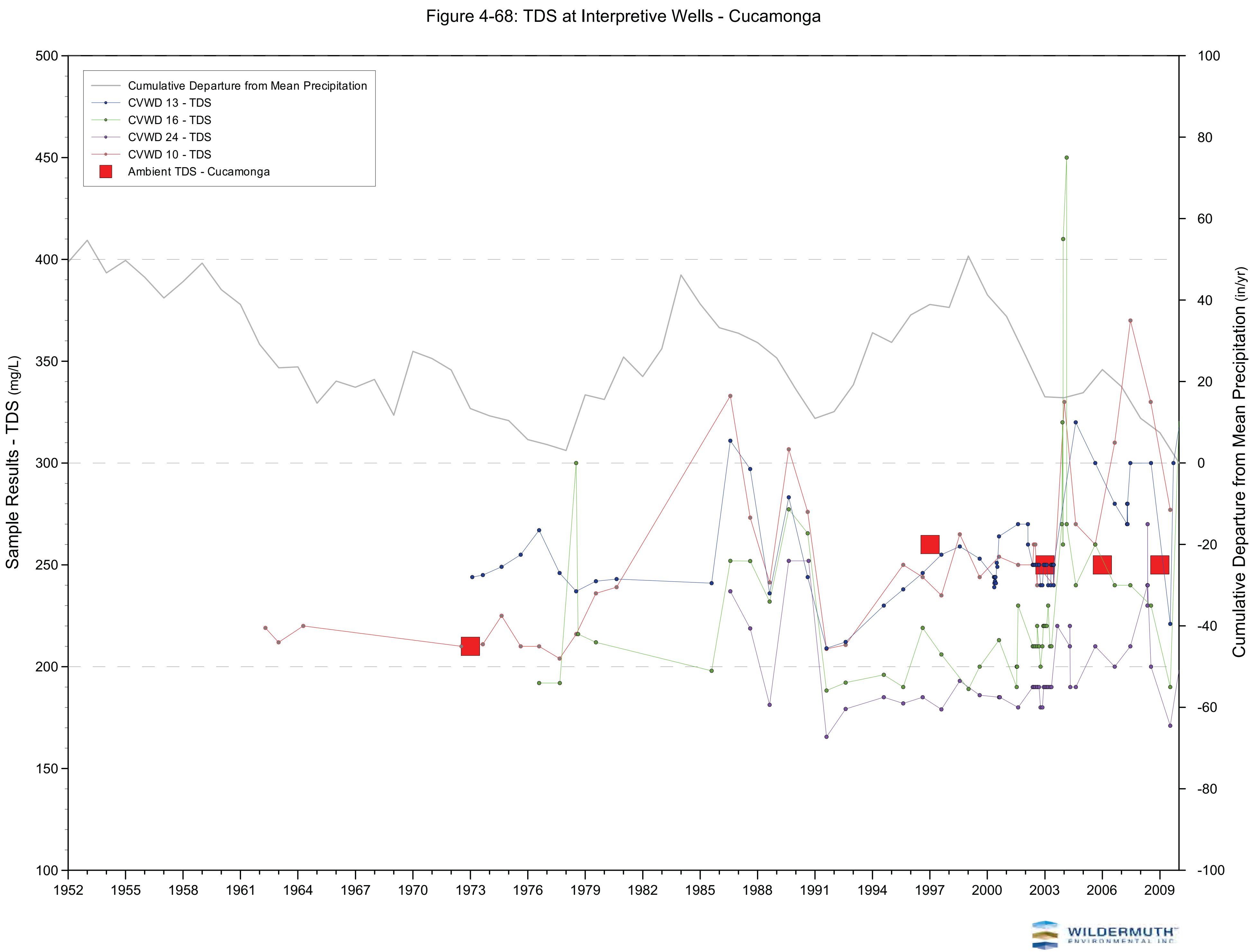
Figure 4-68: TDS at Interpretive Wells - Cucamonga
Cumulative Departure from Mean Precipitation
CVWD 13 - TDS
CVWD 16 - TDS
CVWD 24 - TDS
CVWD 10 - TDS
Ambient TDS - Cucamonga
Sample Results - TDS (mg/L)
Cumulative Departure from Mean Precipitation (in/yr)
500
450
400
350
300
250
200
150
100
100
80
60
40
20
0
-20
-40
-60
-80
-100
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
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Figure 4-69: Nitrate-N at Interpretive Wells - Cucamonga

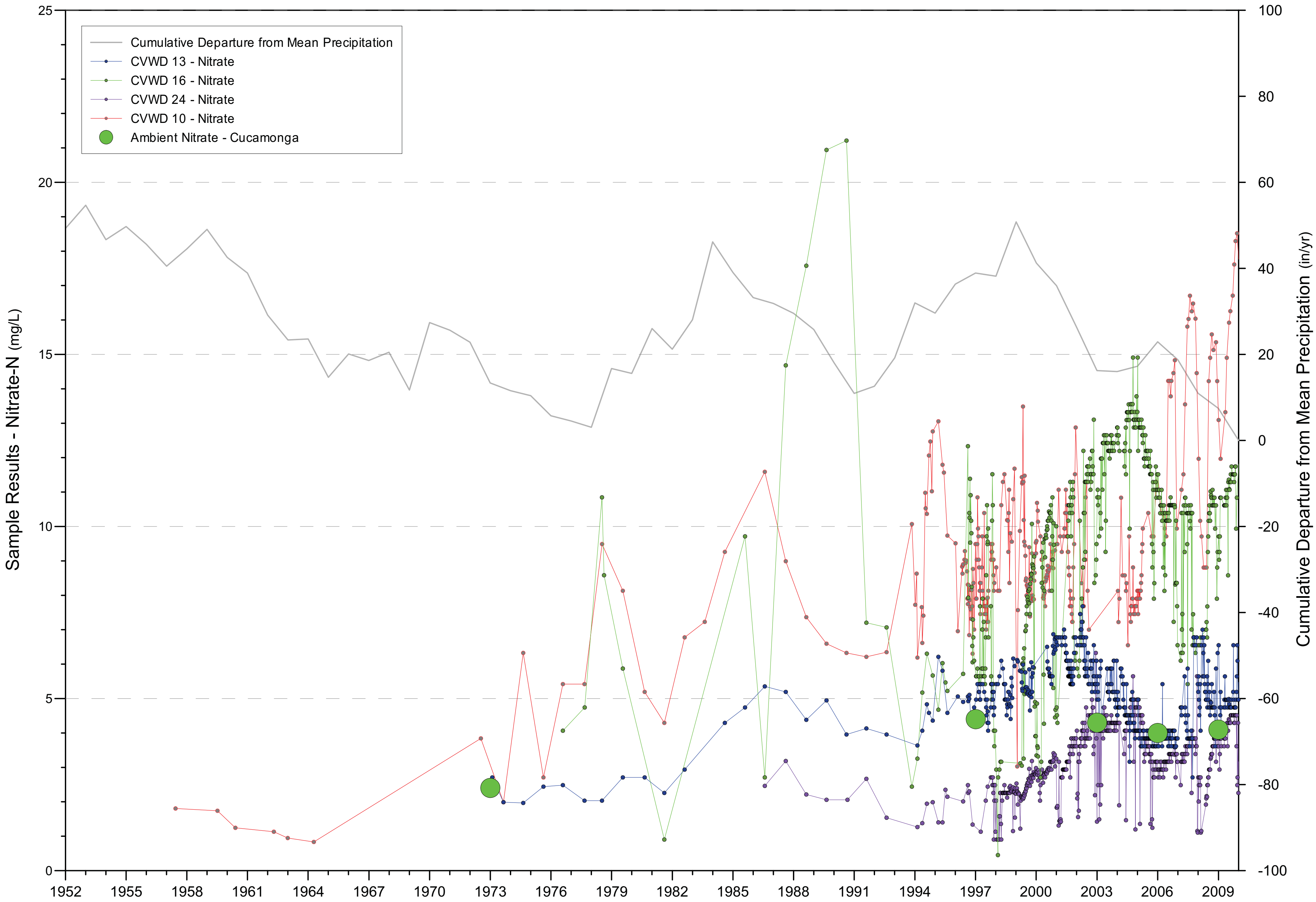

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Figure 4-70: TDS at Interpretive Wells - Irvine

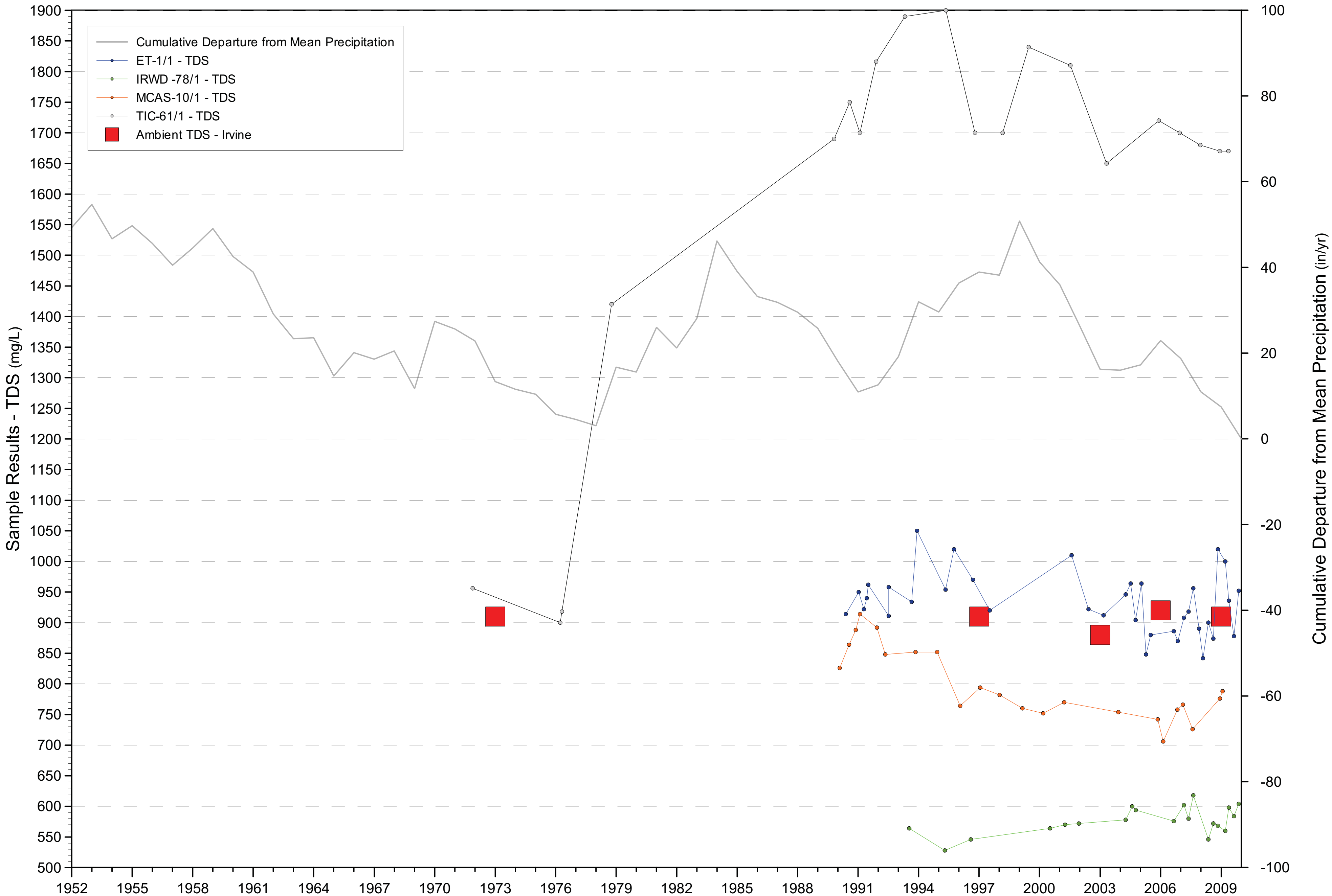

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Figure 4-71: Nitrate-N at Interpretive Wells - Irvine

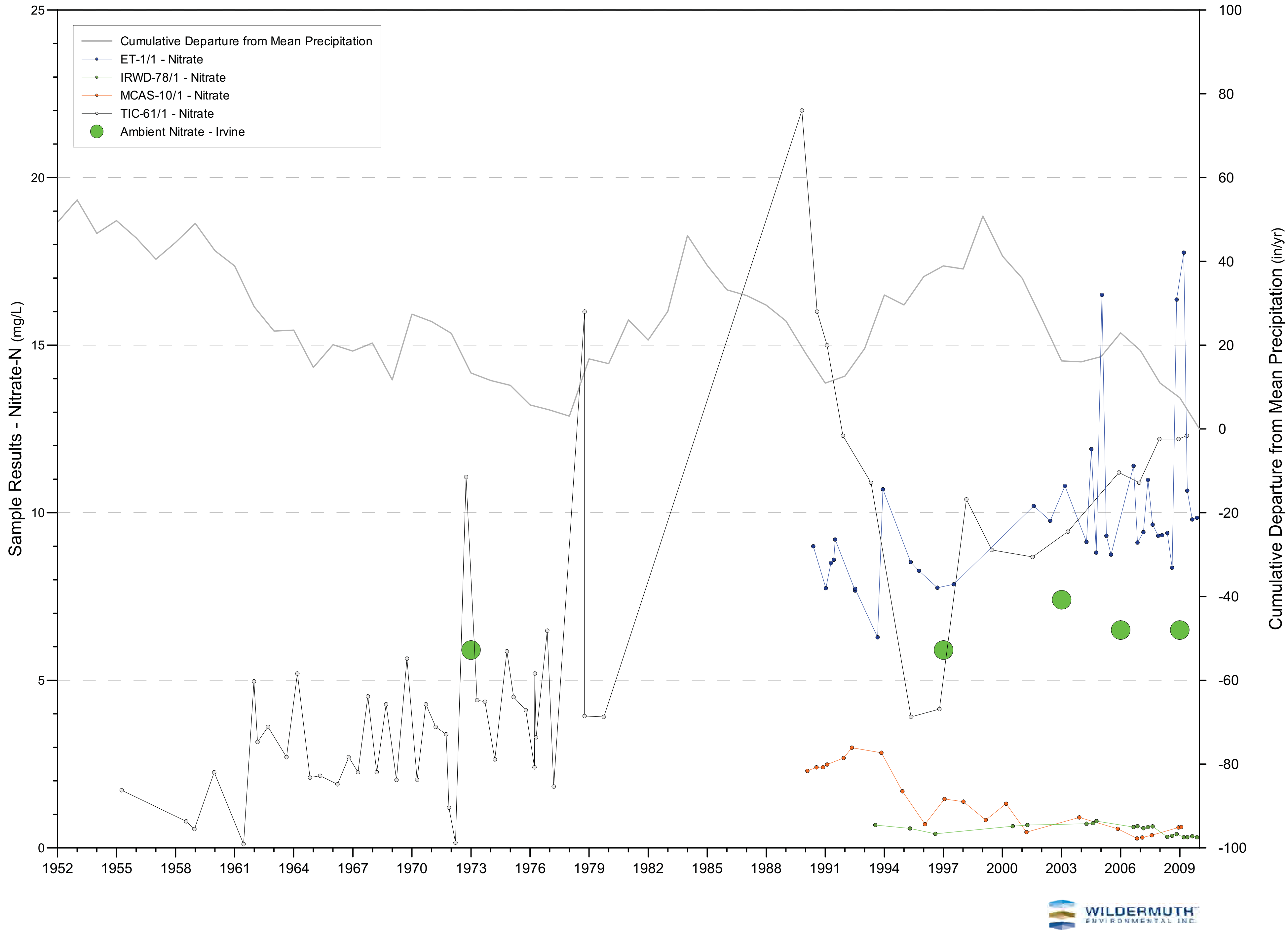

Figure 4-72: TDS at Interpretive Wells - Orange County (Up-Gradient of Artificial Recharge Facilities)

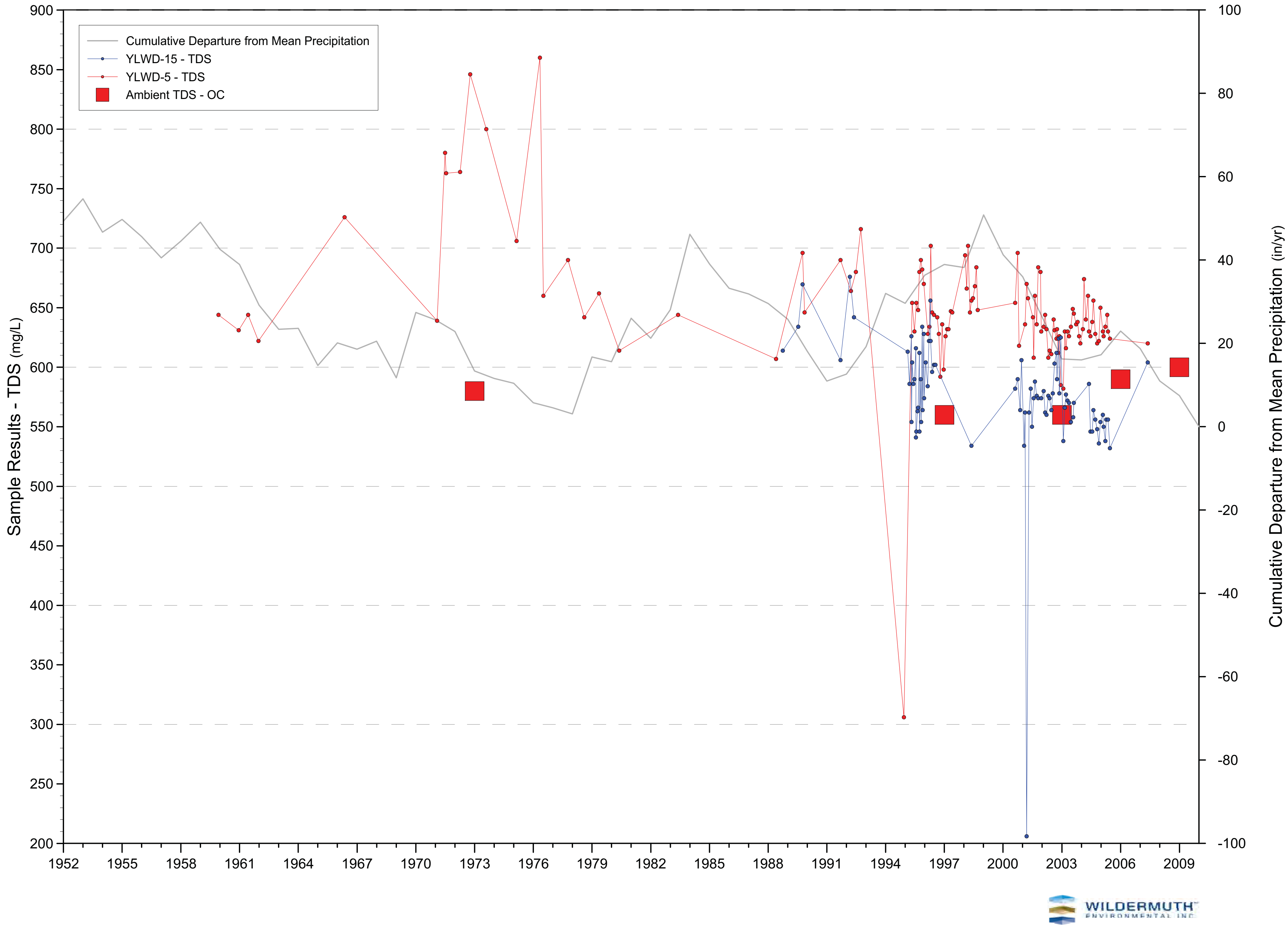

Figure 4-73: Nitrate-N at Interpretive Wells - Orange County (Up-Gradient of Artificial Recharge Facilities)

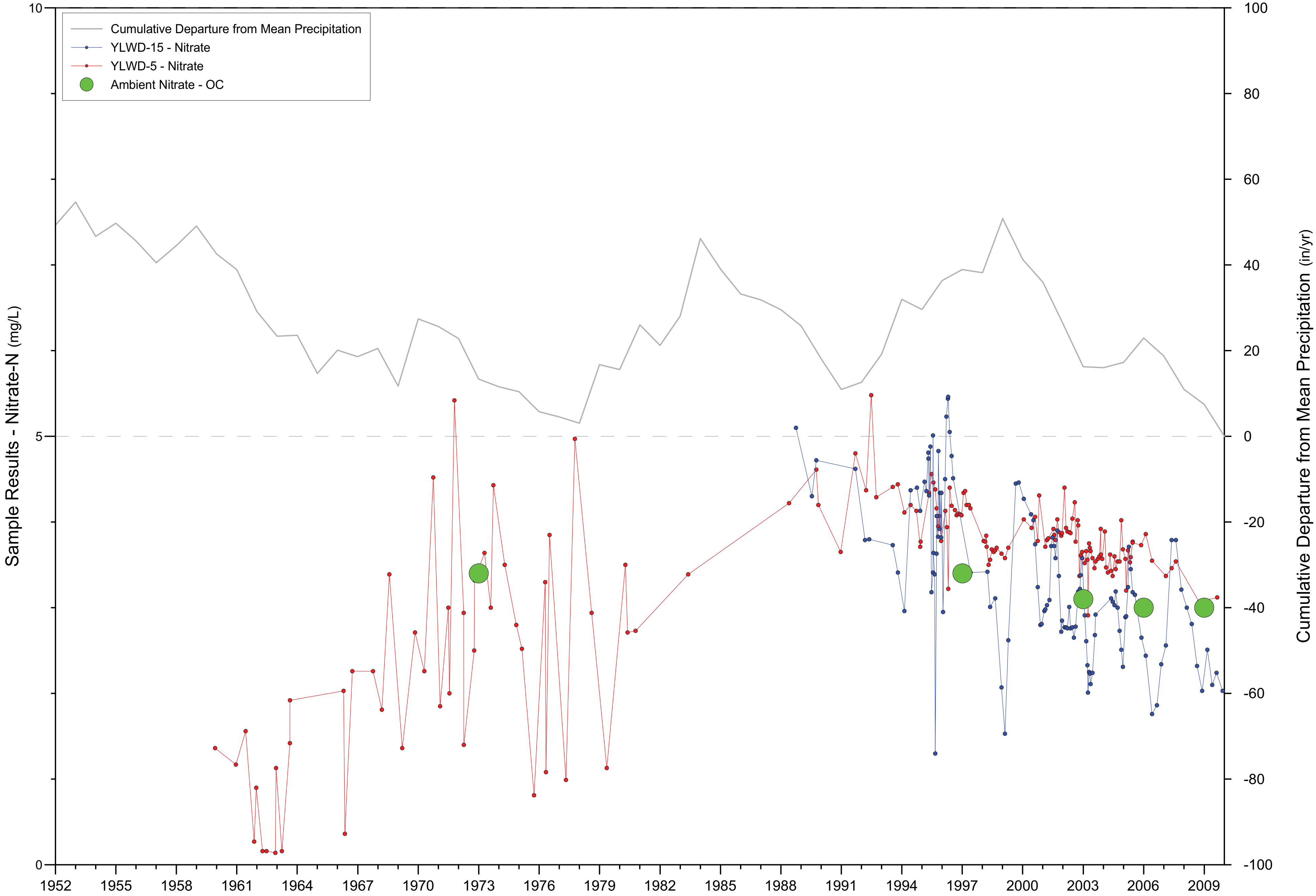

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Figure 4-74: TDS at Interpretive Wells - Orange County (Santa Ana River Recharge)

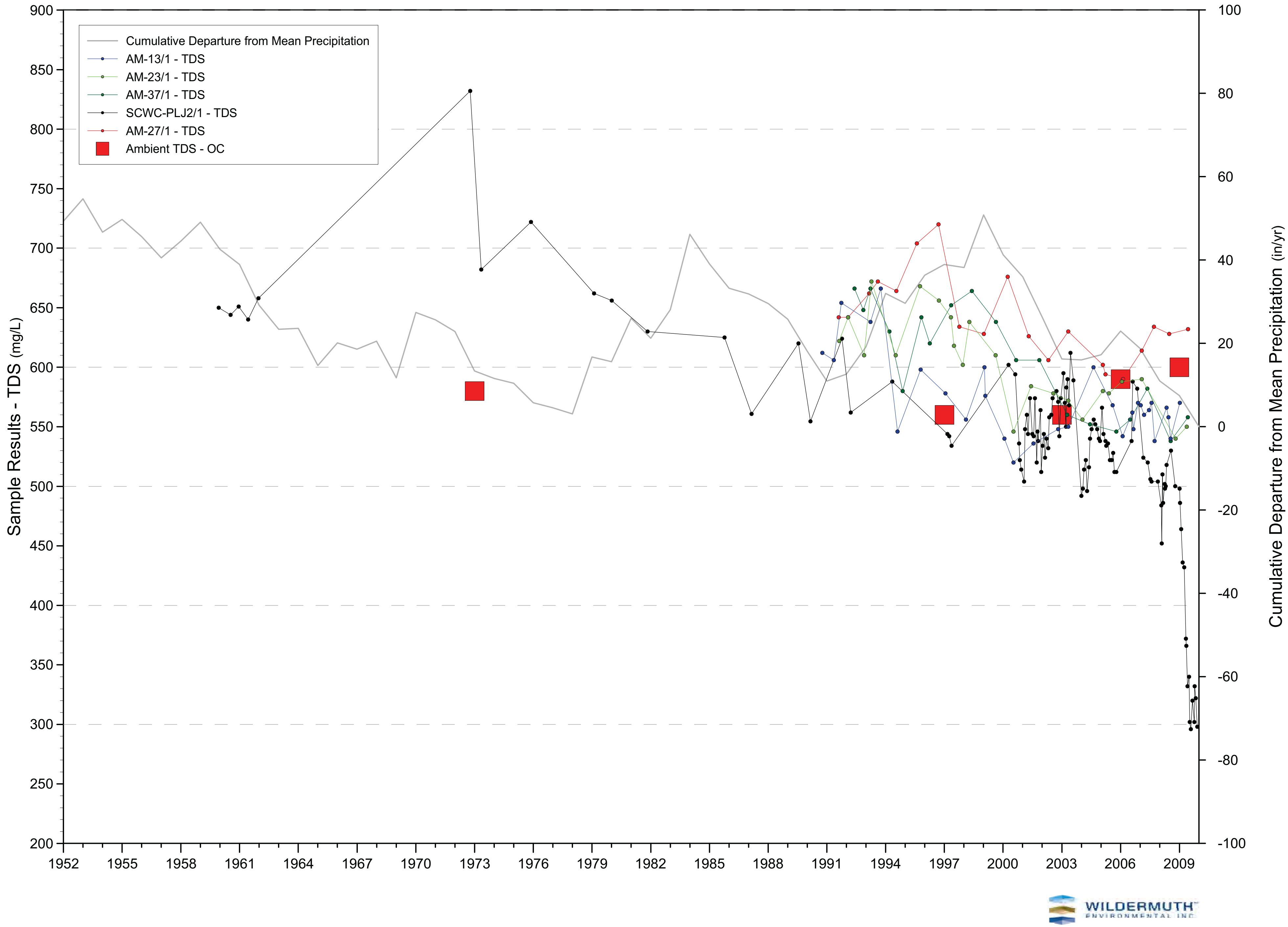

Figure 4-75: Nitrate-N at Interpretive Wells - Orange County (Santa Ana River Recharge)

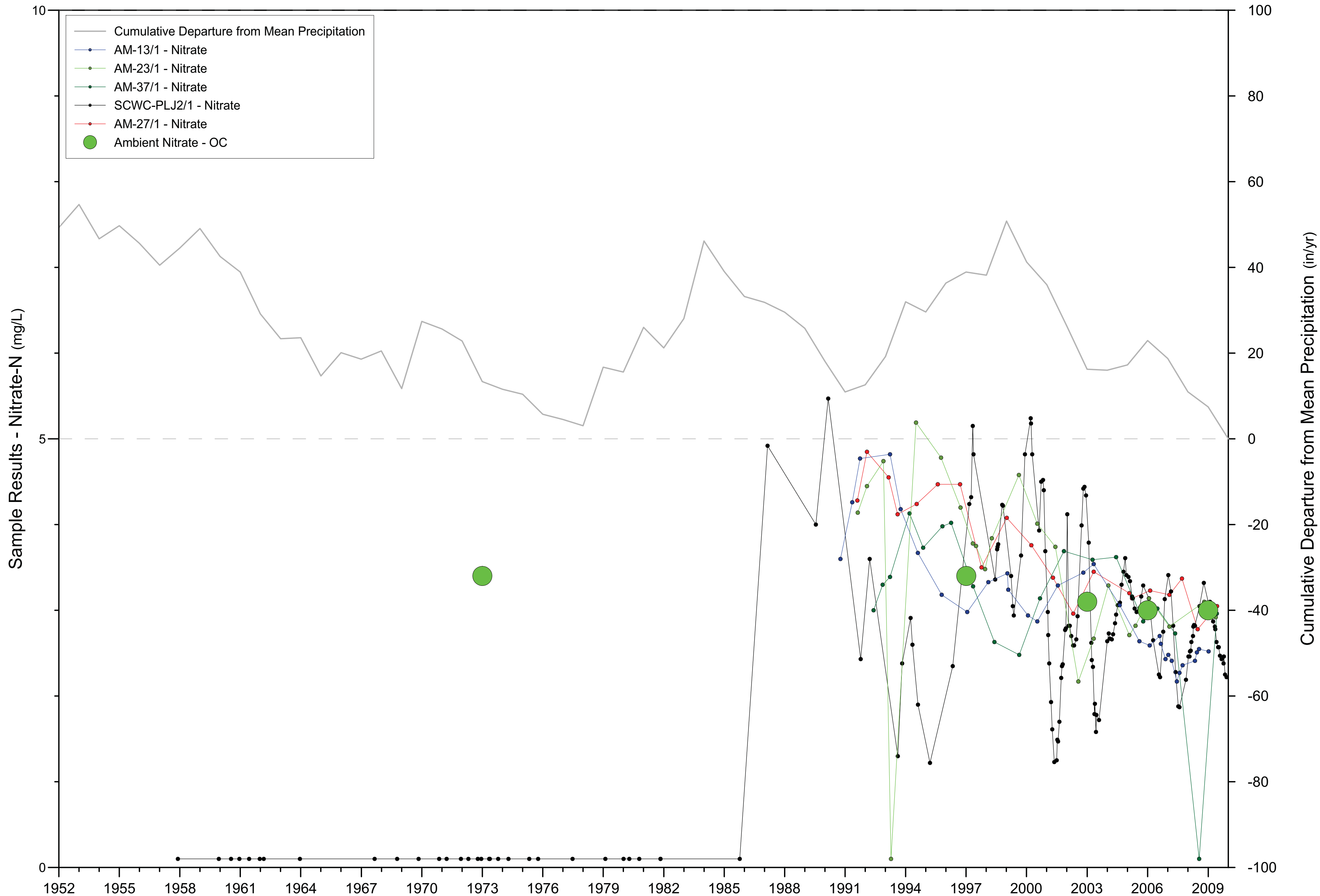

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Figure 4-76: TDS at Interpretive Wells - Orange County (Basin-Wide)

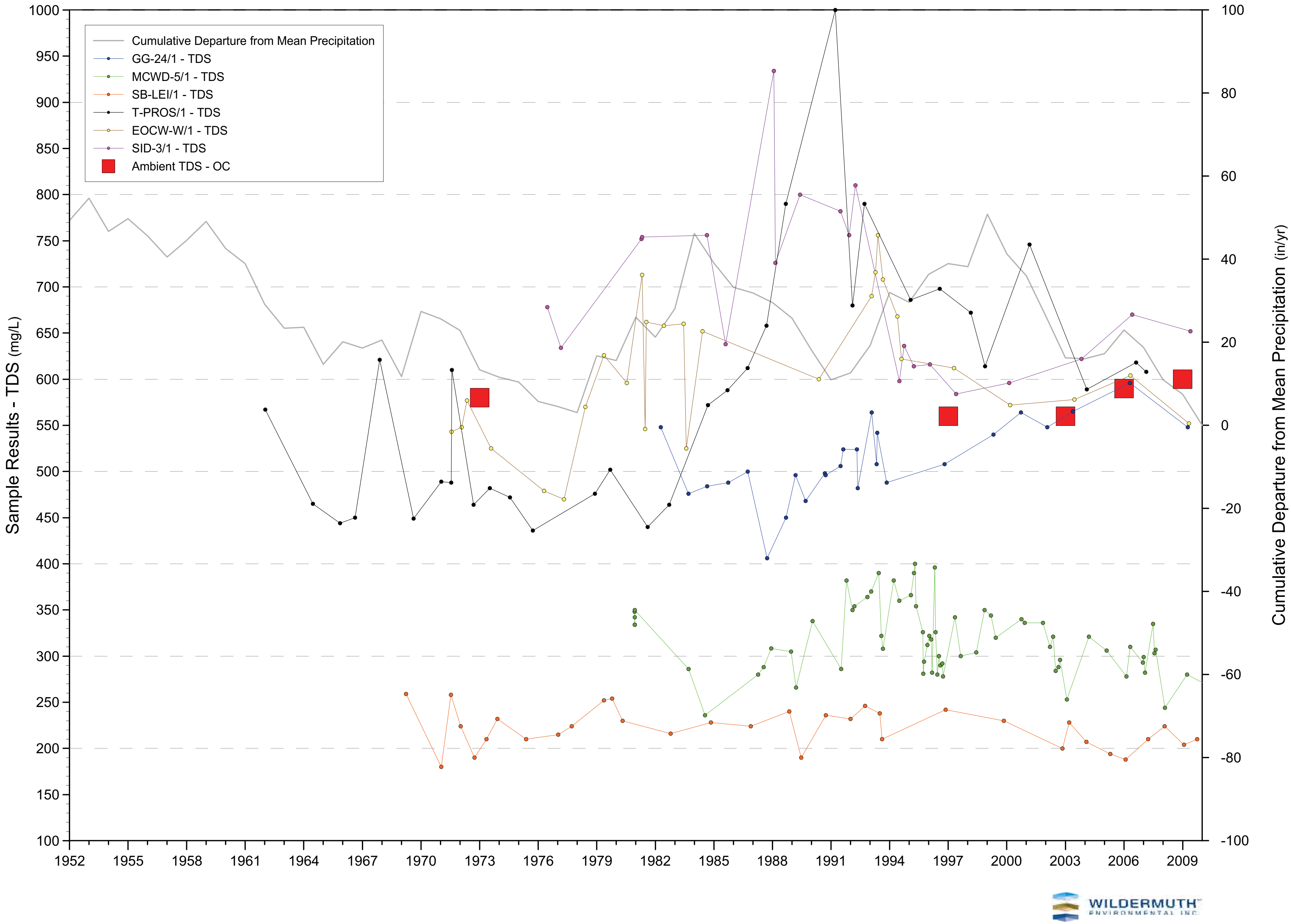
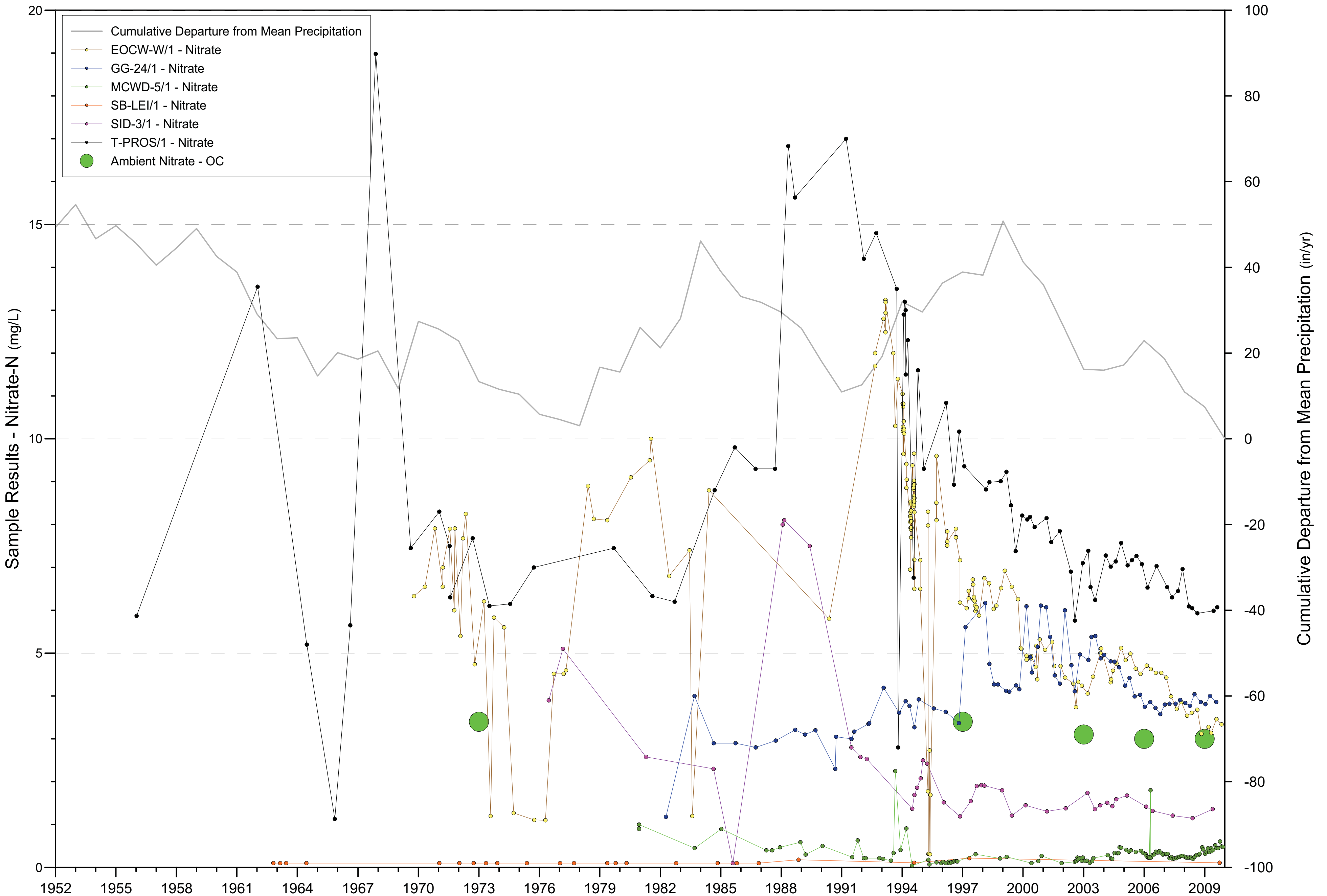
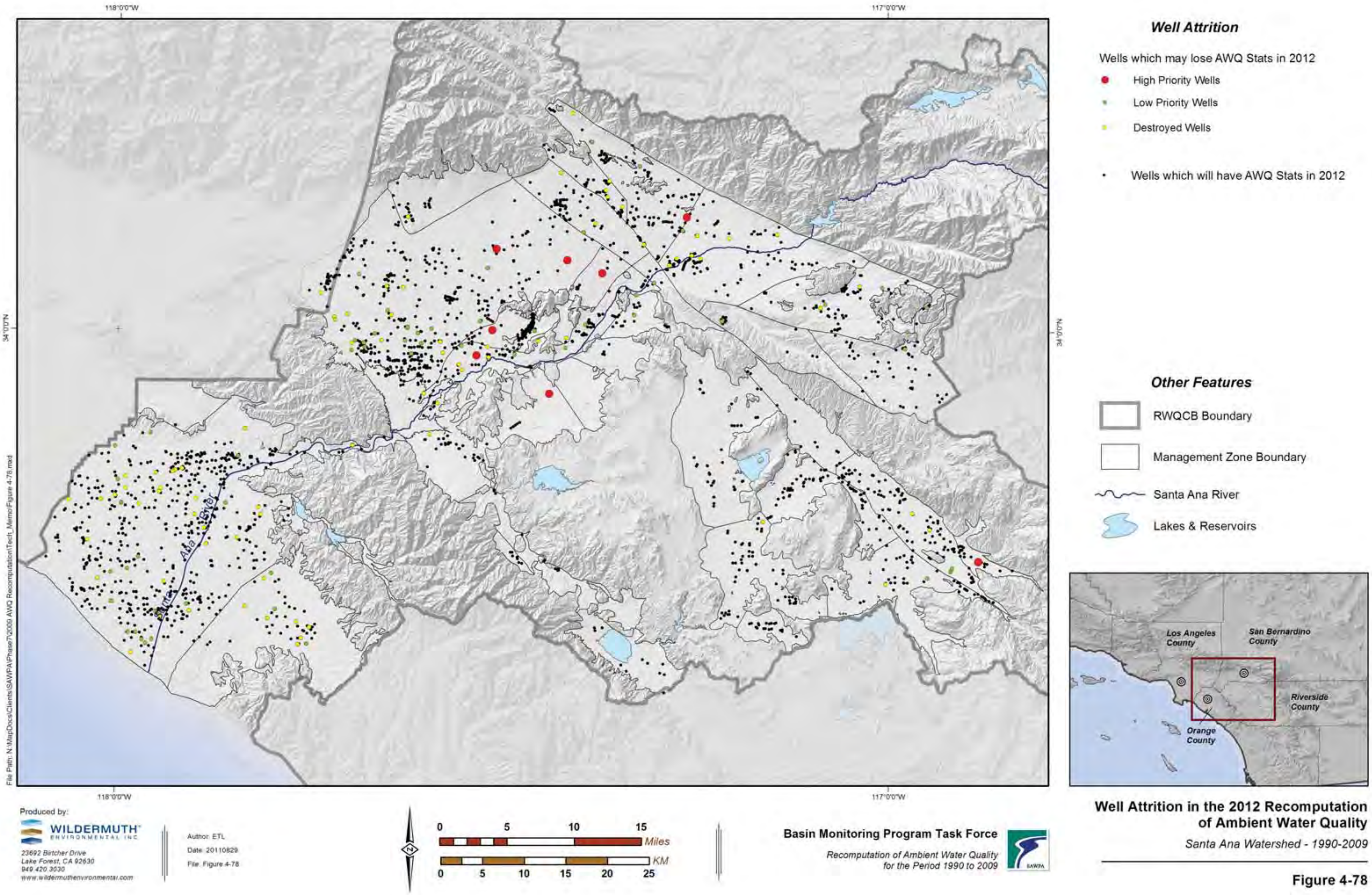


Figure 4-77: Nitrate-N at Interpretive Wells - Orange County (Basin-Wide)





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Author: ETL
Date: 20110829
File: Figure 4-78

Basin Monitoring Program Task Force

Recomputation of Ambient Water Quality for the Period 1990 to 2009

SAWPA

Well Attrition in the 2012 Recomputation of Ambient Water Quality

Santa Ana Watershed - 1990-2009

Figure 4-78

Section 5 - Recommendations for Future Ambient Water Quality Recomputations

The following recommendations for future ambient water quality recomputations are based on WEI staff observations from current and past recomputation efforts and on responses to the comments and concerns raised by the BMPTF (see Appendix A):

1. To reduce the cost of future ambient water quality determinations, the BMPTF should consider performing the data collection, QA/QC, processing, and storage of this data on an ongoing basis. The compilation of well information, water-level data, and groundwater quality data necessary to perform the ambient water quality recomputation continues to be the most time-consuming and expensive task. The collection and processing of data on a more frequent basis, if done efficiently, will allow for a more streamlined data collection effort, and earlier detection and rectification of discrepancies. WEI conducts these processes on a regular basis for several agencies in the watershed and has developed specialized tools to enhance the efficiency and accuracy of this process. If the BMPTF is interested, WEI will prepare detailed specifications for the collection, QA/QC, processing and storage of this data.

2. In Section 2.7, the following management zones were identified as having insufficient data to compute ambient water quality: Bedford, Warm Springs Valley, Lee Lake, Santiago, La Habra, and Riverside-D. Additionally, contouring was possible in the following management zones but difficult due to low data density and/or irregular spatial distributions of data points (i.e. data may be clustered and/or absent in certain areas): Arlington, Chino-East, Colton, Elsinore, Riverside-C, Riverside-E, San Jacinto-Lower Pressure, San Timoteo, and Temescal. Table 3-5 lists the management zones that could benefit from additional groundwater level and quality data and the water agencies that overlie them. Additional groundwater monitoring at appropriate locations and/or depths within the management zones listed in Table 3-5 will increase the number of wells with ambient water quality statistics, better constrain TDS and nitrate-nitrogen contouring, and ultimately make the management zones less susceptible to methodological factors that influence the computation of ambient water quality.

3. Discontinued monitoring at some wells and the subsequent loss of ambient water quality statistics over successive recomputation efforts is a methodological challenge that can influence ambient water quality results. The continued monitoring of groundwater quality at all wells that were used in this and previous recomputations will minimize this challenge. The list of wells where continued monitoring is necessary can be found in the Interpretive Tools section of this report (see Section 4).

4. The BMPTF should consider periodically updating the physical model used to compute ambient water quality. The physical model consists of aquifer properties (i.e. the specific yield of the sediments) and aquifer geometry (i.e. depth to bedrock and aquifer-system layering). Updates to the physical model would be based on

incremental improvements in the understanding of aquifer properties and aquifer geometry, such as new borehole and well information, new hydrogeologic studies, and the development of groundwater-flow models. The objective here is to improve the accuracy of ambient water quality determinations. If the physical model is updated, the BMPTF should consider revising the water quality objectives to be consistent with the new physical model. If this recommendation is implemented periodically over time, eventually enough will be known about the physical nature of the aquifer systems that no new updates to the physical model will be necessary.

California Regional Water Quality Control Board, Santa Ana Region. (2004). *Resolution No. R8-2004-0001— Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated Total Dissolved Solids (TDS) and Nitrogen Management Plan for the Santa Ana Region Including Revised Groundwater Subbasin Boundaries, Revised TDS and Nitrate-Nitrogen Quality Objectives for Groundwater, Revised TDS and Nitrogen Wasteload Allocations, and Revised Reach Designations, TDS and Nitrogen Objectives and Beneficial Uses for Specific Surface Waters.*

California Regional Water Quality Control Board, Santa Ana Region. (2005). *Resolution No. R8-2005-0065—Resolution Approving the San Timoteo and Yucaipa Management Zones Maximum Benefit Surface Water and Groundwater Monitoring Program Proposals as Required in the Total Dissolved Solids and Nitrogen Management Plan Specified in the Water Quality Control Plan for the Santa Ana River Basin.*

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

Wildermuth Environmental, Inc. (2005). *TIN/TDS Phase 4: Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1984 to 2003.* Technical Memorandum. November 2005.

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Wildermuth Environmental, Inc. (2008). *TIN/TDS Phase 6: Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1987 to 2006*. Technical Memorandum. August 2008.

Wildermuth Environmental, Inc. (2009). *Draft Phase 2 Feasibility Study for the Expansion of the Arlington Desalter System.* Prepared for Western Municipal Water District. October 2009.

Wildermuth Environmental, Inc. (2010). *Preliminary Assessment of Assimilative Capacity in the San Timoteo Management Zone.* Prepared for Yucaipa Valley Water District and City of Beaumont. November 2010.

Appendix A

Comments and Responses

A-1 SAWPA Comments and Responses

Comment Number	Reference	Comment	Response
1	Figures 3-1 to 3-6	WE Inc. staff indicated that the Lee Lake Management Zone has enough well data but not enough well distribution to define ambient water quality values. Since this was a judgment call by WE Inc. to continue showing this basin as having insufficient data, please confer with EVMWD, the primary pumper from this basin, to determine if establishing an ambient wq objective is appropriate for this update.	Comment noted.
2	Figures 4-1 to 4-11	The legend shows the scale with the red on the top of the scale and green on the bottom. However, under the previous figures 3-5 and 3-6 reverses the scale with green at the top and red on the bottom. This may result in some confusion to the reader. We recommend uniform color scale code to reflect change for both AWQ report and Interpretive Tool figures.	Comment noted. Revised figures as appropriate.
3	Page 4-3	The assumptions made about "key wells" may be misinterpreted as to whether a basin is degrading or improving. More definition of criteria may be necessary such as calling these wells "indicator or reference wells" perhaps. You may wish to consider adding more of these type of wells for larger groundwater mgt. zones proportionately.	Comment noted. "Key Wells" are now referred to as "Interpretive Wells" to avoid misinterpretation. Interpretive Well selections were reviewed and revised as appropriate. Revised figures and text to reflect these changes.
4	Figures 4-1 to 4-11	Adding additional text boxes with larger bold font to each figure that further explains the reason for water quality changes would be helpful. For example, if the coastline edge of OC mgt zone is degrading due to higher salt concentrations, further call out that these are due to the use of seawater intrusion barrier well data may be necessary and could be shown right on the figures.	Call-outs and interpretations added to figures.
5	Figures 4-6 to 4-7	Some explanation should be added to explain the gray areas that are in the OC and Irvine mgt zones but were not in the OC model in either layer. (shallow, pinch out areas with no well data was the explanation provided by WE Inc. staff) A text box, legend designation or footnote would probably work.	Comment noted. Revised figures as appropriate.

Comment Number	Reference	Comment	Response
6	Figures 4-17 to 4-73	Please show the y axis values to reflect the CDMP values corresponding to the graph line for CDMP.	Comment noted. Revised figures as appropriate.
7	Table 4-1	WE Inc. staff indicated in their scope and on page 4-3 that the number of key (interpretive wells) would vary based on the size and complexity of each mgt zone. However, the Table 4-1 consistently reflects five wells for each management zone. Please add interpretive wells as appropriate to reflect size and complexity as suggested particularly in the OC mgt zone.	Comment noted. It was determined that five or fewer Interpretive Wells were appropriate for most management zones. However, several additional well were selected due to the size and complexity of the Orange County Management Zone. Figures, tables, and text were all updated to reflect this change.
8	Figures 4-1	Please add explanation for why hashed line area was not calculated in 2006.	Comment noted. Revised text as appropriate.
9	Figures 4-1 to 4-11	Please show arrow lines to red font note in separate distinct font/thickness (perhaps red font) along with small arrow head for each line to assure no confusion with surrounding gmz boundary lines.	Comment noted. Revised figures as appropriate.
10	Figures 4-40 to 4-41	The Bunker Hill A well chart seems to missing interpretive well data for 2006. Why?	Comment noted. A previously broken data link was updated and the problem corrected.

A-2 OCWD Comments and Responses

Comment Number	Reference	Comment	Response
1	Table 1-2	The values in this table should be shown with the same number of significant figures as the table in the Basin Plan.	Comment noted. Formatting corrected.
2	Page 3-2	Change the statement in the last sentence from "key-well analysis" to "interpretive well analysis."	Comment noted. Revised text as appropriate.
3	Table 3-5	OCWD is listed incorrectly as the overlying agency for the La Habra Management Zone. This MZ is located outside of OCWD's boundaries. The Santiago Management Zone is not entirely within OCWD boundaries. OCWD should be listed as an overlying agency for only a portion of the Santiago MZ.	Comment noted. Revised table as appropriate.
4	Page 4-1	Additions shown in blue: •The elimination of three years (1987-89) of data from the analysis •The addition of three years (2007-09) of data to the analysis	Comment noted. Revised text as appropriate.
5	Page 4-1	Add text to this page explaining that the methodological factors of eliminating the first three years of data from the previous time period and adding the most recent three years of data for the current time period are intentional factors to evaluate temporal water quality changes.	Comment noted. Revised text as appropriate.
6	Page 4-4	In order to more fully analyze the potential influence of recharge of SAR water on groundwater quality in the Orange County management zone, we recommend the following: 1. Add one of Yorba Linda Water District's wells (YLWD-1, 5, 7, 10, or 18) and YLWD-15 to represent water recharged from the SAR upgradient of the influences of GWRS or imported water recharged at OC-28. 2. Add wells downgradient of Santiago Basins which receive SAR water. Wells to consider include: O-23, O-24, SID-3, SWD-5 and EOCW-E or EOCW-W. *continued*	Comment noted. Nine new Interpretive Wells were added to the analysis. Time history charts of water quality for the Orange County Management Zone were expanded from two to six. Text and map figures were revised to reflect these new wells.

WMWD COMMENTS AND RESPONSES

Comment Number	Reference	Comment	Response
		3. Review the historical data to see which of these wells provide the best trend representations. 4. Include in the interpretive well analysis the five "key" wells identified in the previous draft reports as listed below: (GG-24/1, MCWD-5/1, SB-LEI/1, SCWCPLJ2/1, T-PROS/1)	
7	Page 4-6	Second bullet point, change reference from Table 4-1 to Table 4-2.	Comment noted. Reference revised as appropriate.

A-3 IEUA Comments and Responses

Comment Number	Reference	Comment	Response
1	n/a	Our comments on the first draft have been addressed and we have no further changes to suggest for the final report. The issue of how to avoid causing the Orange County aquifer TDS to appear to go up due to averaging in the results from additional wells in the seawater intrusion impacted zone could be addressed several ways. For example, one suggestion was made to do a special analysis for just the Orange County spreading grounds area; but, another suggestion is to simply continue to exclude the seawater intrusion zone from the calculations. A preliminary recommendation could be made in this year's final report, but it would perhaps be better to list the pros and cons of more than one option before a final recommendation is made.	Comment noted.

A-4 WMWD Comments and Responses

Comment Number	Reference	Comment	Response
1	Figures 4-1 to 4-11	It was pointed out at the July 26 Basin Monitoring Task Force meeting that leaving unmodeled portions of the groundwater management zone gray in Figures 4-1 through 4-11 was confusing without notation. A suggestion is to add a sentence to the end of the second paragraph (beginning with "Eleven maps") of Section 4.1 on page 4-2: "Areas in Figures 4-1 through 4-11 not modeled are shaded gray."	Comment noted. Figures revised as appropriate.
2	Figures 4-1 to 4-11	The shading scheme in the legend for Figures 3-5 (Change in Ambient TDS) and 3-6 (Change in Ambient Nitrate-N) is not consistent with those in Figures 4-1 through 4-11. Select one scheme (improving on top or degrading on top) and stick with it throughout the document.	Comment noted. Figures revised as appropriate.
3	Sec. 4.2	Section 4.2, middle of the third paragraph, describes "key" wells as "illustrat[ing] how groundwater quality is changing in certain areas within each management zone, as compared to the ambient water quality trend for the entire management zone." "Reference" well appears to describe this relationship more precisely.	Comment noted. All references to "Key Wells" have been replaced with "Interpretive Wells."
4	Figures 4-12 to 4-73	What are the units of Cumulative Departure in Mean Precipitation? A secondary axis label would be useful.	Comment noted. Figures revised as appropriate.
5	Figures 4-12 to 4-73	Some charts have narrow y-axis intervals and others are very wide. The axis intervals should be more consistent. Five to seven intervals are visually more pleasing.	Comment noted. Figures revised as appropriate.
6	Figures 4-12 to 4-73	In charts such as Figure 4-22, 4-33, and 4-45, all of the traces are grouped at the bottom, with a lot of empty chart above. Unless there is an outlier that is not visible on the chart, the scale does not make sense. There does not appear to be a reason to default the maximum axis value to 30 mg/L.	Comment noted. Figures revised as appropriate.

WMWD COMMENTS AND RESPONSES

7	Sec. 4	Where there is increased degradation in a management zone, are there any presumptions as to whether it is due to recent activity or is the legacy of past activities, as the groundwater moves through portions of the basin, or solutes bound in the soil release and move through the groundwater over time?	Comment noted. Answering this question is not within the scope of the current project, but the question has merit. Determining specific causes of water quality changes in management zones with the information at-hand is not feasible. Further study and more information is needed in order to determine the impact of both legacy and recent activities on the groundwater quality of management zones.
8	Figure 4-74 (Figure 4-78 in this Final Report)	Reviewing Figure 4-74, my eyes are drawn first to the destroyed and current wells. The high-priority wells do not draw my immediate attention. I recommend that the high-priority and destroyed well symbols be reversed.	Comment noted. Figures revised as appropriate.

A-5 EMWD COMMENTS AND RESPONSES

Comment Number	Reference	Comment	Response
1	Table 4-2	I noticed Table 4-2 shows EMWD as the owner of some of the wells that don't belong to us. Is that because you receive the data from us?	For the agencies which deliver large databases (OCWD and EMWD), the reporting agency is listed as the well owner.
2	Figures 4-50, 4-55, 4-59, 4-62, & 4-72	The ambient TDS/Nitrate results are much higher than the Key Wells, questioning whether these should be classified as the Key Wells or the management zone should include more representative "Key" Wells. Either way, an explanation should be stated for such differences.	The criteria for choosing Interpretive Wells includes the length of data record, geographic location, screened intervals, whether the trends observed in the data record were representative of those observed at other wells in the local area, and the likelihood that the well would continue to be sampled in the future.
3	Page 3-2, 2nd Paragraph	Figures do not match statements.	The figures referenced in this section are: 3-5 Change in Ambient TDS: Santa Ana Watershed 2006-2009 3-6 Change in Ambient Nitrate-N: Santa Ana Watershed 2006-2009
4	Tables 3-1 & 3-2	Footnote #8, why is this stated? Not needed, RWQCB will determine compliance. *(Footnote states: 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.)*	Comment noted. This footnote was added after BMPTF discussion in which it was decided that the stance of the RWQCB to treat the OCMZ as having no assimilative capacity for TDS should be documented. This refers only to periods in the past when ambient TDS estimates were below the anti-degradation objective. The current ambient water quality estimate for the OCMZ is above the anti-degradation objective, so no assimilative capacity currently exists.
5	Table 3-4	Possibly include changes in number of wells (data points) to include historical, previous and current ambient. Not only statistically seeing the number of wells (data points) but also possible changes that can influence the data from each re-computation.	Comment noted. This table is intended to show the relative number of statistics in each management zone. One can quickly assess which management zones may be deficient in data. That said, we think the Change Maps for TDS and Nitrate-N (Sec 4.1) are a more informative tool for determining the spatial extent and density of statistics at management zones for the current and previous periods of study.

EMWD COMMENTS AND RESPONSES

Comment Number	Reference	Comment	Response
6	Table 3-5	Need associated paragraph/statement explaining why for this table. Might be better place in Section 4.	Comment noted. Text revised as appropriate.

A-6 YVWD Comments and Responses

Comment Number	Reference	Comment	Response
1	Tables 1-1, 1-2, 3-1, and 3-2.	Based on my review, I recommend the footnote at the bottom of Tables 1-1 and 1-2 (as well as 3-1 and 3-2) that states, "Assimilative capacity created by maximum benefit objectives is allocated solely to agencies responsible for maximum benefit implementation" be deleted.	Comment noted. Footnote removed from the tables.

Appendix B

Compact Disk

Appendix C

Preliminary Assessment of Assimilative Capacity for TDS and Nitorgen in the San Timoteo Management Zone

November 1, 2010

City of Beaumont
Attention: David Dillon
Director of Economic Development
550 East 6th Street
Beaumont, CA 92223

Yucaipa Valley Water District
Attention: Joseph Zoba
General Manager
12770 Second Street
Yucaipa, CA 92399

Subject: Preliminary Assessment of Assimilative Capacity for TDS and Nitrogen in the San Timoteo Management Zone

Dear Messrs. Dillon and Zoba:

On February 22, 2010, Wildermuth Environmental, Inc. (WEI), on behalf of the City of Beaumont (City), the Yucaipa Valley Water District (YVWD), and Regional Board staff met to discuss compliance with the Maximum Benefit objectives and commitments in the San Timoteo Management Zone (STMZ). During the meeting, the parties discussed the locations of new monitoring wells planned for construction pursuant to their October 30, 2008 monitoring well work plan (WEI, 2008b), a revised schedule for well completion, and the Regional Board's directive to perform a preliminary assessment of assimilative capacity in the STMZ in parallel with the watershed-wide effort to re-compute ambient groundwater quality that is being conducted by the Basin Monitoring Program Task Force (BMPTF). Official correspondence from the Regional Board, dated July 27, 2010, mandated that the City and the YVWD perform a Preliminary Assessment of Assimilative Capacity for TDS and Nitrogen in the STMZ (preliminary assessment) by October 30, 2010. The City and the YVWD subsequently retained WEI to work with the Regional Board to develop a methodology and perform the preliminary assessment. This report summarizes the background, technical approach, results, and next steps of the preliminary assessment.

BACKGROUND

The methodology for computing groundwater quality objectives, current ambient groundwater quality, and assimilative capacity for total dissolved solids (TDS) and nitrate as nitrogen (nitrate-N) in groundwater management zones was developed by the N/TDS Task Force in 2000 and is documented in the TIN/TDS Study – Phase 2A Final Technical Memorandum (WEI, 2000). The

Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) was amended in January 2004 to include the results and methodology from the TIN/TDS Study. As part of 2004 Basin Plan amendment, the TDS and nitrate-N objectives for the STMZ (and a few other management zones) were raised to create assimilative capacity to encourage reclamation and the maximum beneficial use of State waters. These "maximum benefit" water quality objectives are contingent on the implementation of certain projects and programs by the stakeholders that petitioned for the "maximum benefit" objectives.

The TDS and Nitrogen Management Implementation Plan outlined in Section 5 of the Basin Plan requires that ambient groundwater quality be recomputed every three years using the same methodology developed by the N/TDS Task Force to compute the objectives. The triennial recomputation requirement is reiterated as a specific commitment in the Maximum Benefit Implementation Plan for Salt Management in the STMZ.

In 2003 and 2006, current ambient groundwater quality was estimated in management zones across the entire watershed, but insufficient data were available in the STMZ. In the current (2009) ambient water quality recomputation period, the data are still insufficient in the STMZ to compute ambient water quality per the adopted methodology, despite increased monitoring efforts and the construction of new monitoring wells. Thus, the Regional Board mandated that the City and the YVWD develop a comparable, alternative methodology to make a preliminary estimation of current ambient groundwater quality and assimilative capacity in the STMZ.

TECHNICAL APPROACH

In general, the recomputation effort is performed per the following steps (i) development of statistics for TDS and nitrate-N at wells for the current time period, (ii) estimation (contour mapping) of TDS and nitrate-N across the management zone, and (iii) computation of a volume-weighted estimate of current ambient TDS and nitrate-N based on the groundwater quality, groundwater levels, aquifer geometry, and aquifer properties. A moving 20-year period of water quality data from wells is used in each recomputation. In order to compute TDS and nitrate-N statistics at a well, at least one water-quality sample must have been collected in a minimum of three separate calendar years within the 20-year time period. A step-by-step description of the methodology to estimate ambient groundwater quality is included in the Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1987 to 2006 Final Technical Memorandum (WEI, 2008a).

The 20-year period for the 2009 recomputation of ambient groundwater quality is January 1, 1990 to December 31, 2009. As previously stated, the data from wells in the STMZ for the 2009 recomputation is insufficient to estimate current ambient TDS and nitrate-N concentrations. In order to make a preliminary assessment of current ambient TDS and nitrate-N concentrations in the STMZ, the ambient water quality methodology was modified as follows:

- The computation period was shifted to the 20-year period of January 1, 1991 to December 31, 2010 to allow for inclusion of results from monitoring wells constructed in 2010. This shift also allows for the calculation of a TDS and nitrate-N statistic at three wells that would not have had a statistic calculated in the 2009 time period.
- A water-quality sample and groundwater-elevation measurement were collected at all wells in the STMZ that were able to be sampled during August 2010.

- For those wells with a TDS or nitrate-N statistic for the 1991 to 2010 time period, TDS and nitrate-N contours were drawn to the statistic value.
- For those wells that do not have the minimum three-year dataset required to compute a TDS or nitrate-N statistic for 1991 to 2010 time period, TDS and nitrate-N contours were drawn to the average value of all sample results available during the 20-year time period.
- For those wells that were sampled for the first time in August 2010, TDS and nitrate-N contours were drawn to the single sampling result for TDS and nitrate-N.
- Groundwater volume was based on groundwater elevation contours for measurements made in August 2010.

The maximum benefit objectives for TDS and nitrate-N in the STMZ are 400 milligrams per liter (mg/L) and 5.0 mg/L, respectively. The preliminary current ambient concentrations of TDS and nitrate-N are to be compared against the "maximum benefit" objectives for the STMZ to determine if assimilative capacity exists. Assimilative capacity is described as:

> *If the preliminary current ambient TDS or nitrate-N concentration of the management zone is equal to or greater than the objectives, then assimilative capacity does not exist. If the preliminary current ambient TDS or nitrate-N concentration is less than the water quality objectives, then assimilative capacity exists. In the later case, the difference between the objective and the preliminary current ambient TDS or nitrate-N concentration is the amount of assimilative capacity available.*

The preliminary assessment methodology was developed by WEI in cooperation with the Regional Board and was presented to the BMPTF on July 21, 2010.

PRELIMINARY ASSESSMENT RESULTS

The results of the preliminary assessment of assimilative capacity in the STMZ are summarized in the following table.

Constituent	Antidegradation Objective (mg/L)	Maximum Benefit Objective (mg/L)	2010 Preliminary Current Ambient Concentration (mg/L)	2010 Preliminary Assimilative Capacity (mg/L)
TDS	300	400	420	**- 20**
nitrate-N	2.7	5	0.8	4.2

Included with this letter report are a series of figures and tables that further describe the data used in the analysis. Figure 1 shows the location of all wells in the STMZ used in the preliminary analysis. Tables 1 and 2 summarize the TDS and nitrate-N at the wells, including the total number of samples, the number of annual averages, the average constituent concentration, the current ambient statistic, the August 2010 sample result, and the value used to contour the management zone. Figures 2 and 3 show the current ambient statistics, the average values, and the contours of TDS and nitrate-N, respectively. Figure 4 shows the groundwater elevation contours for August 2010. Figures 5 and 6 show the aquifer volume by grid-cell, as a percent of the total volume, overlain by the TDS and nitrate-N contours.

All groundwater well, water-level, and water-quality data used in the preliminary assessment are provided in an access database included on the enclosed CD. Also included on the CD are the GIS shapefiles created and used in the assessment, including points, contours, and the management zone grid.

NEXT STEPS

Per the July 27, 2010 letter from the Regional Board, each agency is required to prepare a salt-offset plan to mitigate discharges above the Maximum Benefit objectives for which there is no assimilative capacity. The salt-offset plan is due to the Regional Board by December 30, 2010. We recommend that you set up a meeting with Regional Board staff as soon as possible to discuss the results of this analysis, their expectations for the salt-offset plan, and to clarify any additional monitoring and reporting requirements related to the Maximum Benefit commitments in the STMZ.

Please call me if you have any questions or concerns regarding this report. It has been our pleasure to assist the City and the YVWD on this important and timely assignment.

Wildermuth Environmental, Inc

Mark J. Wildermuth, MS, PE
Chairman

Samantha S. Adams
Senior Scientist

Encl. Tables 1 and 2; Figures 1 – 6; Compact Disc with data and GIS files
Cc. Kurt Berchtold and Cindy Li/Santa Ana Regional Water Quality Control Board

REFERENCES

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

Wildermuth Environmental, Inc. (2008a). *Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1987 to 2006, Final Technical Memorandum*. August 2008.

Wildermuth Environmental, Inc. (2008b). *San Timoteo Management Zone Monitoring Network Development Workplan*. October 2008.

Table 1
Summary of Total Dissolved Solids (TDS) Data for Wells in the San Timoteo Management Zone
1991 - 2010

Well ID	Well Owner	Well Name	Sample Count	TDS Average *(mg/L)*	TDS August 2010 *(mg/L)*	TDS Statistic *(mg/L)*	TDS Contour Value *(mg/L)*
1003044	Hudson, O.	NA	4	243	not sampled	263	263
1003049	El Casco Lake Ranch	ONE	3	653	660	676	676
1003079	Rutherford, Mark	Fishermen's Retreat 1	6	570	580	582	582
1201539	Schwenckert, Henry	1	4	843	820	878	878
1201582	Fisherman's Retreat	Fishermen's Retreat 2	5	416	450	434	434
1205019	County of San Bernardino	ST-02	60	315	*	337	337
1205020	County of San Bernardino	ST-03	27	504	*	514	514
1205021	County of San Bernardino	ST-05C	60	326	*	322	322
1205023	County of San Bernardino	ST-07	23	348	*	353	353
1205024	County of San Bernardino	ST-08	50	433	*	445	445
1205025	County of San Bernardino	ST-10	47	389	*	399	399
1205026	County of San Bernardino	ST-11	39	284	*	315	315
1207472	County of San Bernardino	ST-07A	24	231	*	250	250
1207756	East Valley Golf Club	335645117024201	1	242	not sampled	n/a	242
1208660	City of Beaumont	Heartland Well	4	380	390	446	446
1220051	Metropolitan Water District	BH-9	2	400	260	n/a	400
1220052	Metropolitan Water District	BH-19	3	720	590	815	815
1221779	Yucaipa Valley Water District	YVWD GWMW-3	3	473	470	n/a	473
1221780	Yucaipa Valley Water District	YVWD GWMW-2	2	530	550	n/a	530
1221782	Yucaipa Valley Water District	YVWD GWMW-4	1	570	570	n/a	570
1222061	City of Beaumont	SanTim-1	2	420	420	n/a	420
1222079	City of Beaumont	San Tim-2B/1	2	285	260	n/a	**253**
1222080	City of Beaumont	San Tim-2B/2	2	220	240	n/a	**253**
1222103	Yucaipa Valley Water District	YVWD GWMW-5A	3	477	430	n/a	**411**
1222104	Yucaipa Valley Water District	YVWD GWMW-5B	3	497	490	n/a	**411**
1222105	Yucaipa Valley Water District	YVWD GWMW-5C	1	260	260	n/a	**411**
1222106	Martie Wells	Deep Well	10	380	400	n/a	380

Notes:

*San Timoteo Landfill wells are sampled by the County of San Bernardino, the most recent sample date is June 2010

n/a indicates that data are insufficient to compute an ambient water quality statistic for TDS

Contour point values in bold indicate that the contour value is the average of the "TDS average" values for nested monitoring wells

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Table 2

Summary of Nitrate as Nitrogen (NO_3-N) Data for Wells in the San Timoteo Management Zone

1991 - 2010

Well ID	Well Owner	Well Name	Sample Count	NO_3-N Average *(mg/L)*	NO_3-N August 2010 *(mg/L)*	NO_3-N Statistic *(mg/L)*	NO_3-N Contour Value *(mg/L)*
1003044	Hudson, O.	NA	4	0.92	not sampled	1.33	1.33
1003049	El Casco Lake Ranch	ONE	3	0.11	ND	0.05	0.05
1003079	Fisherman's Retreat	Fishermen's Retreat 1	4	0.12	ND	0.05	0.05
1201539	Schwenckert, Henry	1	4	28.84	30	29.44	29.44
1201582	Fisherman's Retreat	Fishermen's Retreat 2	5	0.13		0.05	0.05
1205019	County of San Bernardino	ST-02	60	3.77	*	3.5	3.5
1205020	County of San Bernardino	ST-03	27	2.07	*	2.18	2.18
1205021	County of San Bernardino	ST-05C	60	2.18	*	2.25	2.25
1205023	County of San Bernardino	ST-07	23	0.09	*	0.06	0.06
1205024	County of San Bernardino	ST-08	50	0.53	*	0.79	0.79
1205025	County of San Bernardino	ST-10	47	2.99	*	3.05	3.05
1205026	County of San Bernardino	ST-11	39	0.06	*	0.05	0.05
1207472	County of San Bernardino	ST-07A	24	0.71	*	0.76	0.76
1208660	City of Beaumont	Heartland Well	4	1.23	0.95	1.53	1.53
1220051	Metropolitan Water District	BH-9	2	3.35	2	n/a	3.35
1220052	Metropolitan Water District	BH-19	3	0.12	ND	0.05	0.05
1221779	Yucaipa Valley Water District	YVWD GWMW-3	3	0.3	ND	n/a	0.3
1221780	Yucaipa Valley Water District	YVWD GWMW-2	2	0.84	0.77	n/a	0.84
1221782	Yucaipa Valley Water District	YVWD GWMW-4	1	0.32	ND	n/a	0.32
1222061	City of Beaumont	SanTim-1	2	1.1	1.2	n/a	1.1
1222079	City of Beaumont	San Tim-2B/1	2	3	2.6	n/a	**1.86**
1222080	City of Beaumont	San Tim-2B/2	2	0.72	0.34	n/a	**1.86**
1222103	Yucaipa Valley Water District	YVWD GWMW-5A	3	2.83	1.7	n/a	**2.39**
1222104	Yucaipa Valley Water District	YVWD GWMW-5B	3	2.05	1.9	n/a	**2.39**
1222105	Yucaipa Valley Water District	YVWD GWMW-5C	1	2.3	2.3	n/a	**2.39**
1222106	Martie Wells	Deep Well	10	0.24	ND	n/a	0.24

Notes:

*Landfill wells last sampled in June 2010, not August

For wells with non-detect results, the nitrate as nitrogen average result was calculated by diving the detection limit by the square root of 2

"ND" values represent Non-Detect result for August 2010

"n/a" indicates that data are insufficient to compute an ambient water quality statistic for nitrate as nitrogen

Contour point values in **bold** indicate that the contour value is the average of the "NO_3-N average" values for nested monitoring wells

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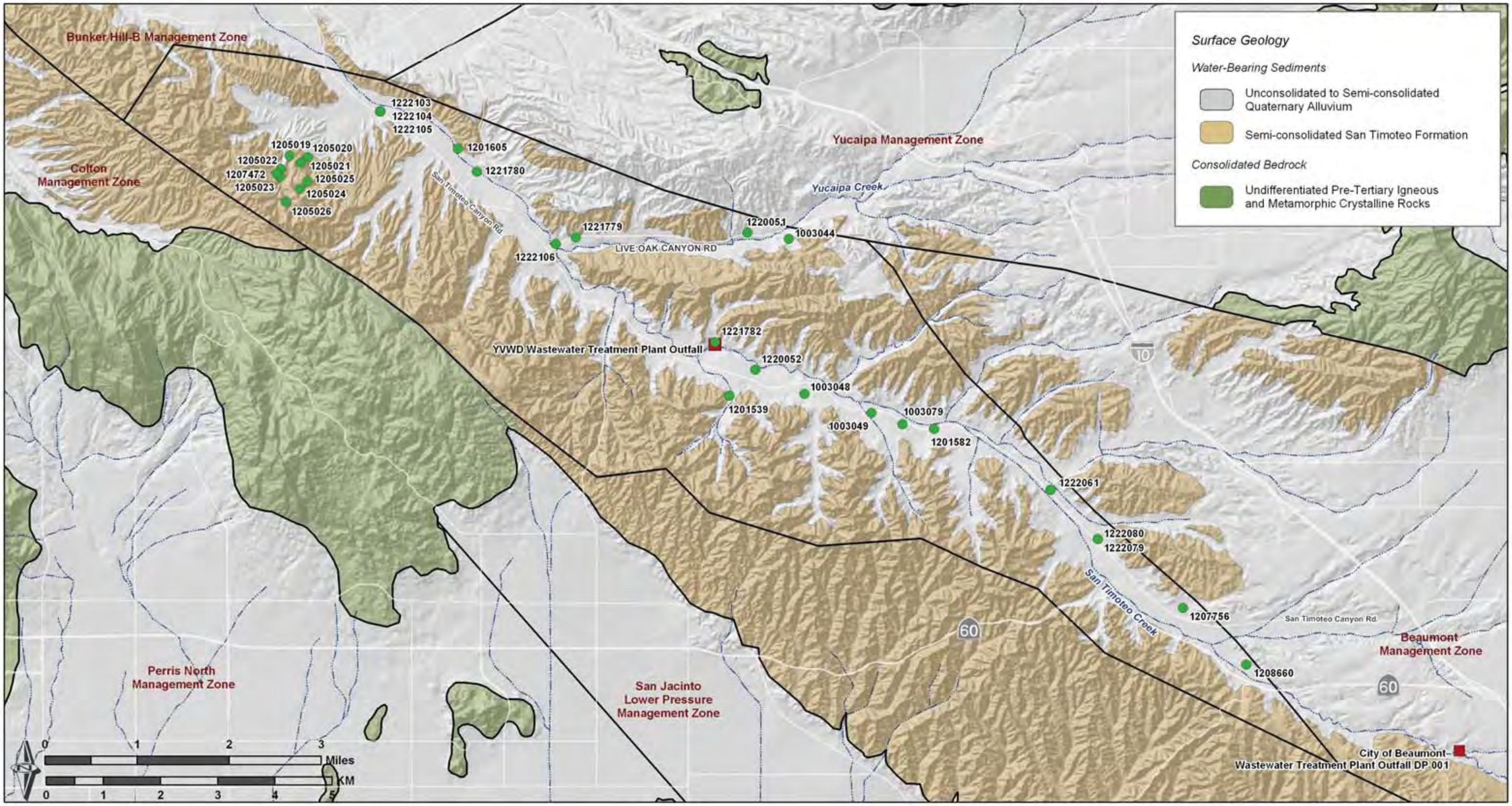

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Author: SSA/ETL
Date: 20100100б
File: Draft WL Elevation Contours.mxd

1208660 Well ID of STMZ Wells Used in the Prelminary Assessment

Management Zone Boundary

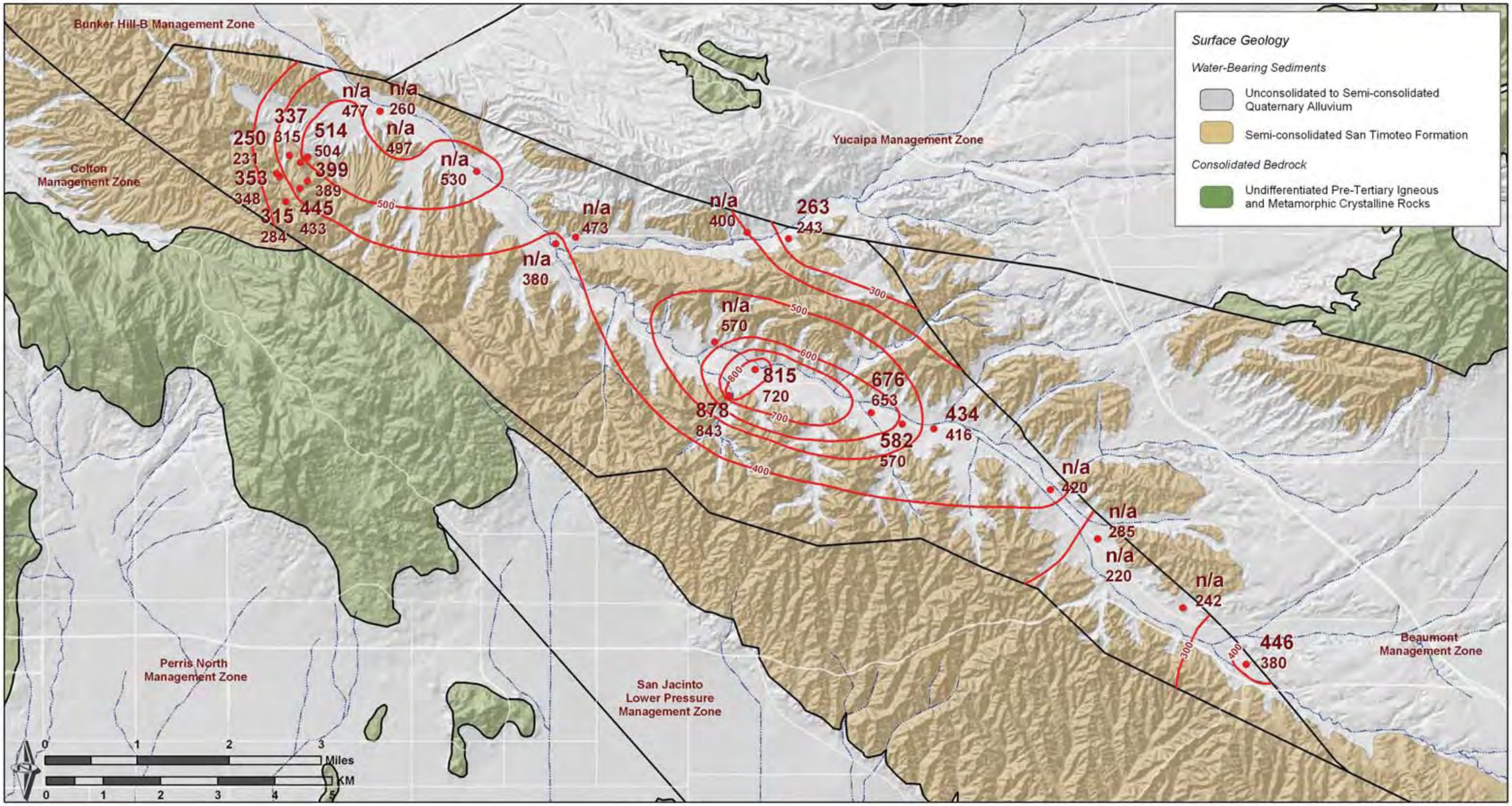
Wastewater Treatment Plant Discharge Points

Rivers and Streams

Preliminary Assessment Wells
San Timoteo Management Zone

Figure 1

Prepared for:
City of Beaumont & YVWD



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23692 Birtcher Drive
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949.420.3030
www.wildermuthenvironmental.com

Author: SSA/ETL
Date: 20100108
File: TDS Contours.mxd

400 / 450 TDS Concentration Contour (mg/L)

446 / 380 TDS Statistic* / TDS Average
(*n/a ndicates data insufficient to compute statistic)

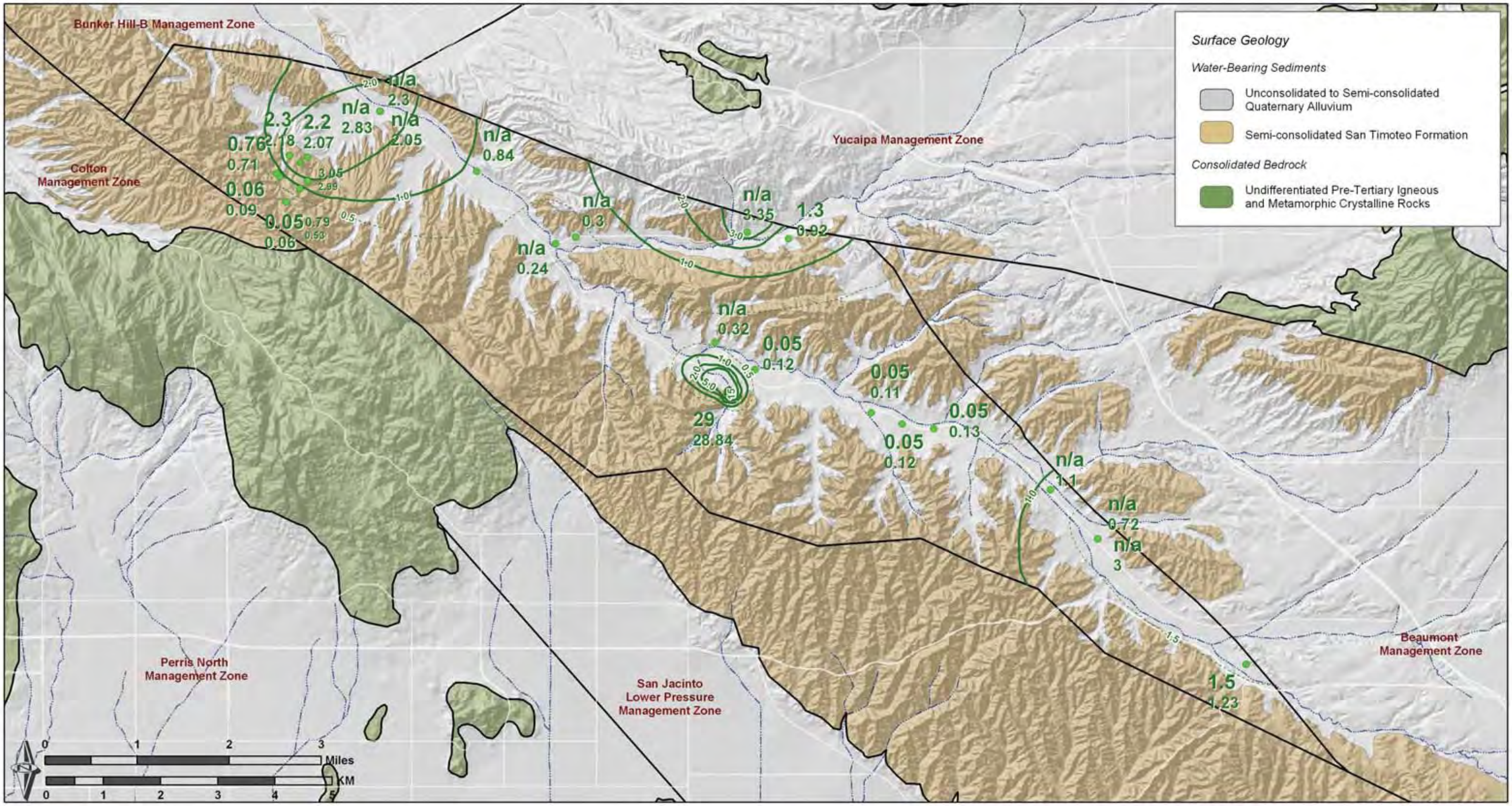
Management Zone Boundary

Rivers and Streams

TDS Concentration Contours
San Timoteo Management Zone

Figure 2

Prepared for:
City of Beaumont & YVWD



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23692 Birtcher Drive
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Author: SSA/ETL
Date: 20100106
File: Nitrate-N Contours.mxd

1.0 / 0.5 — Nitrate-N Concentration Contour (mg/L)

1.5 / 1.23 — Nitrate-N Statistic*
Nitrate-N Average
(*n/a ndicates data insufficient to compute statistic)

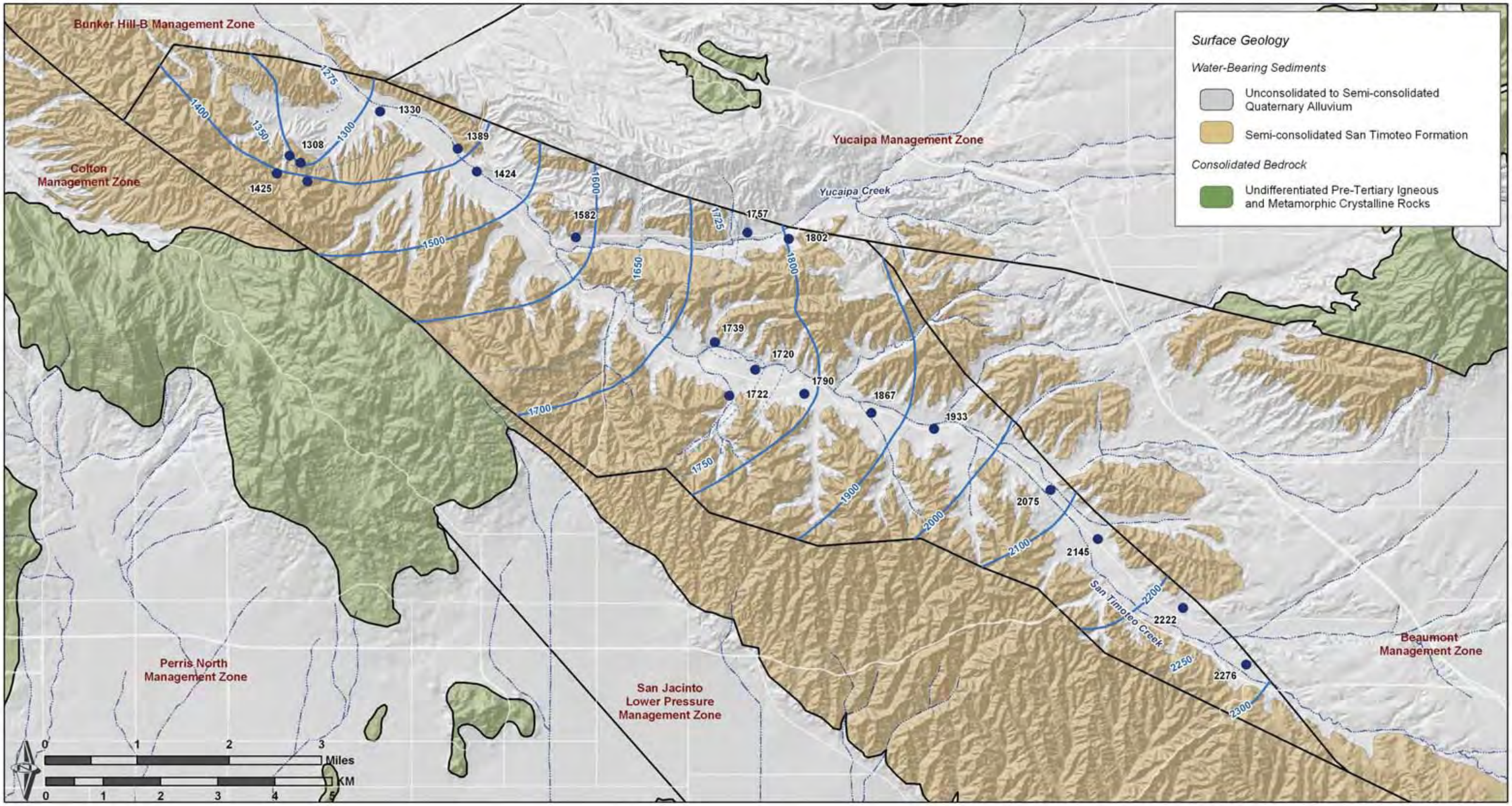
Management Zone Boundary

Rivers and Streams

Nitrate-N Concentration Contours
San Timoteo Management Zone

Figure 3

Prepared for:
City of Beaumont & YVWD



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Author: SSA/ETL
Date: 20101006
File: Draft WL Elevation Contours.mxd

2200 2250 Groundwater Level Elevation Contour (feet above mean sea level)

● 2276 Measured August 2010 Elevation

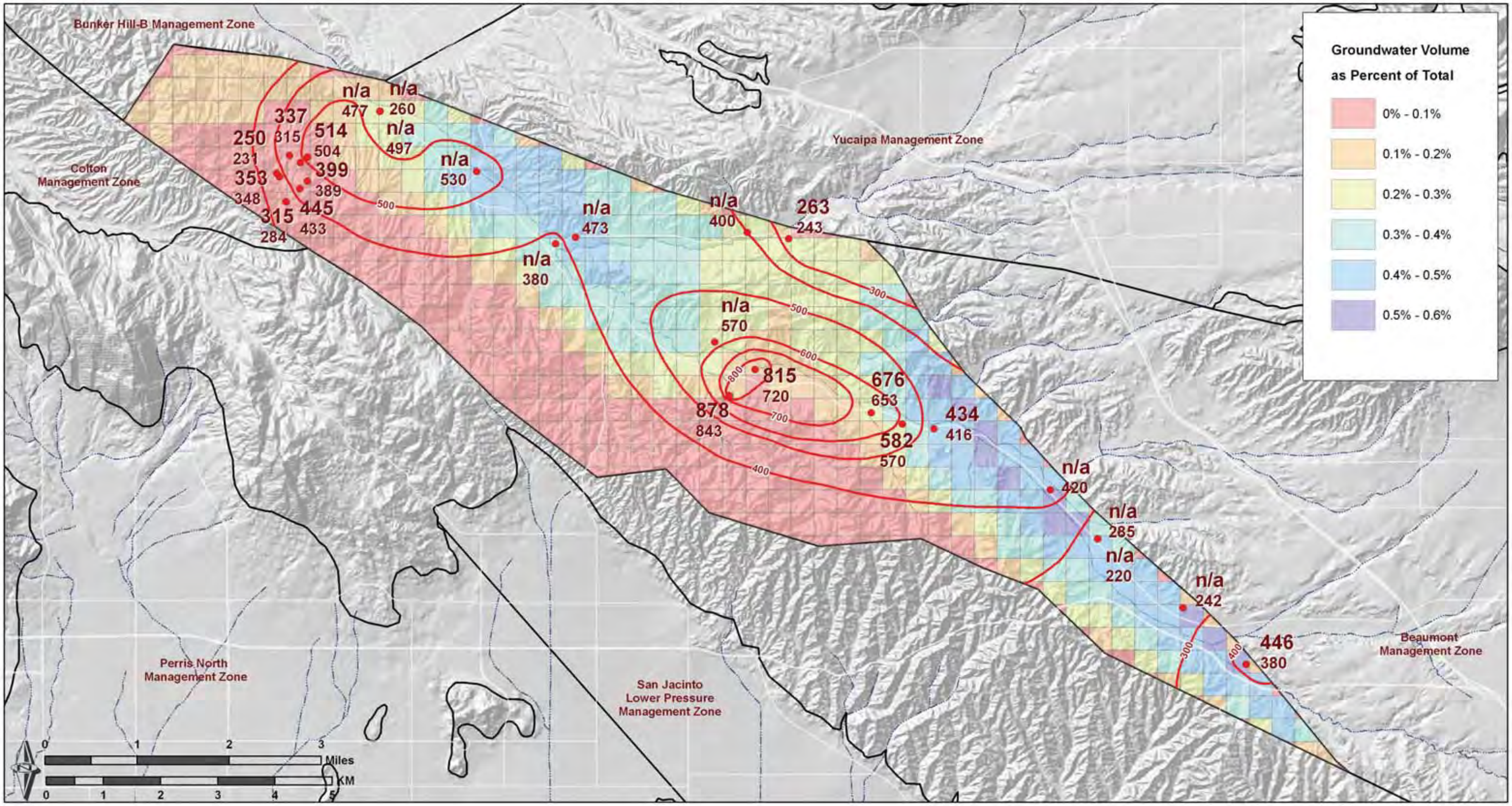
Management Zone Boundary

Rivers and Streams

Groundwater Level Elevation Contours
San Timoteo Management Zone

Figure 4

Prepared for:
City of Beaumont & YVWD



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Author: SSA/ETL
Date: 20100102б
File: TDS Contours.mxd

400 TDS Concentration Contour (mg/L)
450

446 / 380 TDS Statistic*
TDS Average
(*n/a ndicates data insufficient to compute statistic)

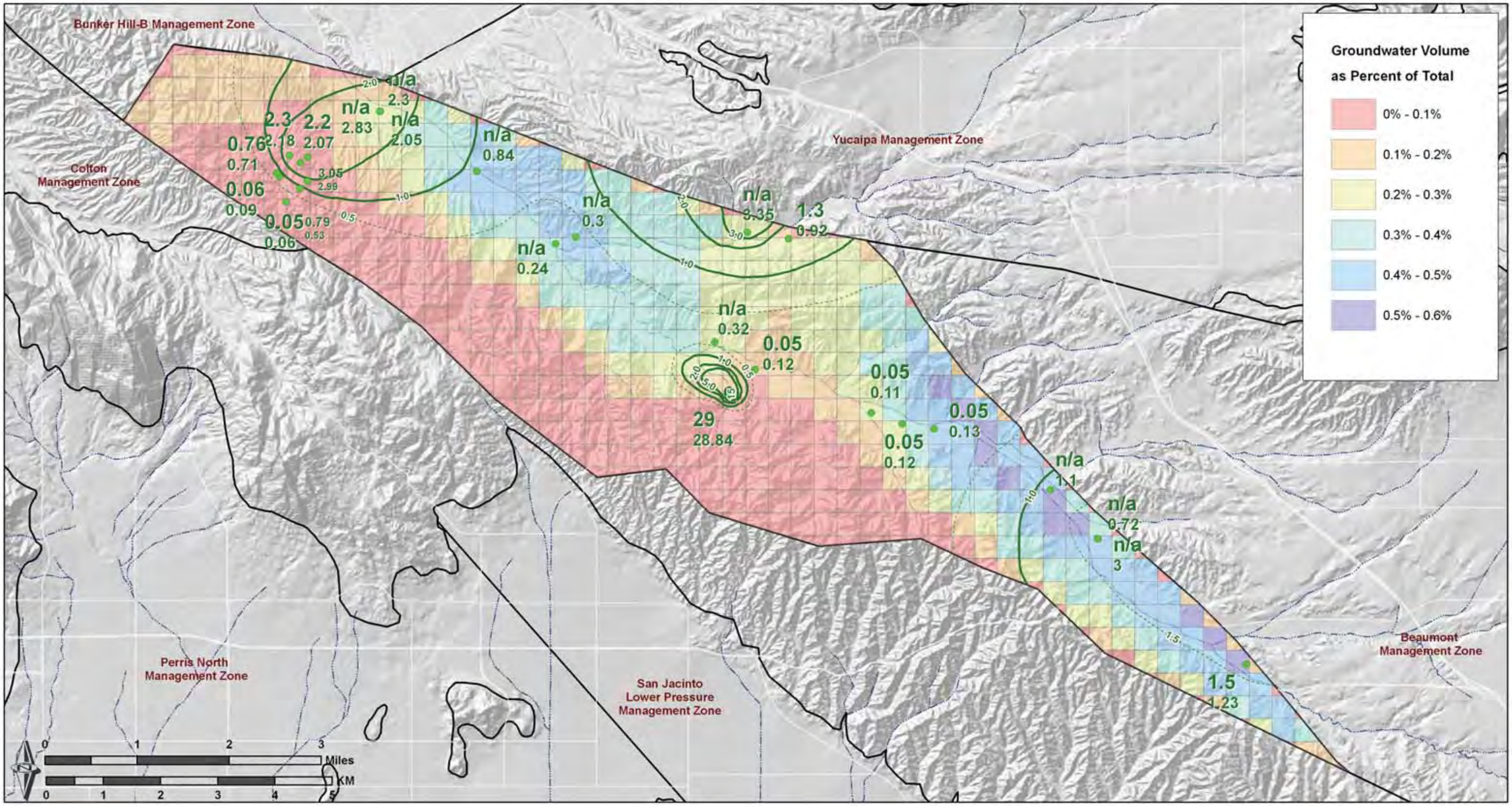
Management Zone Boundary

Rivers and Streams

TDS Concentration Contours
San Timoteo Management Zone

Figure 5

Prepared for:
City of Beaumont & YVWD



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Author: SSA/ETL
Date: 20101026
File: Nitrate-N and Volume.mxd

1.0 / 0.5 Nitrate-N Concentration Contour (mg/L)

1.5 / 1.23 Nitrate-N Statistic*
Nitrate-N Average
(*n/a ndicates data insufficient to compute statistic)

Management Zone Boundary

Rivers and Streams

Nitrate-N Concentration Contours
San Timoteo Management Zone

Figure 6

Prepared for:
City of Beaumont & YVWD