4 Basin Water Quality

4.1 DATA SOURCES

Groundwater and surface water data were compiled for the SNMP from the following sources of data:

- UWCD provided Geographical Information System (GIS) shapefiles for their monitoring wells, production wells, and surface water sampling sites. Well depth characterization, upper aquifer system or lower aquifer system, was provided included in the UWCD GIS files for UWCD monitoring wells and production wells.
- Ventura County provided GIS shapefiles for their monitoring wells, and wells registered with the County.
- UWCD provided groundwater data (1996 to 2012) collected by UWCD as well as other entities, including Ventura County and data submitted to the California Department of Public Health (CDPH) by municipal/community water purveyors.
- UWCD provided surface water quality data associated with their sampling locations. In addition, UWCD provided the data that they have compiled for a variety of sources including Ventura County, municipal water suppliers, and data provided by growers.
- Larry Walker Associates provided stormwater quality data collected as part of the Ventura Countywide Stormwater Quality Management Program.

The groundwater and surface water quality data included nitrate, TDS and chloride. Since the data were compiled from a variety of sources, there were some issues to resolve related to the analytical methods and reporting of the results, including

- TDS data – EPA Method 1601 and Standard Methods 2540C are included as approved methods in the Code of Federal Regulations (CFR) (40 CFR 136) for TDS (or total filterable residue). The majority of the TDS data were determined by one of these methods. However, some TDS values in the data set were determined by summation. These values are included in the database, but were not used in the analysis or presentation of results since summation is not an approved method.
- Nitrate data – Most of the nitrate data were reported as nitrate as nitrogen. However, some data were only reported as nitrate. In this analysis the calculated nitrate as N values were used, except in cases where the calculated values differed from the reported values. For these exceptions, the reported nitrate as N values were used.

4.2 GROUNDWATER QUALITY OVERVIEW

Detailed analysis of groundwater quality is provided in **Subsections 4.3** through **4.8**. To provide an initial overview of groundwater concentration time series and the variability of groundwater concentrations within a sub area, box and whisker plots were developed. These plots show the minimum, 25th percentile, median, 75th percentile, and maximum values from a specific basin within a specific year. The box and whisker plots are included in **Appendix A**.

4.3 HISTORIC DATA TRENDS AND EXISTING GROUNDWATER QUALITY

4.3.1 Methodology

Existing groundwater quality is estimated by subarea within sub-basins, or for the sub-basin, if it is not divided into subareas. The Piru, Fillmore and Santa Paula basins are divided into subareas pursuant to the Basin Plan. Based on descriptions in the Basin Plan, approximate subarea boundaries were developed with input from the Los Angeles RWQCB (**Figure 1-1**).

The method used to determine existing groundwater quality relies on a 17-year groundwater quality dataset (1996-2012) from monitoring, agricultural, and domestic/municipal wells. This period was selected because:

1) the more recent five year period (2008-2012) yielded a lower number of wells to use for analysis (**Table 4-1**);
2) the 5-year and 17-year dataset have a similar range of results, indicating the longer dataset is representative of conditions in the more recent period **(Table 4-2**); and
3) the 1996-2012 period is representative of the long-term precipitation record (**Table 4-3**).

Because of the absence of well depth information, an approach was taken to include all wells, regardless of depth, to identify areas of similar groundwater quality. By including wells that pump groundwater from different aquifers, there will be significant variability in some of the data, producing a corresponding measure of averaging and uncertainty in some of the analysis. Median concentrations for each well and constituent for the entire dataset (1996-2012) were calculated and plotted on maps. From the spatial distribution of median concentrations, zones of similar water quality were hand delineated. The aggregation of water quality data results in generalized water quality zones that cannot accommodate all median water quality values. Also, subarea and sub basin boundaries are sometimes assigned as contours in order to contain zones where needed.

The median concentrations for all the wells located within each zone of the subarea or sub-basin were averaged to provide an overall average concentration for the zone, shown as the larger bold numbers on the maps. Where possible, all wells were included in the averaging calculation. Only those wells that clearly stood out as having different water quality from nearby wells were excluded. Excluded wells are identified on the maps. The acreage of the zone between contours, and its average concentrations were used to estimate an area-weighted average concentration for each subarea/basin. The area-weighted average concentrations are regarded as the existing groundwater quality. The existing groundwater quality concentrations for each subarea or sub-basin are included in a table on each of the sub-basin maps that shows the distribution of water quality data and contour zones.

4.3.2 Data Statistics and Trends

To test the validity of using the median statistic, a comparison was made between the 90th percentile and the median for wells with more than 10 records. **Figure 4-1** through **Figure 4-3** show the difference between the 90th percentile and the median concentrations as relatively sized dots. These maps show that for the most part, the difference is small, except in a few localized areas, some of which are associated with WWTP percolation ponds. Those wells with the largest differences are included as charts on **Figure 4-1** through **Figure 4-3**. In some cases, the higher values occurred historically and there has since been a decreasing trend. The maps also show a lack of wells in the Mound basin because there are few wells with more than 10 water quality records. Based on the evaluation of the 90th percentile, the use of median statistics as overall existing water quality is representative.

To evaluate whether there are localized or regional groundwater quality trends, chloride, TDS, and nitrate-N concentrations for wells with more than 10 data records over the 1996-2012 period were plotted on charts. **Table 4-4** summarizes the wells identified with visually discernable chloride trends. Most wells in the LSCR are fairly stable or fluctuate without a visually discernable trend. Only 7 out of 329 wells (2% of the wells) used in the analysis had a visually discernable chloride trend and the trends were a mix of increasing and decreasing trends. The Oxnard Forebay basin has the most wells with decreasing chloride concentrations. This is because of the managed aquifer recharge operated by UWCD that has, over time, diluted salts in the basin. The locations of the wells with trends are shown on **Figure 4-4** along with the charts depicting the trend. In general, other than the Oxnard Forebay basin, no other subarea or basin has an overall increasing or decreasing trend, however, there may be localized areas of increasing or decreasing concentrations.

Table 4-1. Summary of Total Number of Wells and Data Points (in parentheses) Available for Water Quality Analysis

Basin	Subarea	TDS		Chloride		Nitrate-N	
		2008-2012	1996-2012	2008-2012	1996-2012	2008-2012	1996-2012
Piru	Below Lake Piru	0	0	0	0	0	0
	East of Piru Creek	5 (30)	5 (57)	5 (33)	6 (63)	5 (25)	6 (53)
	West of Piru Creek	17 (148)	38 (332)	36 (213)	44 (406)	36 (171)	43 (229)
Fillmore	Pole Creek Fan	10 (57)	20 (144)	13 (63)	23 (149)	13 (92)	24 (217)
	Remaining Fillmore	11 (47)	23 (144)	20 (68)	30 (166)	21 (100)	32 (262)
	South Fillmore	3 (19)	15 (72)	10 (44)	19 (99)	10 (48)	19 (108)
Santa Paula	East of Peck Rd	6 (26)	37 (638)	33 (221)	39 (656)	33 (204)	39 (625)
	West of Peck Rd	7 (57)	46 (456)	32 (234)	46 (445)	28 (171)	41 (229)
Mound		19 (139)	19 (139)	20 (139)	27 (139)	13 (92)	21 (217)
Oxnard Forebay		16 (124)	100 (2809)	77 (793)	95 (2231)	71 (658)	98 (8718)
	Total	**94 (647)**	**303 (4791)**	**246 (1808)**	**329 (4354)**	**230 (1607)**	**323 (10,859)**
Percent of 1996-2012 Wells		**31%**		**75%**		**71%**	

Table 4-2. Range of Medians in Wells for 1996-2012 and 2008-2012 Data Periods

Basin	Subarea	TDS		Chloride		Nitrate-N	
		2008-2012	1996-2012	2008-2012	1996-2012	2008-2012	1996-2012
Piru	Below Lake Piru	-	-	-	-	-	-
	East of Piru Creek	892-1250	892-1180	108-141	108-146	1.58-3.32	1.58-3.96
	West of Piru Creek	660-1435	660-2360	38-129	36-125	0.84-22	0.82-22
Fillmore	Pole Creek Fan	760-1855	660-1660	40-75	35-72	1.11-7.59	0.09-7.59
	Remaining Fillmore	640-1030	490-1290	12-64	6-64	0.79-20.89	0.79-22.18
	South Fillmore	961-1580	940-2280	51-190	40-195	0.5-20.07	0.5-20.07
Santa Paula	East of Peck Rd	650-1620	390-2305	11-116	5-120	0.1-11.44	0.1-11.97
	West of Peck Rd	660-1435	660-2360	46-184	47-164	0.05-6.91	0.05-7.59
Mound		900-6180	910-6180	45-498	44-482	0.13-47.52	0.16-38.14
Oxnard Forebay		724-1970	530-1970	0-155	36-155	0.18-24.61	0.14-22.81

Table 4-3. Precipitation Averages for 1996-2012 and Full Record Periods

Station	Period of Data Record	Full Record Average (inches)	Water Year 1980-2012 Average (inches)	Water Year 1996-2012 Average (inches)
El Rio-UWCD Spreading Grounds #239	10/01/1972 - 09/30/2012	15.8	15.8	15.6
Ventura-Hall Canyon #167	10/01/1956 - 09/30/2012	16.2	16.9	16.9
Santa Paula-UWCD #245, 245A, 245B	10/01/1960 - 09/30/1986	18.4	18.9	18.5
Ventura-County Government Center #222A	10/01/1977 - 09/30/2012	17.5	16.9	16.6
Fillmore-Fish Hatchery #171	10/01/1956 - 09/30/2012	18.8	19.6	18.6
Piru-Newhall Ranch #025	10/01/1927 - 09/30/2012	17.4	18.4	17.3
Piru-Temescal Guard Station #160	10/01/1949 - 09/30/2012	20.5	21.5	20.7

Table 4-4. Summary of Chloride Concentration Trends,1996-2012

Basin	Well	Chloride Concentration Trends	
		Decreasing	Increasing
Piru	04N18W20M03S	X	
	04N18W20P02S		X
	04N18W20R01S	X	
Fillmore	No wells with trends		
Santa Paula	02N22W02K09S		X
Mound	No wells with trends		
Oxnard Forebay	02N22W23B03S	X	
	02N22W14F03S	X	
	02N22W14G04S	X	

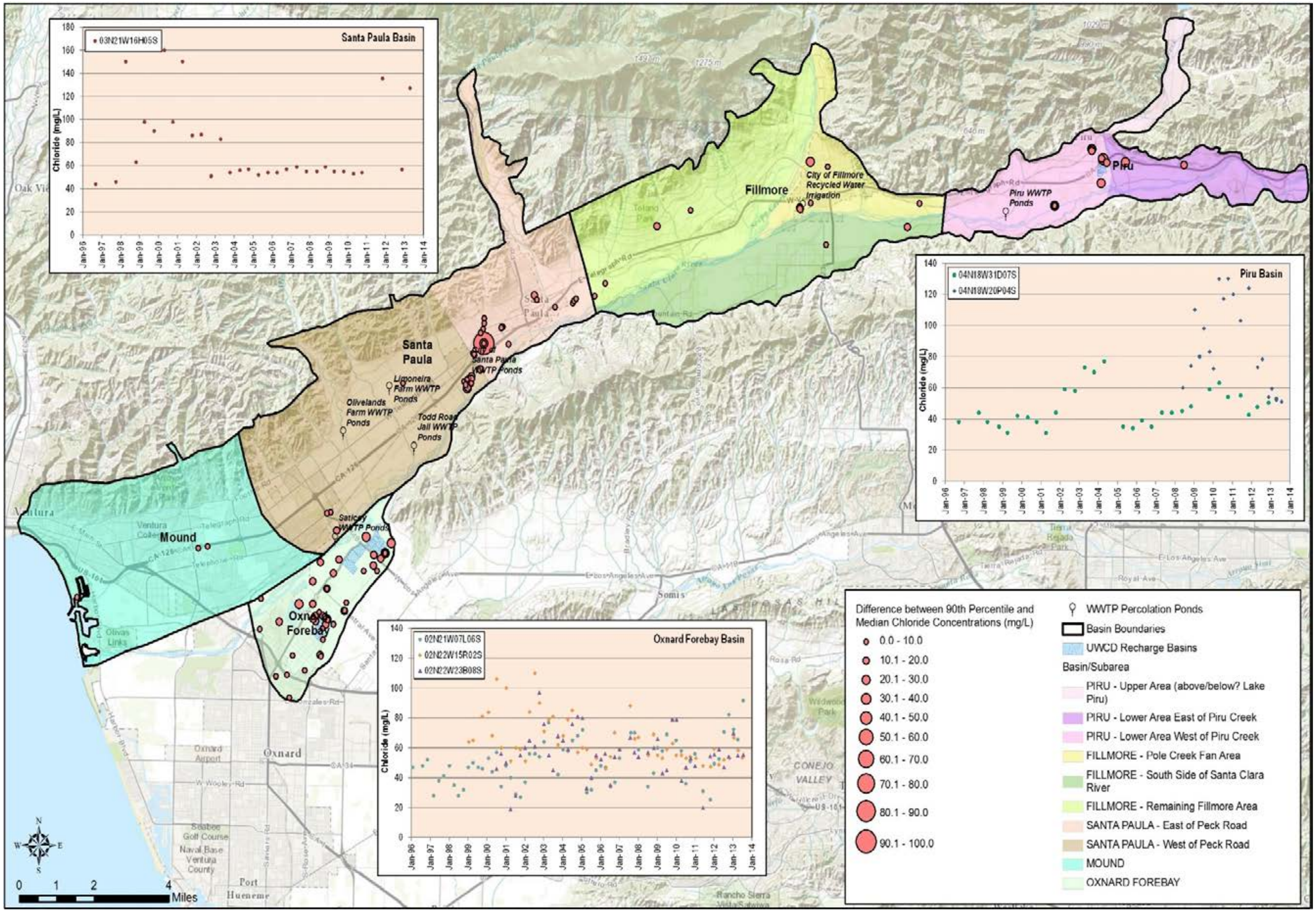


Figure 4-1 Difference between Chloride 90th Percentile and Median Concentrations

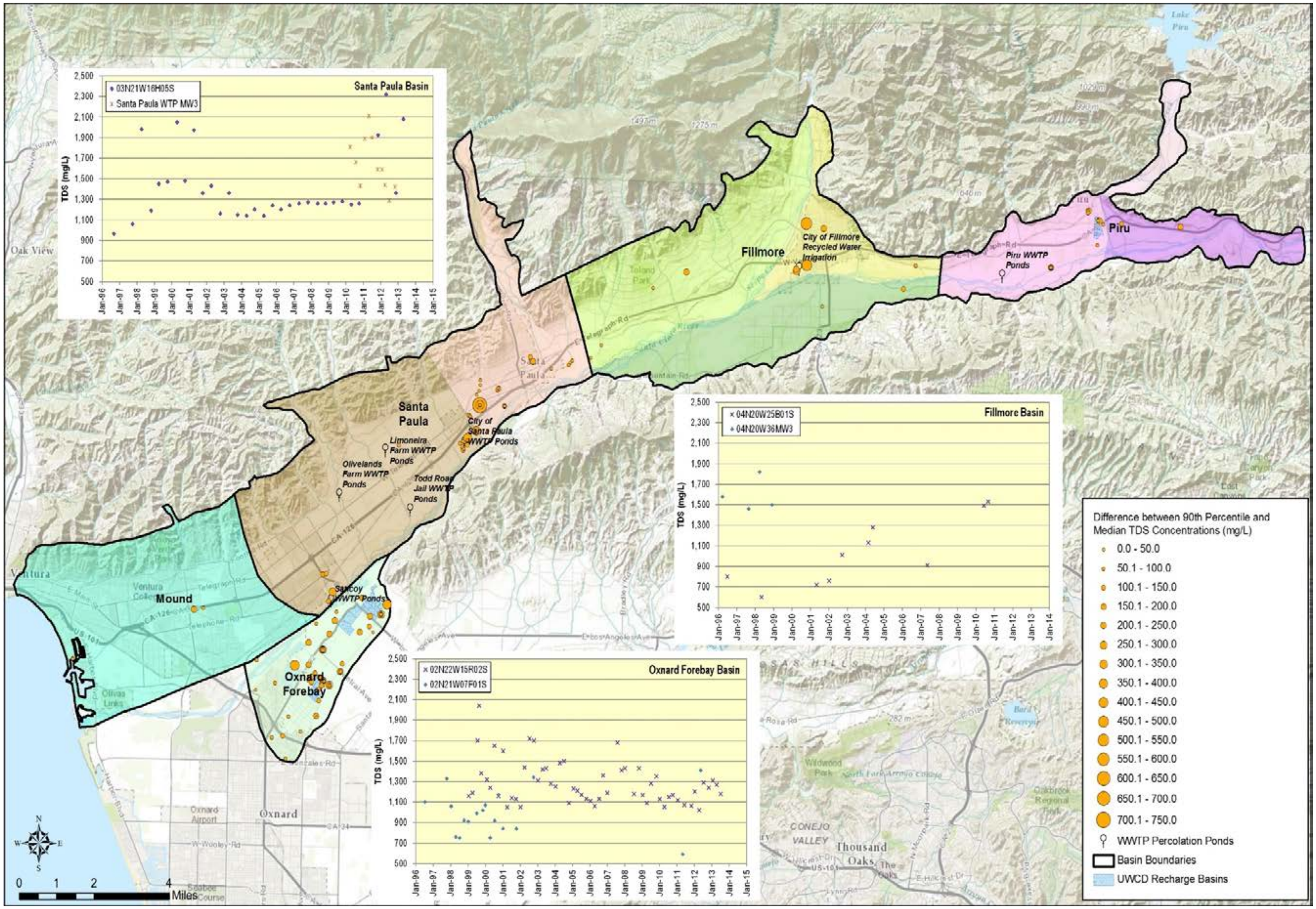


Figure 4-2 Difference between TDS 90th Percentile and Median Concentrations

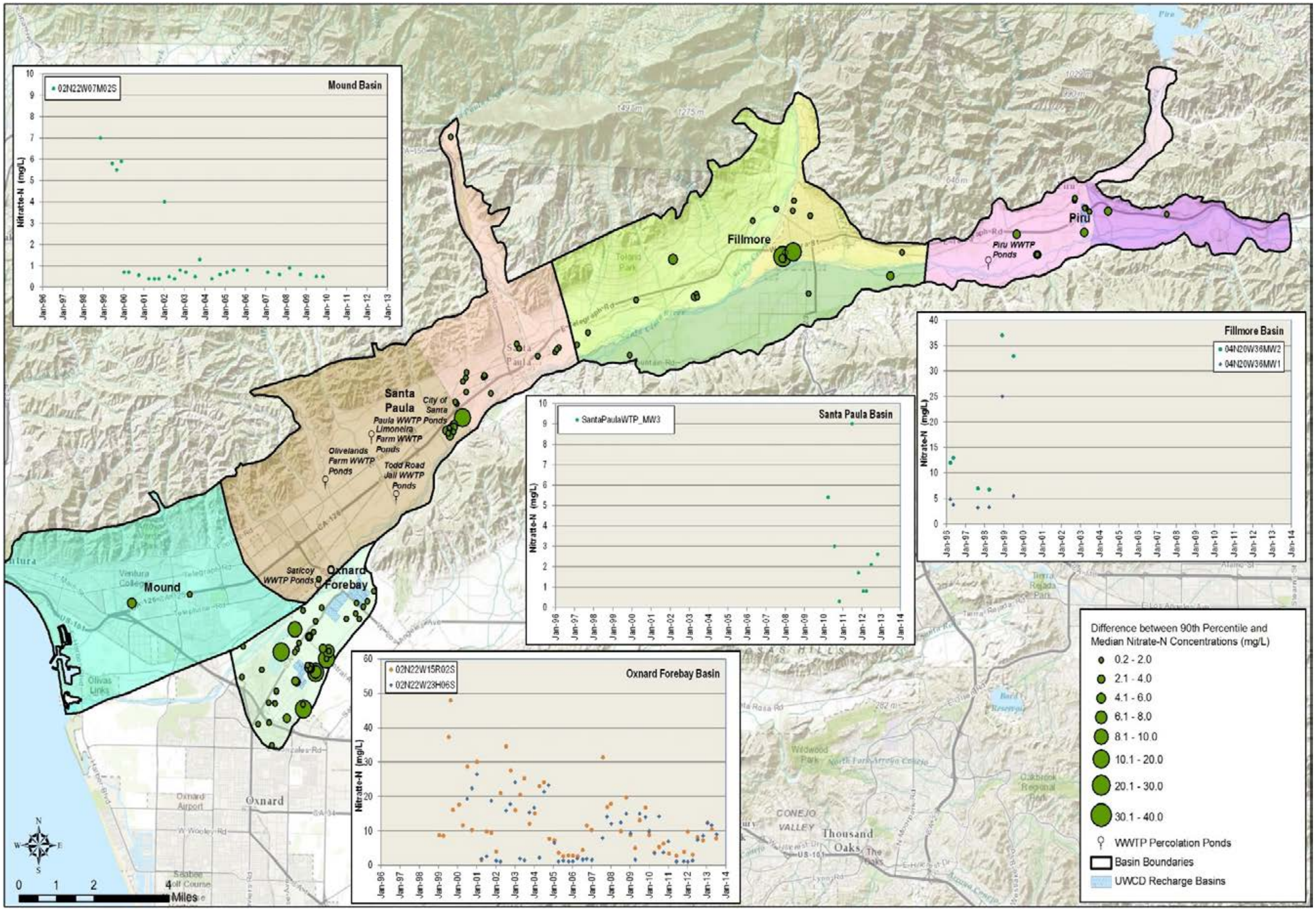


Figure 4-3 Difference between Nitrate-N 90th Percentile and Median Concentrations

Table 4-5 summarizes the wells identified with visually discernible TDS trends. Most wells in the LSCR are fairly stable or fluctuate without a visually discernible trend. Only 8 out of 303 wells (2.6% of the wells) used in the analysis had a visually discernable TDS trend and the trends were a mix of increasing and decreasing trends. The Oxnard Forebay basin has the most wells with decreasing TDS concentrations. This is because of the managed aquifer recharge operated by UWCD that has, over time, diluted salts in the basin. The locations of the wells with trends are shown on **Figure 4-5** along with the charts depicting the trend. In general, other than the Oxnard Forebay basin, no other subarea or basin has an overall increasing or decreasing trend, however, there may be localized areas of increasing or decreasing concentrations.

Table 4-5: Summary of TDS Concentration Trends, 1996-2012

Basin	Well	TDS Concentration Trends	
		Decreasing	Increasing
Piru	none		
Fillmore	04N19W30D01S		X
	04N19W33B01S	X	
Santa Paula	02N22W02K09S		X
Mound	02N22W08F01S		X
Oxnard Forebay	02N22W23B06S	X	
	02N22W15R02S	X	
	02N22W11J01S		X
	02N22W14G04S	X	

Table 4-6 summarizes the wells identified with visually discernible nitrate-N trends. The locations of wells with trends are shown on **Figure 4-6**. Only 13 out of 323 wells (4%) of the wells used in the analysis had a visually discernable nitrate-N trend and the trends were a mix of increasing and decreasing trends. In the Oxnard Forebay basin, many wells exhibit nitrate-N concentration fluctuations that correlate with groundwater levels, as shown on **Figure 4-21**. This figure shows nitrate-N concentrations increasing when groundwater levels are low and concentrations decreasing when groundwater levels rise during active recharge at the UWCD recharge basins. The nitrate-N fluctuations are seasonal and respond rapidly to changes in recharge. In general, no subarea or basin has an overall increasing or decreasing trend, however, there may be localized areas of increasing or decreasing concentrations.

Table 4-6 Summary of Nitrate-N Concentration Trends, 1996-2012

Basin	Well	Nitrate-N Concentration Trends	
		Decreasing	Increasing
Piru	04N18W31D03S		X
	04N18W31D05S	X	
Fillmore	03N20W06N02S	X	
	04N19W33B01S		X
	04N20W25B01S		X
Santa Paula	03N21W16A02S		X
	03N21W16H06S	X	
	03N21W15G01S	X	
	03N21W15C04S		X
	03N21W16H07S	X	
	03N21W11F03S		X
Mound	02N22W08G01S		X
Oxnard Forebay	02N22W15R02S	X	

The following subsections discuss the development of existing water qualities for each subarea or basin in more detail.

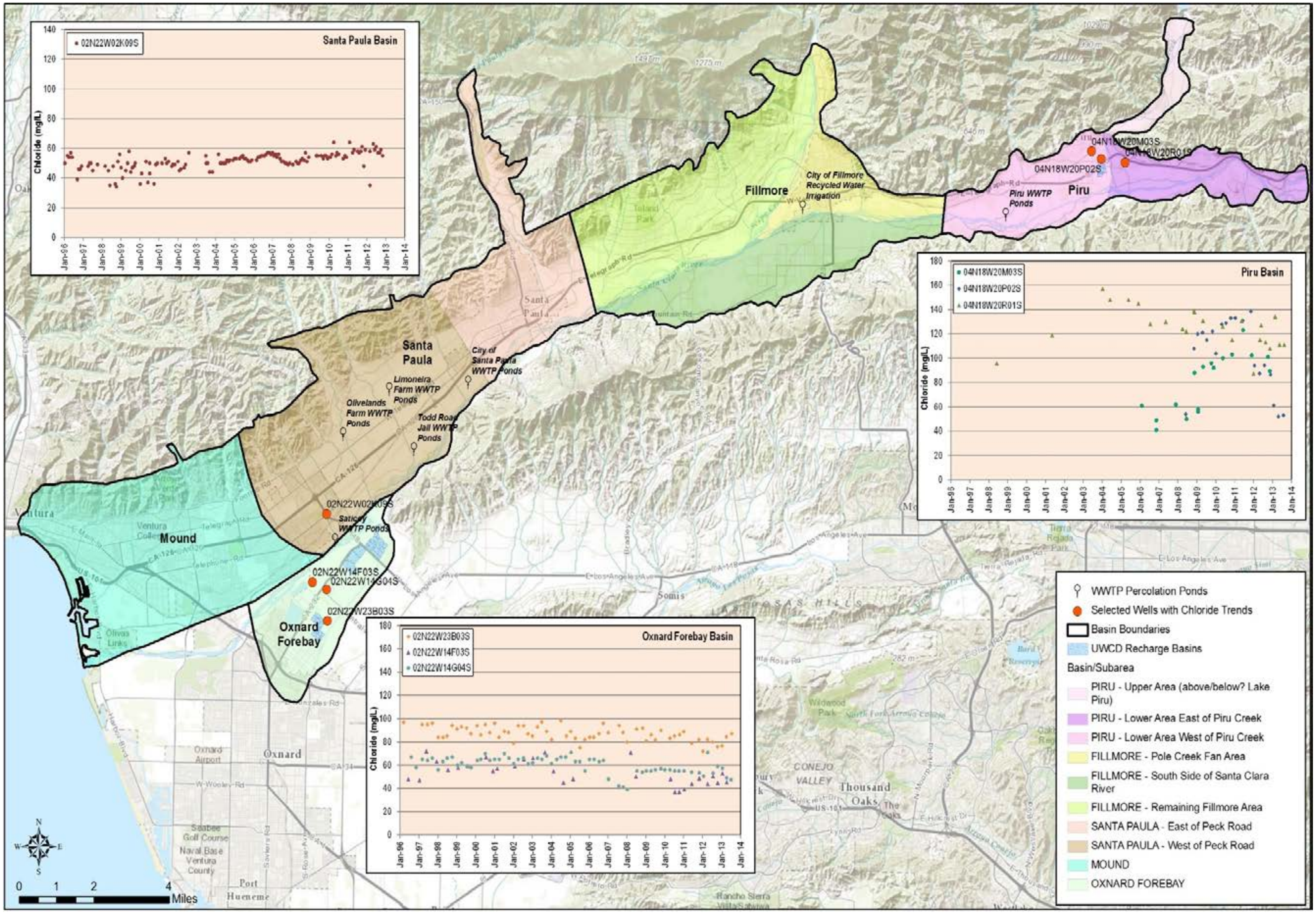


Figure 4-4 Wells with Chloride Trends

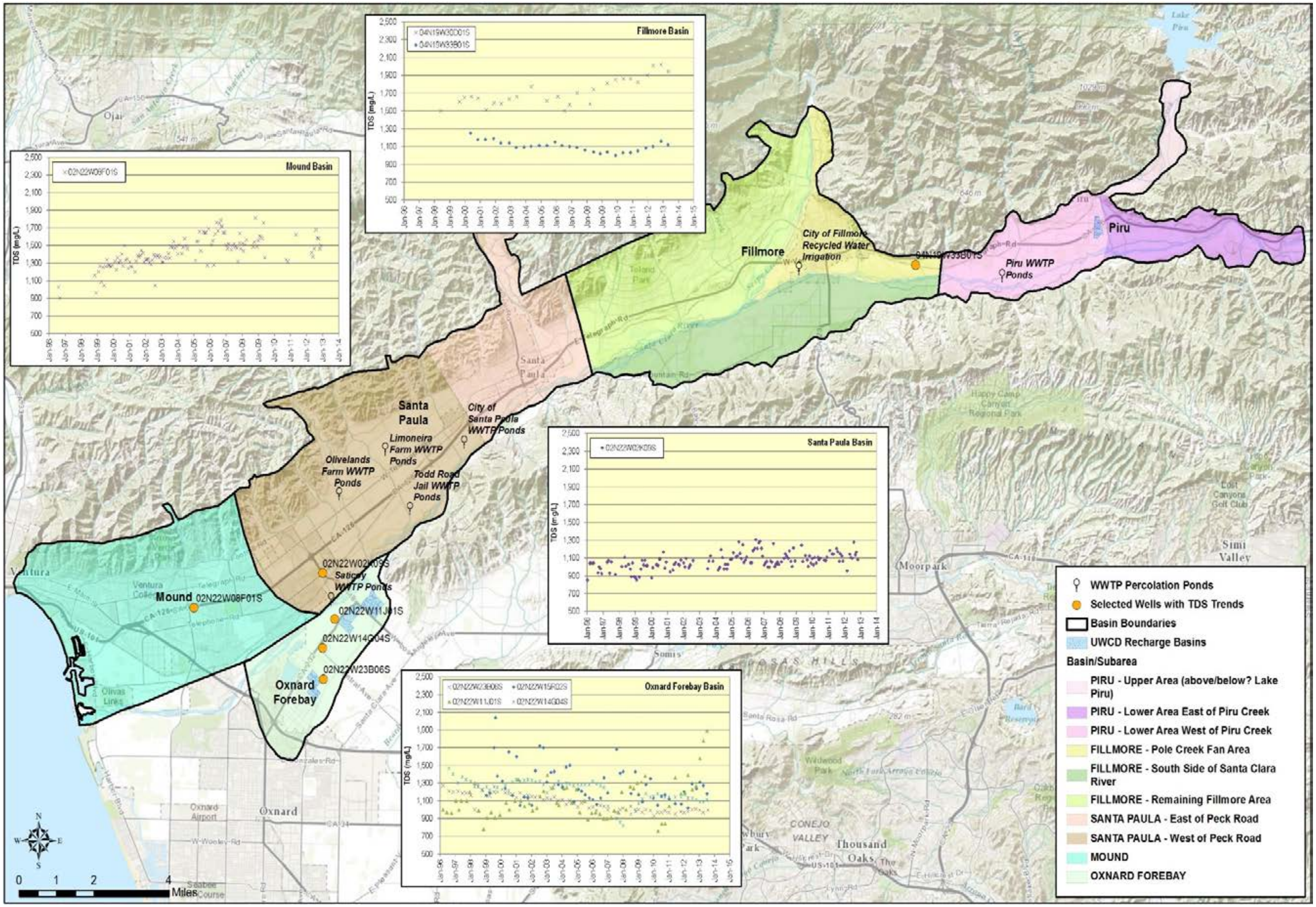


Figure 4-5 Wells with TDS Trends

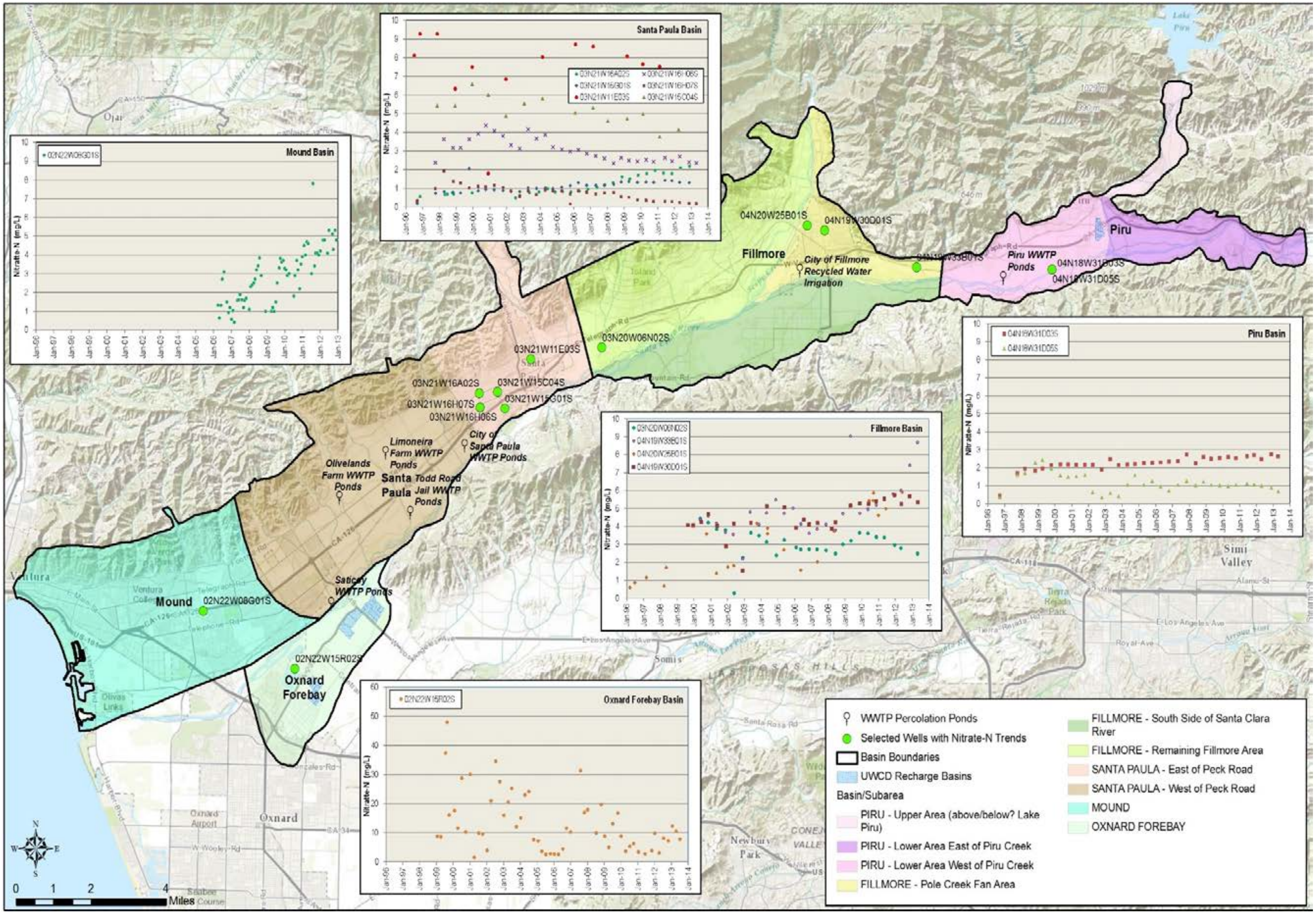


Figure 4-6 Wells with Nitrate-N Trends

4.4 PIRU BASIN

The Piru basin has three subareas: east of Piru Creek, west of Piru Creek, and below Lake Piru. **Figure 4-7** through **Figure 4-9** show the groundwater quality for the Piru basin. A table listing the existing groundwater quality of the constituents is included on each map

4.4.1 Piru Basin – East of Piru Creek Subarea

4.4.1.1 Chloride Existing Water Quality

As shown by the distribution of wells in the east of Piru Creek subarea, data are limited to the western portion of the subarea (**Figure 4-7**). To fill in the area where no wells exist to provide water quality control, water quality from the SCR adjacent to that area was used to extend the groundwater quality zones to the east. Santa Clara River water chloride and TDS in the far eastern Piru Basin has been found to correlate directly with chloride and TDS in wells in the Camulos Ranch area (UWCD, 2006). Surface water in this location and upstream to the county line is the sole significant source of recharge to the underlying groundwater (UWCD, 2006), which supports the assumption that the surface water quality can be used to define existing groundwater quality in the eastern part of the subarea. A time-series plot of SCR chloride concentrations in the eastern portion of Piru basin at Newhall Crossing is provided in **Figure 4-10**.

In general, the highest chloride concentrations in the east of Piru Creek subarea occur in the northwestern and eastern portions of the subarea, with lower concentrations in the southern portion (**Figure 4-7**). The source of elevated chloride concentrations in the subarea is predominantly from streambed percolation of SCR water that flows from Los Angeles County. Most of the subarea's groundwater pumping takes place in the area with the highest chloride concentrations. Tributary flow introduces low chloride recharge water which is the cause of lower chloride in the eastern portion of the subarea. The estimated existing groundwater quality of chloride for the east of Piru Creek subarea of the Piru basin is 118 mg/L.

4.4.1.2 TDS Existing Water Quality

Similar to chloride, in the absence of wells in the eastern portion of the subarea, TDS groundwater concentrations were correlated from surface water quality. **Figure 4-11** provides a time-series plot of TDS in the SCR at Newhall Crossing.

The distribution of TDS similarly follows the distribution of chloride in the subarea; highest concentrations occurring in the northern and eastern portions of the subarea and lower concentrations in the south. The estimated existing groundwater quality of TDS for the east of Piru Creek subarea of the Piru basin is 1,000 mg/L.

4.4.1.3 Nitrate-N Existing Water Quality

Nitrate-N data for the subarea is limited to the western portion with only five well locations available (**Figure 4-9**). Nutrient sources other than the SCR occur in the eastern portion of the subarea. This precludes the use of surface water to provide control for contouring nitrate-N where groundwater control is lacking, as was done for chloride and TDS. In general, nitrate-N concentrations in the east of Piru Creek subarea are less than 5 mg/L with a range between 1.6 and 4.0 mg/L. The estimated existing groundwater quality of nitrate-N for the east of Piru Creek subarea of the Piru basin is 2.6 mg/L.

4.4.2 Piru Basin – West of Piru Creek Subarea

4.4.2.1 Chloride Existing Water Quality

Chloride concentrations decrease westward as Piru Creek recharge dilutes higher concentrations from the eastern portion of the subarea and the east of Piru Creek subarea (**Figure 4-8**). At the western edge of the subarea, chloride concentrations are approximately 60 mg/L. The estimated existing groundwater quality of chloride for the west of Piru Creek subarea of the Piru basin is 69 mg/L.

4.4.2.2 TDS Existing Water Quality

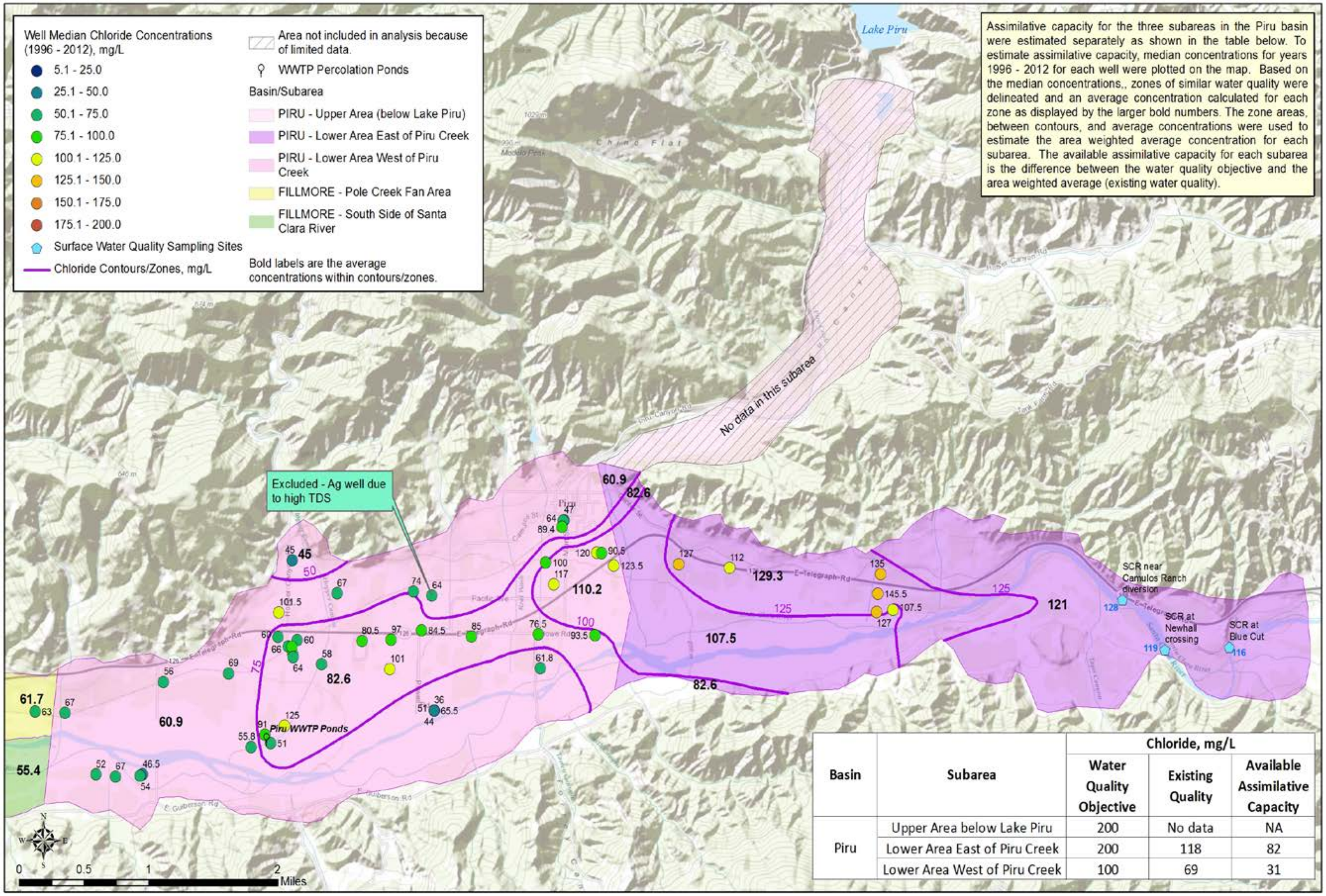
TDS in the west of Piru Creek subarea is generally less than 1,000 mg/L, except in the central portion of the subarea and in focused areas just west of Hopper Canyon and in the area where Piru WWTP percolates its recycled wastewater north of the SCR (**Figure 4-8**). The largest area of TDS concentrations greater than 1,000 mg/L is north of the SCR. The cause of localized high TDS west of Hopper Canyon is unknown. The estimated existing groundwater quality of TDS for the west of Piru Creek subarea of the Piru basin is 992 mg/L.

4.4.2.3 Nitrate-N Existing Water Quality

The greatest nitrate-N concentrations are found in the central portion of the subarea where concentrations are still relatively low and generally range between 4 and 10 mg/L (**Figure 4-9**). Nitrate-N concentrations decrease away from the central area towards the basin edges, where concentrations are generally 1 to 2 mg/L or less. The estimated existing groundwater quality of nitrate-N for the west of Piru Creek subarea of the Piru basin is 3.6 mg/L.

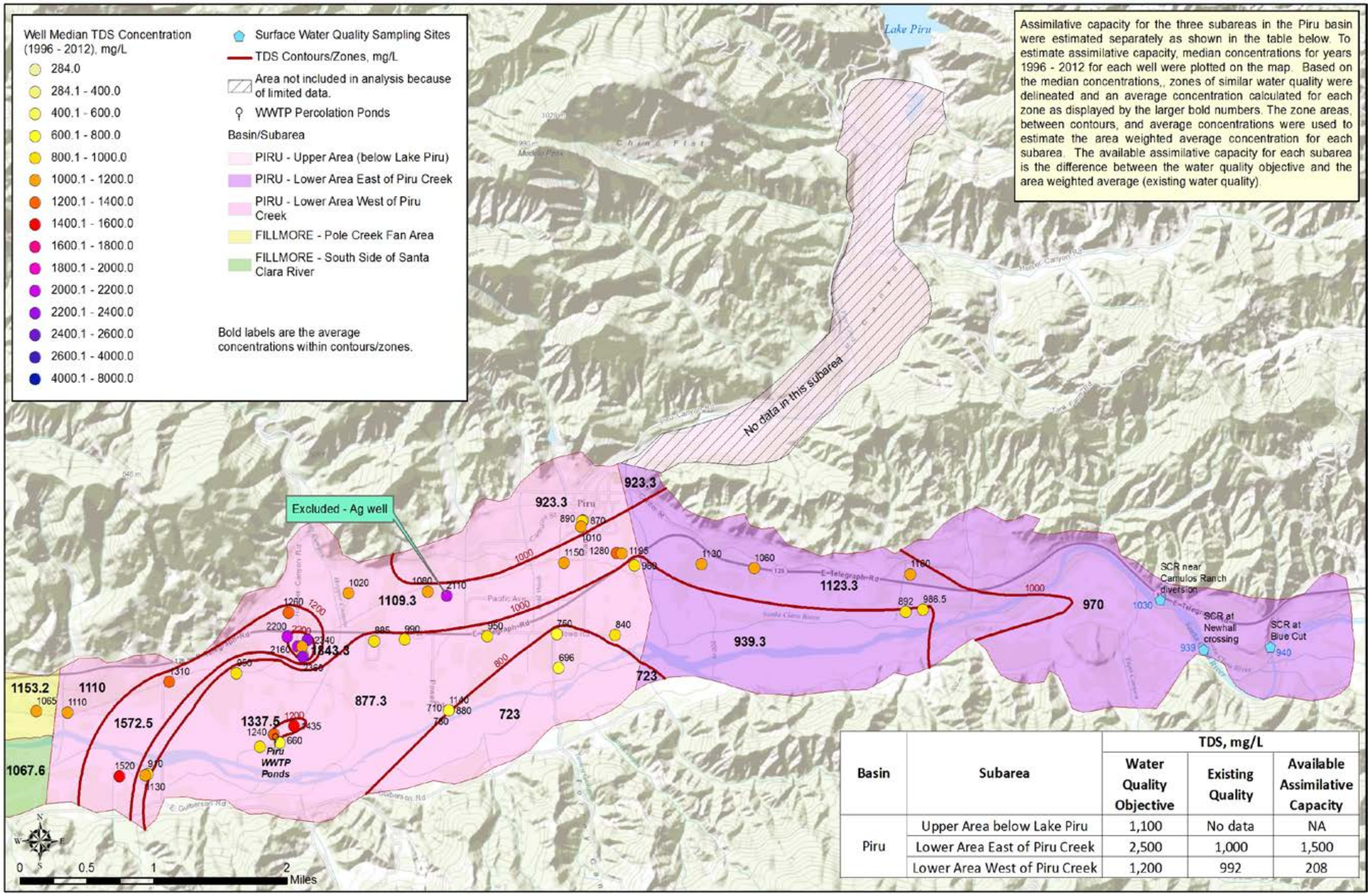
4.4.3 Piru Basin – Below Lake Piru Subarea

No groundwater quality data exist for this subarea for the period between 1996 and 2012. Existing monitoring well information will be further reviewed with stakeholders to determine if there is an appropriate location to use to extend the spatial distribution for water quality analysis. If there is not an existing appropriate location, data from the lower area west of Piru Creek will be used to assess the water quality in this subarea.



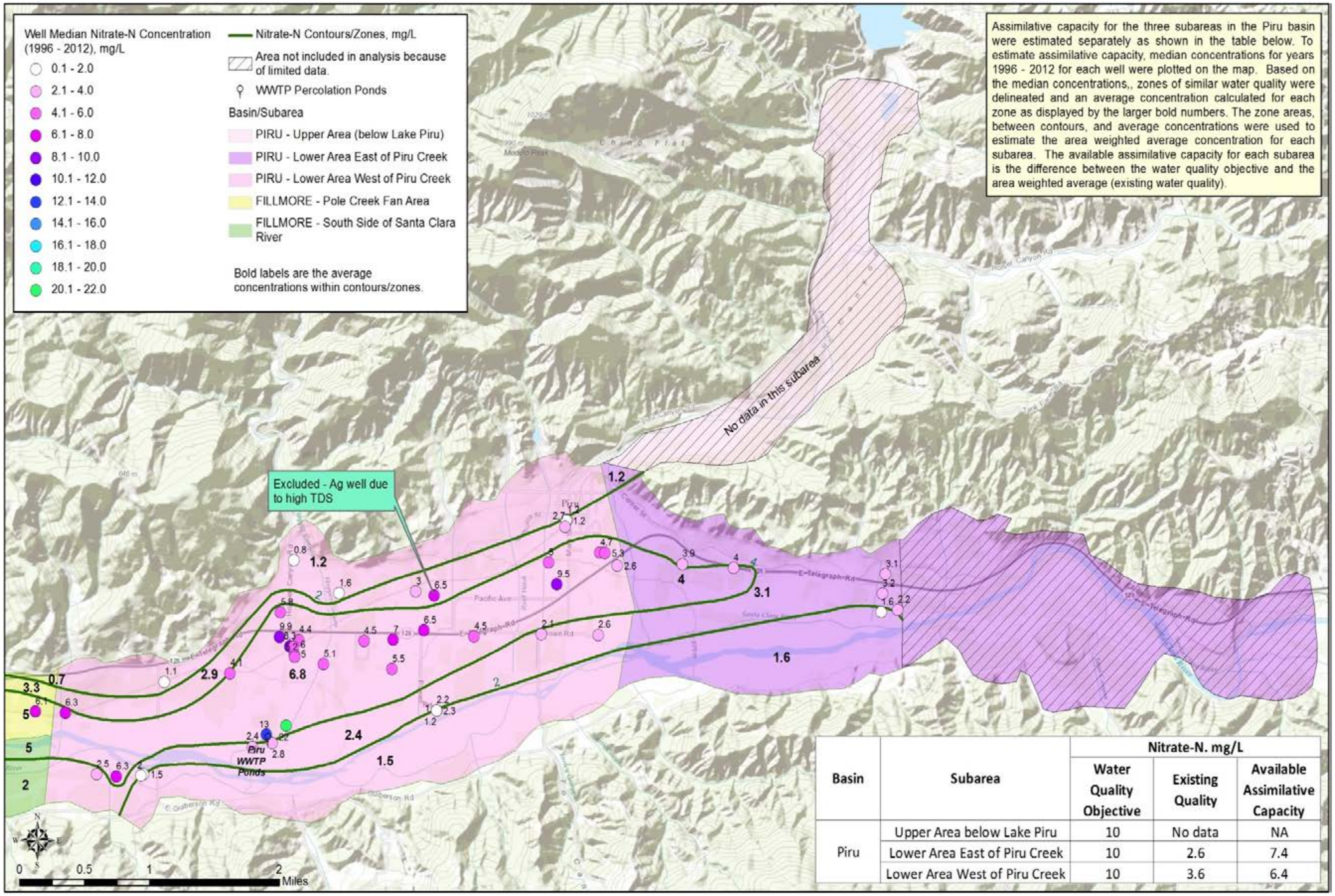
Basin	Subarea	Chloride, mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	200	No data	NA
	Lower Area East of Piru Creek	200	118	82
	Lower Area West of Piru Creek	100	69	31

Figure 4-7 Chloride Existing Water Quality of Piru Basin



Basin	Subarea	TDS, mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	1,100	No data	NA
	Lower Area East of Piru Creek	2,500	1,000	1,500
	Lower Area West of Piru Creek	1,200	992	208

Figure 4-8 TDS Existing Water Quality of Piru Basin



Basin	Subarea	Nitrate-N. mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Piru	Upper Area below Lake Piru	10	No data	NA
	Lower Area East of Piru Creek	10	2.6	7.4
	Lower Area West of Piru Creek	10	3.6	6.4

Figure 4-9 Nitrate-N Existing Water Quality of Piru Basin

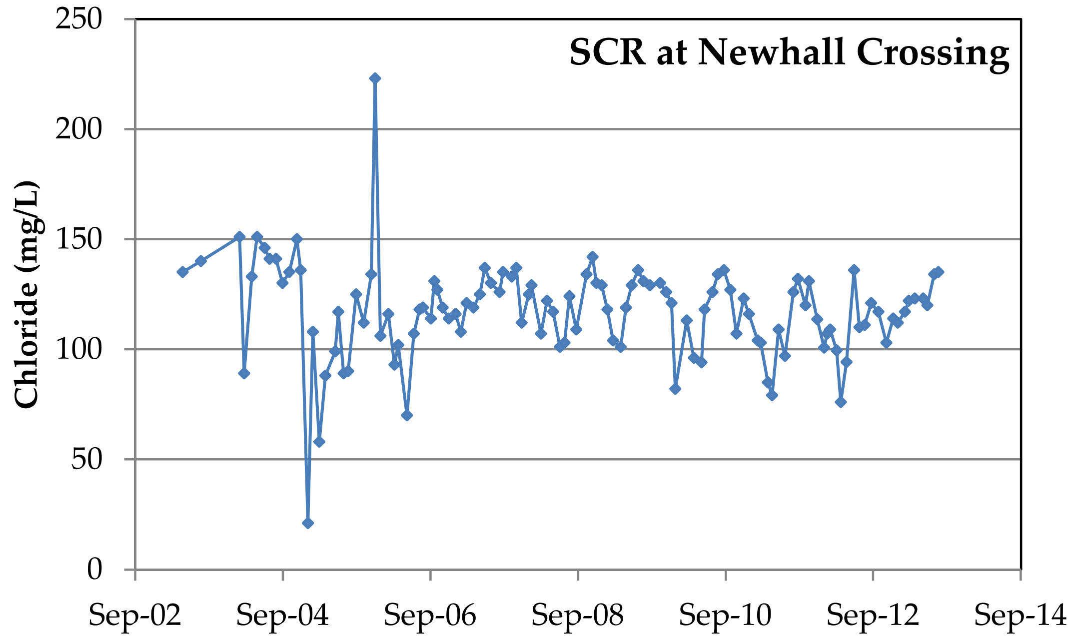


Figure 4-10 Historical Chloride Concentrations at Santa Clara River at Newhall Crossing

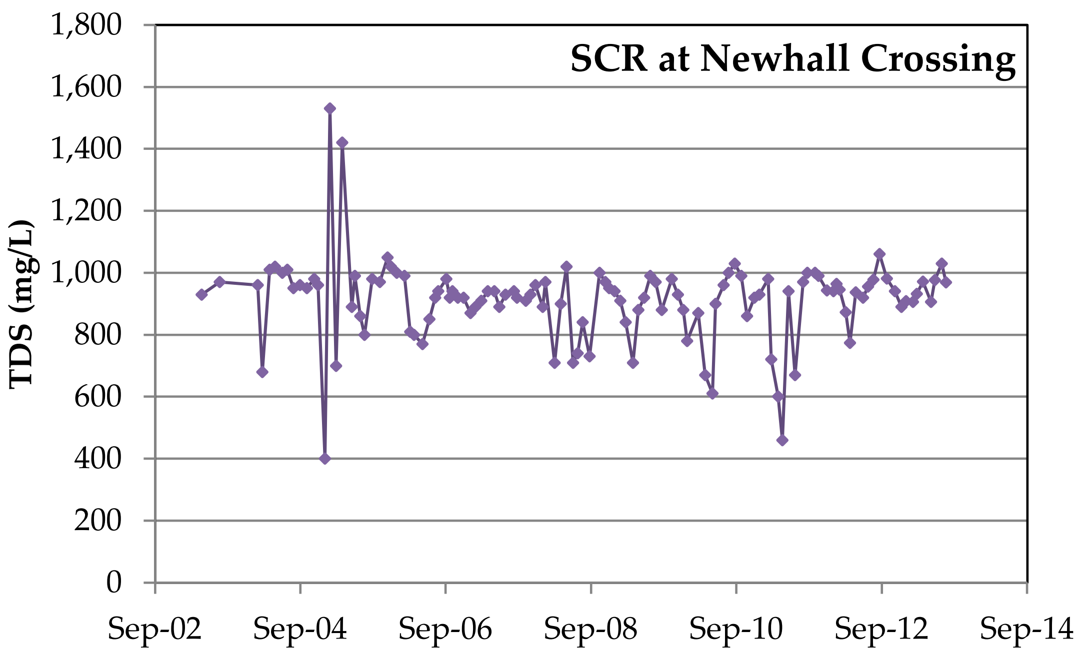


Figure 4-11 Historical TDS Concentrations at Santa Clara River at Newhall Crossing

4.5 FILLMORE BASIN

The Fillmore basin has three subareas: Pole Creek Fan Area, south side of Santa Clara River, and remaining Fillmore area. **Figure 4-12** through **Figure 4-14** show the groundwater quality for the Fillmore basin. A table listing the existing groundwater quality of the constituents is included on each map.

4.5.1 Fillmore Basin – Pole Creek Fan Area Subarea

4.5.1.1 Chloride Existing Water Quality

Chloride concentrations in the Pole Creek Fan area are fairly consistent and range between 46 and 72 mg/L (**Figure 4-12)**. There is one small area in the western portion of the subarea that straddles Sespe Creek which has lower chloride concentrations than the rest of the subarea. The estimated existing groundwater quality of chloride for the Pole Creek Fan Area subarea of the Fillmore basin is 59 mg/L.

4.5.1.2 TDS Existing Water Quality

The subarea generally has uniform TDS ranging between 900 and 1,300 mg/L (**Figure 4-13**). The exception is a small area in the north, defined by just two wells, that overlaps somewhat with the low chloride area described above and overlies the urban area of the City of Fillmore. The TDS concentration in this area is higher than the surrounding areas, unlike the chloride concentrations which are lower than the surrounding area. The estimated existing groundwater quality of TDS for the Pole Creek Fan Area subarea of the Fillmore basin is 1,101 mg/L.

4.5.1.3 Nitrate-N Existing Water Quality

Nitrate-N concentrations across the Pole Creek Fan subarea increase towards the southwest from just under 1 mg/L to approximately 4 mg/L (**Figure 4-14**). Much of the subarea is underlain by the urban landscape of the City of Fillmore. Higher nitrate-N concentrations in the central portion of the Piru basin extend across the Piru/Fillmore boundary into a small area of the easternmost portion of the Pole Creek Fan area subarea. None of the median concentrations in the subarea exceed 7 mg/L. The estimated existing groundwater quality of nitrate-N for the Pole Creek Fan Area subarea of the Fillmore basin is 2.9 mg/L.

4.5.2 Fillmore Basin – South Side of Santa Clara River Subarea

4.5.2.1 Chloride Existing Water Quality

The highest chloride concentrations of the subarea are found along the southern boundary of the subarea (**Figure 4-12**). Here concentrations are in excess of 190 mg/L. Because only the southern portion of the subarea has elevated chloride despite similar land use across the subarea, connate water that was trapped during deposition of the basin’s sediments is its most likely cause.

Chloride concentrations decrease northwards towards the SCR where concentrations generally range between 50 and 70 mg/L. Recharge of lower chloride surface water by streambed percolation in the SCR has most likely diluted the connate water occurring in the aquifers of the subarea closer to the river. The estimated existing groundwater quality of chloride for the South Side of Santa Clara River subarea of the Fillmore basin is 74 mg/L.

4.5.2.2 TDS Existing Water Quality

Similar to chloride concentrations, TDS concentrations are highest along the southern boundary of the subarea and decrease towards the SCR (**Figure 4-13**). The dilution mechanisms for TDS are the same as those described above for chloride. The estimated existing groundwater quality of TDS for the South Side of Santa Clara River subarea of the Fillmore basin is 1,411 mg/L.

4.5.2.3 Nitrate-N Existing Water Quality

From east to west, nitrate-N concentrations increase towards the central portion of the south side of SCR subarea (**Figure 4-14**) here concentrations can reach 12 mg/L. West of central portion of elevated concentrations, nitrate-N in the subarea decreases again towards the subarea's western boundary to just over 2 mg/L. The estimated existing groundwater quality of nitrate-N for the South Side of Santa Clara River subarea of the Fillmore basin is 5.6 mg/L.

4.5.3 Fillmore Basin – Remaining Fillmore Area Subarea

4.5.3.1 Chloride Existing Water Quality

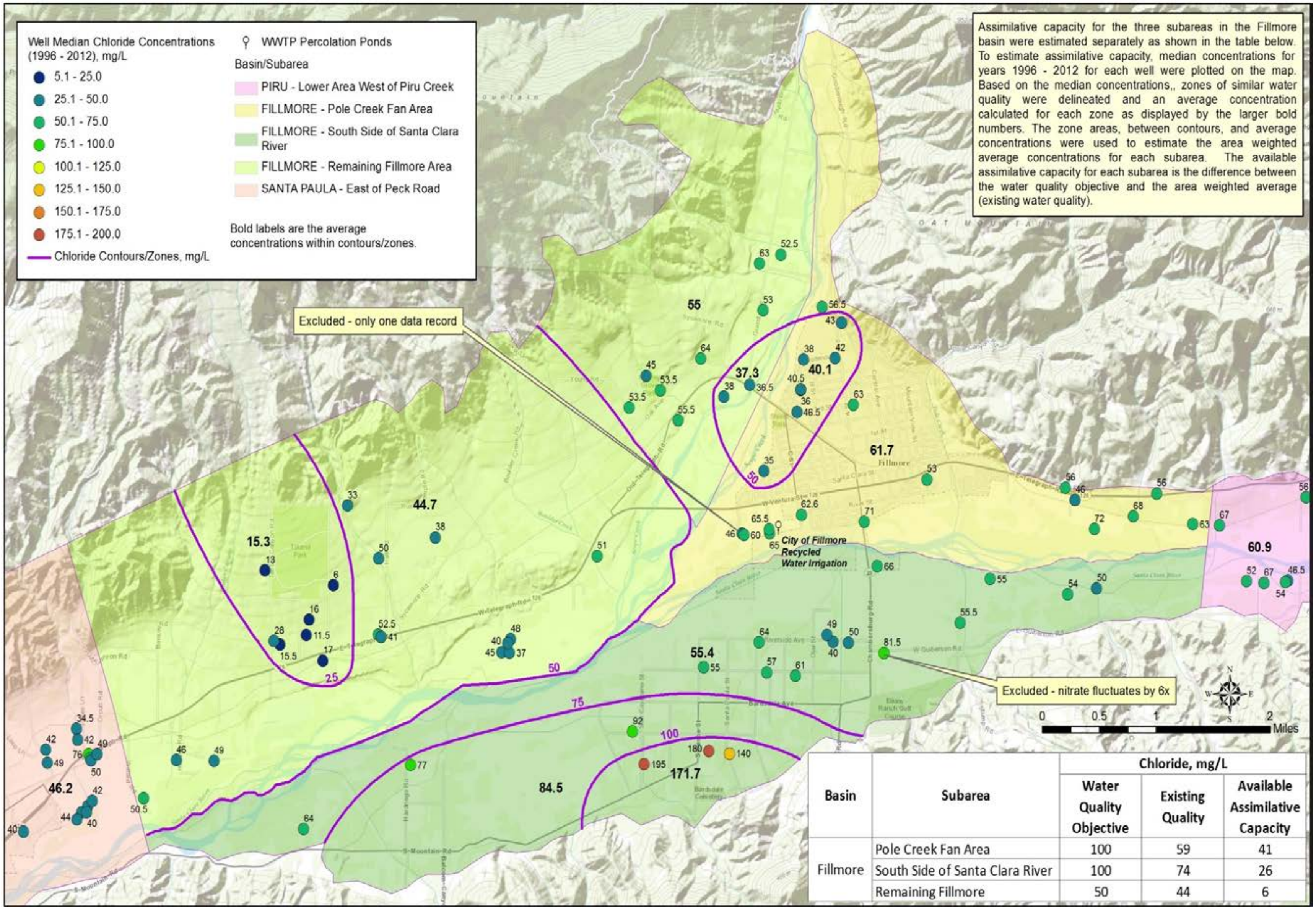
The northeastern portion of the subarea has the highest median chloride concentrations in the subarea, but does not exceed 65 mg/L (**Figure 4-12**). Tributary flow from Hopper Canyon in the western portion of the subarea dilutes chloride concentrations to approximately 15 mg/L. The majority of the subarea has an average concentration below 45 mg/L. The estimated existing groundwater quality of chloride for the Remaining Fillmore Area subarea of the Fillmore basin is 44 mg/L.

4.5.3.2 TDS Existing Water Quality

The TDS concentrations of the subarea are fairly uniform and range between 600 and 1,000 mg/L (**Figure 4-13**). From the limited data available, TDS concentrations appear to increase southwards towards the SCR. The estimated existing groundwater quality of TDS for the Remaining Fillmore Area subarea of the Fillmore basin is 846 mg/L.

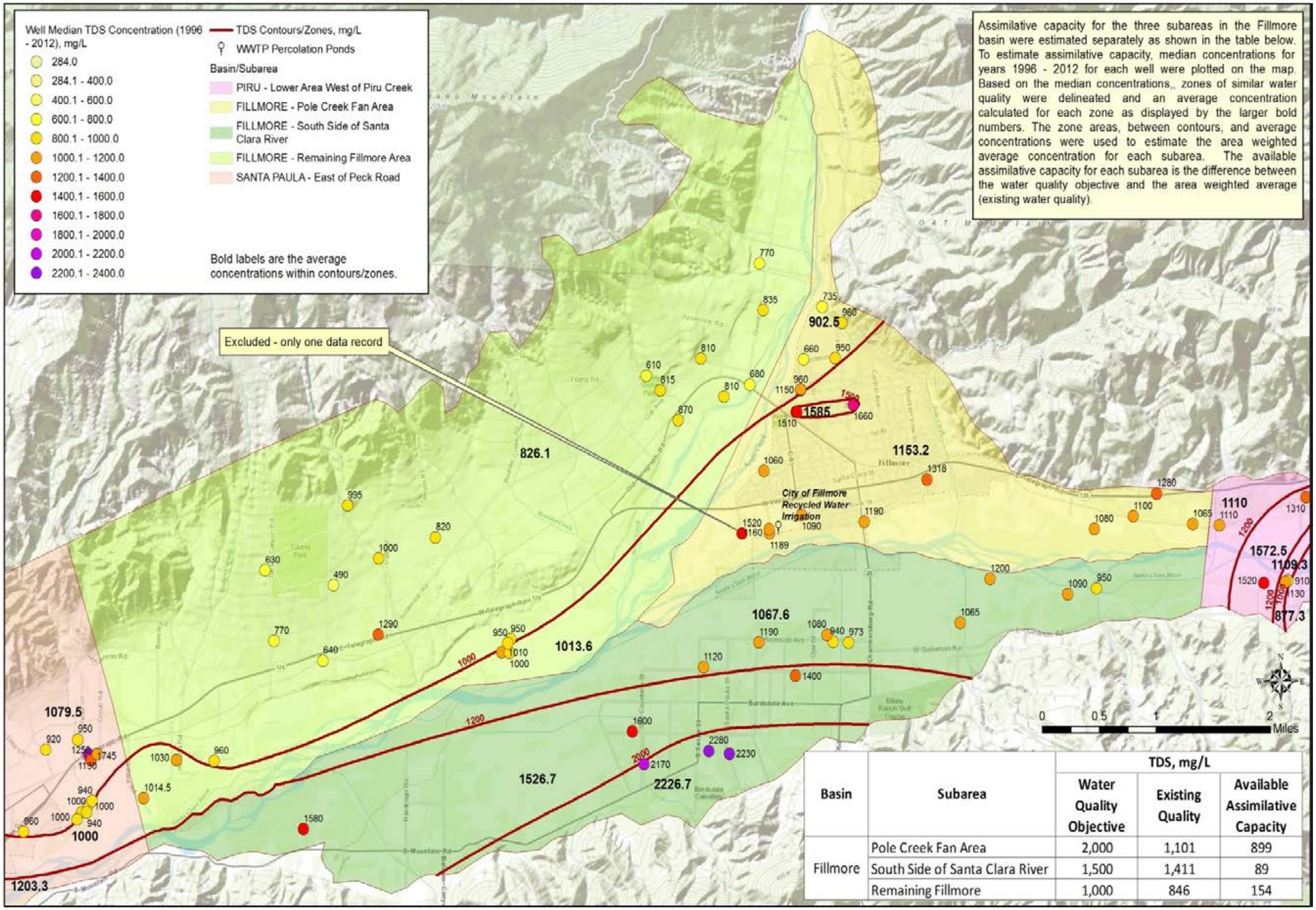
4.5.3.3 Nitrate-N Existing Water Quality

Similar to the south side of Santa Clara River subarea, the highest nitrate-N concentrations occur in the central portion of the subarea (**Figure 4-14**). From the northeast of the subarea, concentrations increase towards the center of the subarea to a maximum of 22 mg/L, and decrease towards the subarea's western boundary to just over 2 mg/L. The Fillmore WWTP percolation ponds have a diluting effect around them with the median nitrate-N concentrations at the monitoring wells not exceeding 6 mg/L. The estimated existing groundwater quality of nitrate-N for the Remaining Fillmore Area subarea of the Fillmore basin is 6.7 mg/L.



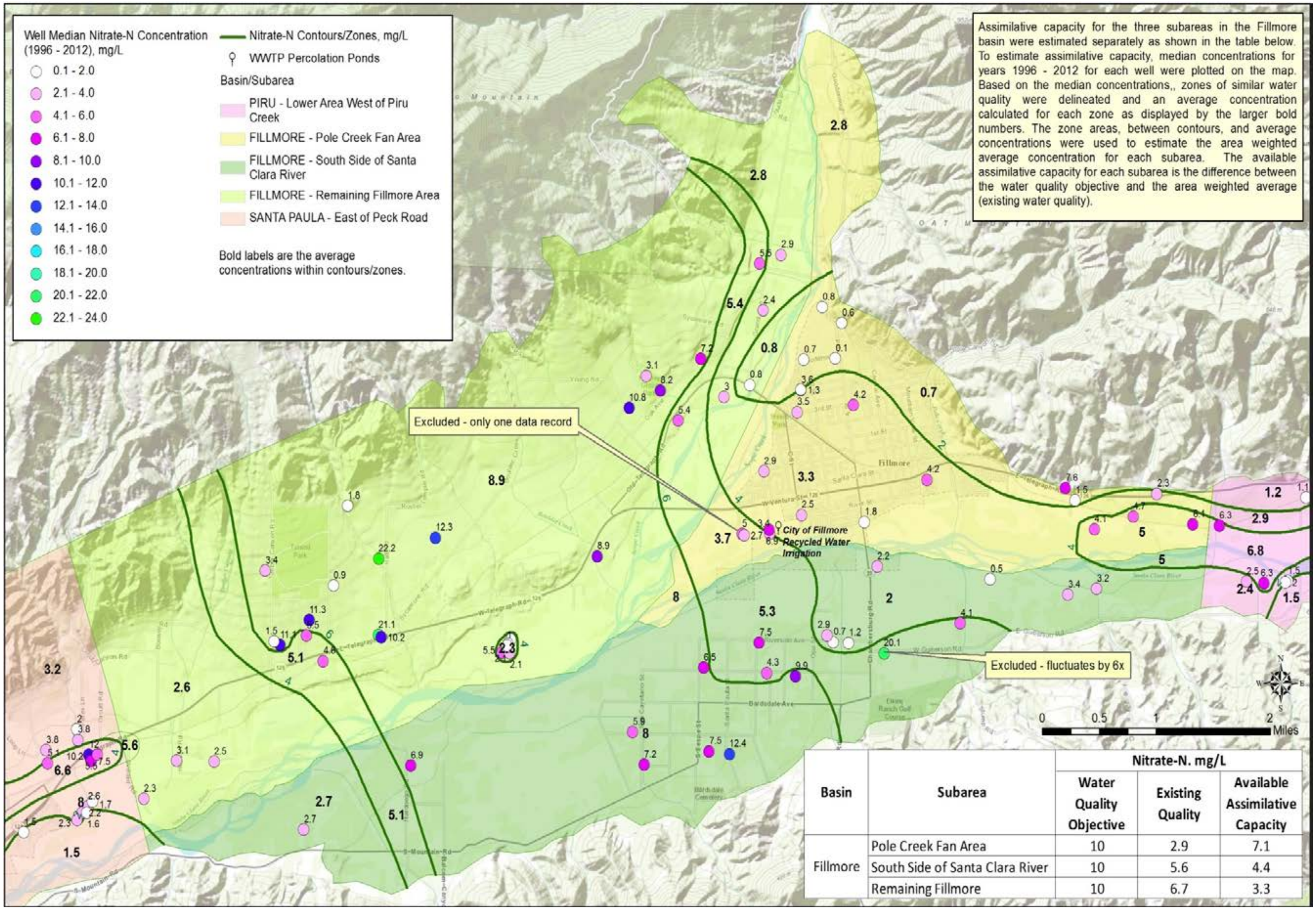
Basin	Subarea	Chloride, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Fillmore	Pole Creek Fan Area	100	59	41
	South Side of Santa Clara River	100	74	26
	Remaining Fillmore	50	44	6

Figure 4-12 Chloride Existing Water Quality of Fillmore Basin



Basin	Subarea	TDS, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Fillmore	Pole Creek Fan Area	2,000	1,101	899
	South Side of Santa Clara River	1,500	1,411	89
	Remaining Fillmore	1,000	846	154

Figure 4-13 TDS Existing Water Quality of Fillmore Basin



Basin	Subarea	Nitrate-N. mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Fillmore	Pole Creek Fan Area	10	2.9	7.1
	South Side of Santa Clara River	10	5.6	4.4
	Remaining Fillmore	10	6.7	3.3

Figure 4-14 Nitrate-N Existing Water Quality of Fillmore Basin

4.6 SANTA PAULA BASIN

The Santa Paula basin is split into two subareas: east of Peck Road and west of Peck Road. **Figure 4-15** through **Figure 4-17** show the groundwater quality for the Santa Paula basin. A table listing the existing groundwater quality of the constituents is included on each map.

4.6.1 Santa Paula Basin - East of Peck Road Subarea

4.6.1.1 Chloride Existing Water Quality

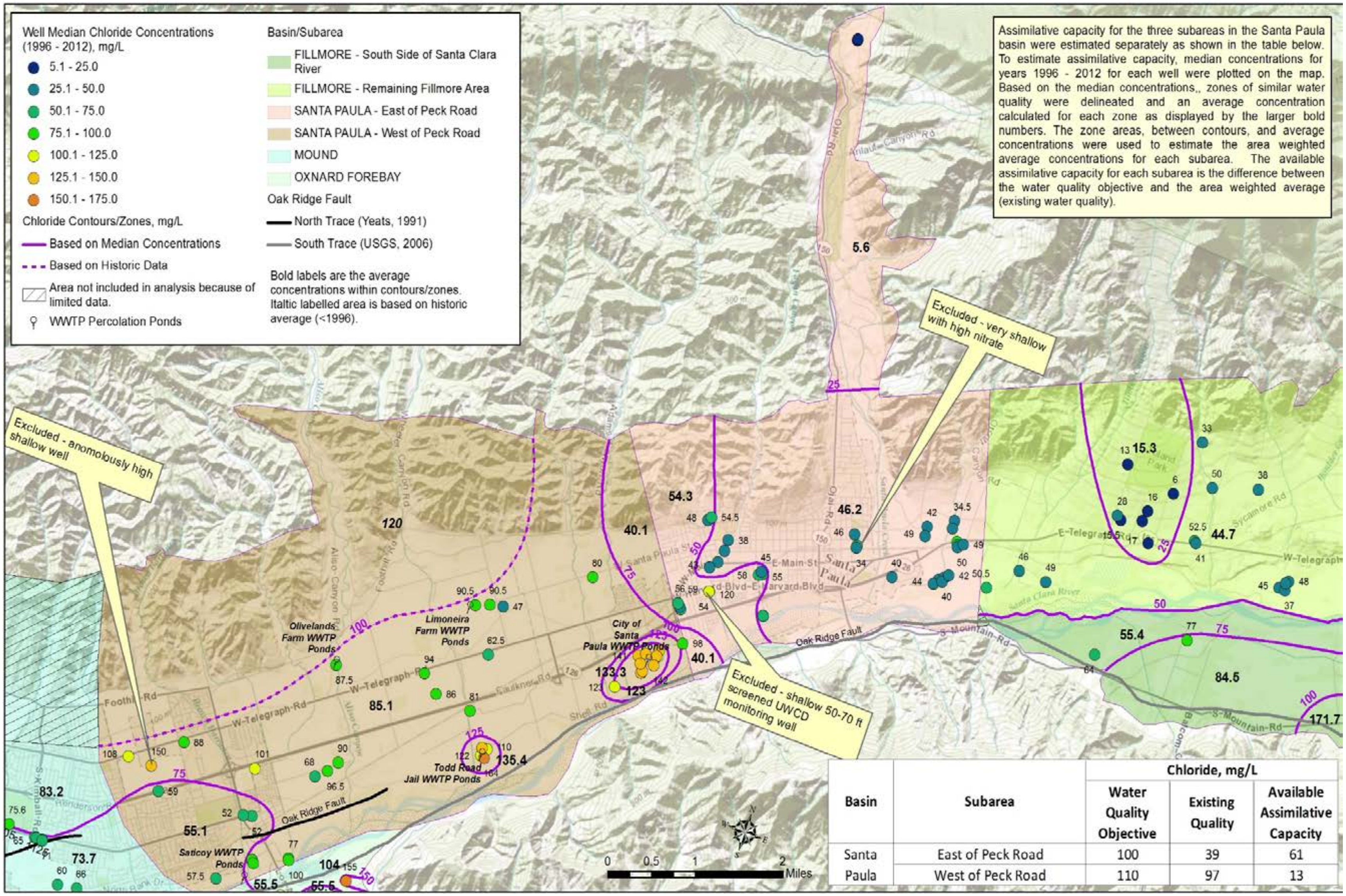
Median chloride concentrations in the majority of the subarea do not exceed 50 mg/L (**Figure 4-15)**. The western portion of the subarea marks where concentrations increase slightly across into the west of Peck Road subarea. The estimated existing groundwater quality of chloride for the east of Peck Road subarea of the Santa Paula basin is 39 mg/L.

4.6.1.2 TDS Existing Water Quality

The distribution of TDS in groundwater in the subarea does not follow the distribution of chloride as well as in other subareas. The majority of the subarea generally has TDS concentrations of approximately 1,000 mg/L (**Figure 4-16**) but an increase occurs in the lower third of the subarea where concentrations increase to approximately 1,200 mg/L at the southern subarea boundary. The estimated existing groundwater quality of TDS for the east of Peck Road subarea of the Santa Paula basin is 953 mg/L.

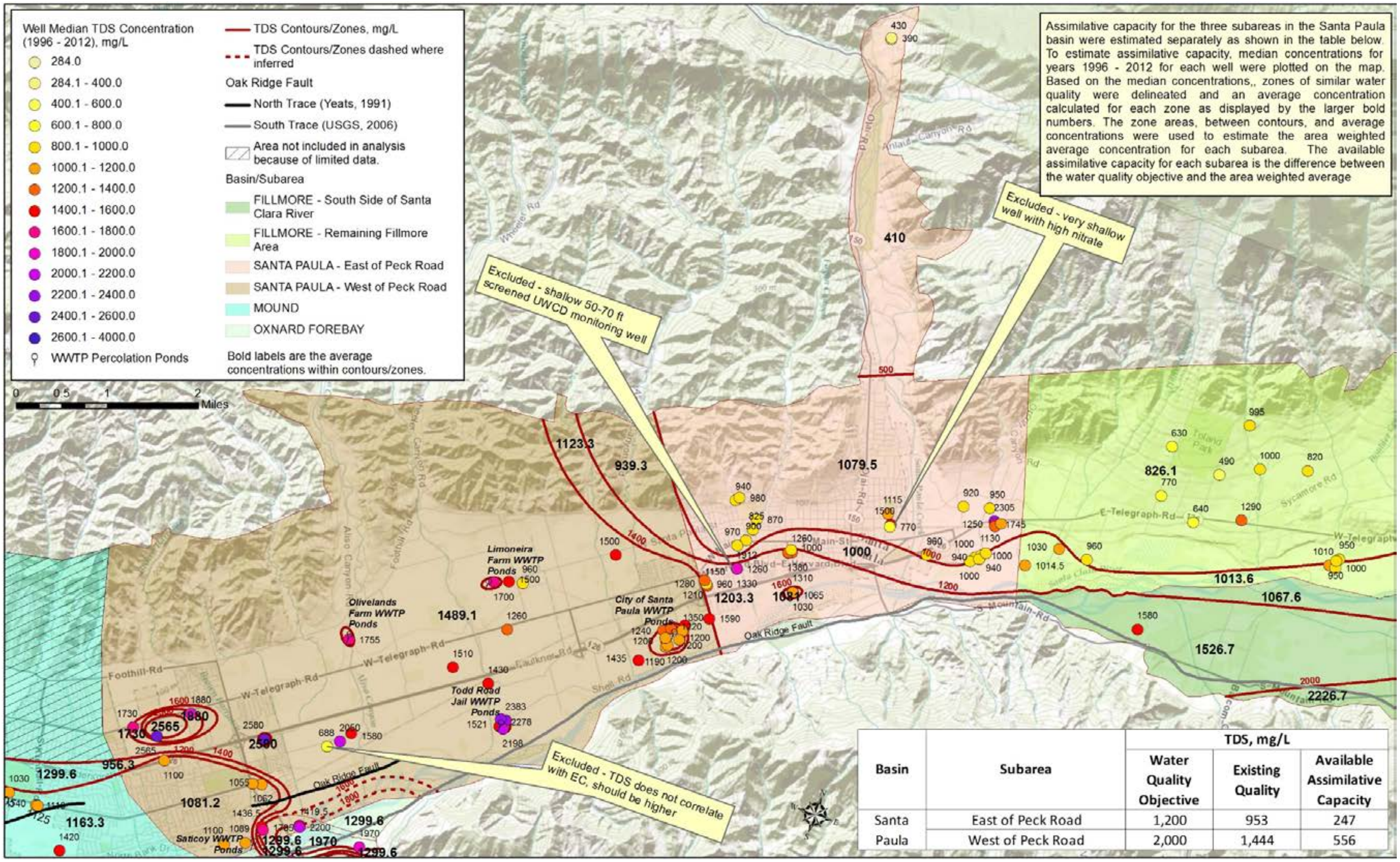
4.6.1.3 Nitrate-N Existing Water Quality

For the most part, nitrate-N concentrations throughout the subarea are less than 3 mg/L (**Figure 4-17**). The central portion of the subarea, like many other subareas, is where the highest nitrate-N concentrations occur. The average concentrations in this portion of the subarea are approximately 6 mg/L. Overall, the estimated existing groundwater quality of nitrate-N for the east of Peck Road subarea of the Santa Paula basin is 5 mg/L.



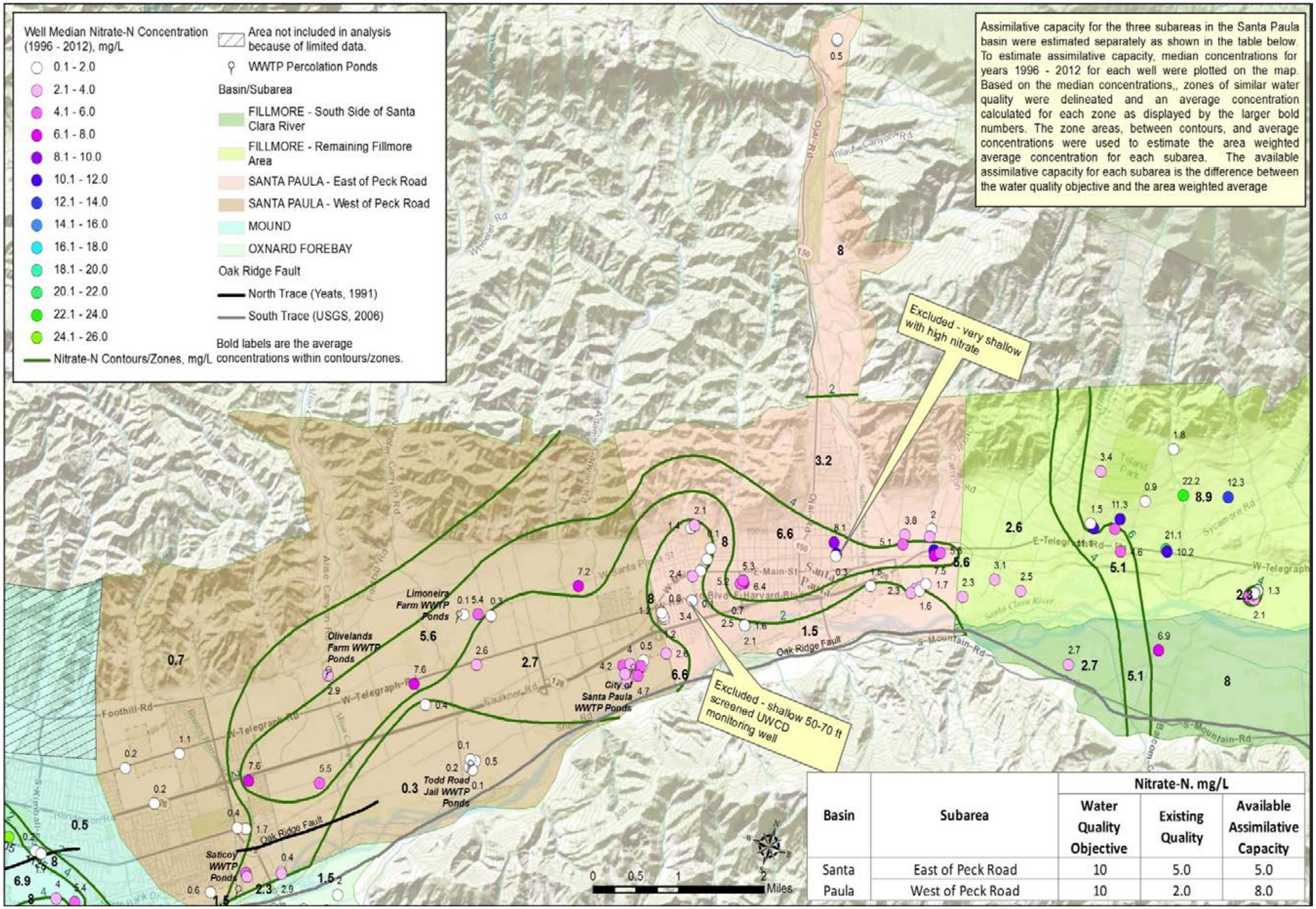
Basin	Subarea	Chloride, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Santa Paula	East of Peck Road	100	39	61
	West of Peck Road	110	97	13

Figure 4-15 Chloride Existing Water Quality of Santa Paula Basin



Basin	Subarea	TDS, mg/L Water Quality Objective	Existing Quality	Available Assimilative Capacity
Santa	East of Peck Road	1,200	953	247
Paula	West of Peck Road	2,000	1,444	556

Figure 4-16 TDS Existing Water Quality of Santa Paula Basin



Basin	Subarea	Nitrate-N. mg/L		
		Water Quality Objective	Existing Quality	Available Assimilative Capacity
Santa	East of Peck Road	10	5.0	5.0
Paula	West of Peck Road	10	2.0	8.0

Figure 4-17 Nitrate-N Existing Water Quality of Santa Paula Basin

4.6.2 Santa Paula Basin - West of Peck Road Subarea

There are no wells in the northern portion of the subarea (**Figure 4-15** through **Figure 4-17**). This is due to the naturally high mineral content of the groundwater. Farmers rely on water distributed from the eastern part of the basin. Data from 1923 through 1995 were reviewed to determine if any additional data points in this area could be used to extrapolate groundwater quality to the north. The subsections below discuss use of these historic data.

4.6.2.1 Chloride Existing Water Quality

The majority of the subarea has chloride concentrations between 50 and 100 mg/L (**Figure 4-15**). Its eastern and western margins have slightly lower concentrations. Areas of elevated chloride occur at the City of Santa Paula and Todd Road Jail WWTP percolation ponds.

Data older than 1996 showed higher historic chloride concentrations occurring in the northern portion of the subarea. A greater than 100 mg/l chloride concentration contour was added based on these data, which are regarded as reliable because the elevated chloride in this area is regarded as naturally occurring and not man-made. This contour is dashed on **Figure 4-15** because it was not derived from the 1996-2012 median dataset used for the rest of the subarea. The estimated existing groundwater quality of chloride for the west of Peck Road subarea of the Santa Paula basin is 97 mg/L.

4.6.2.2 TDS Existing Water Quality

TDS concentrations in the majority west of Peck Road subarea are relatively high averaging almost 1,500 mg/L (**Figure 4-16**). There are several localized areas of even higher concentrations that are typically associated with WWTP percolation ponds. An agricultural area, near the subarea western boundary with the Mound basin has TDS concentrations greater than 1,800 mg/L.

TDS concentrations decrease in the southwestern portion of the subarea although there is an area of elevated TDS in the northern portion of the Oxnard Forebay basin, north and west of the Saticoy recharge basins, extending across the basin boundary slightly into the west of Peck Road subarea of the Santa Paula basin. The cause of this area of elevated TDS concentrations appears to be connate water confined by the north trace of the Oak Ridge fault and beyond the influence of recharge activities by UWCD.

The data reveal that historic TDS concentration in the northern portion of the subarea generally fall within the 1,400 to 1,600 mg/L groundwater quality zone developed from 1996-2012 median data.

The estimated existing groundwater quality of TDS for the west of Peck Road subarea of the Santa Paula basin is 1,438 mg/L.

4.6.2.3 Nitrate-N Existing Water Quality

Similar to the upgradient subarea (Santa Paula basin's east of Peck Road subarea), the central portion of the west of Peck Road subarea has the highest nitrate-N concentrations in the subarea (less than 8 mg/L, see **Figure 4-17**). Concentrations decrease away from the center of the subarea.

Historic data revealed that nitrate-N concentrations in the northern portion of the subarea were less than 2 mg/L near the foothills and increased slightly towards the south and the 4 mg/L contour delineated from 1996-2012 median data. This information was used to adjust the 2 mg/L contour to be parallel to the 4 mg/L contour.

The estimated existing groundwater quality of nitrate-N for the West of Peck Road subarea of the Santa Paula basin is 2 mg/L.

4.7 OXNARD FOREBAY BASIN

The Oxnard Forebay basin does not have any subareas delineated. **Figure 4-18** through **Figure 4-20** provide maps of the groundwater quality of the basin. A table listing the existing groundwater quality of the constituents is included on each map. Water quality in the Oxnard Forebay is influenced strongly by the water quality of recharge water diverted from the SCR at the Freeman Diversion.

4.7.1 Chloride Existing Water Quality

Chloride concentrations are generally less than 60 mg/L (**Figure 4-18**). Upgradient of the UWCD's Saticoy recharge basins there is a monitoring well with a median concentration of 155 mg/L; this is the highest concentration in the basin. The cause of this elevated concentration is likely due to connate water that was trapped in the underlying sediments during deposition, which is beyond the influence of the downgradient managed aquifer recharge operations and therefore has not been diluted.

The estimated existing groundwater quality of chloride for the Oxnard Forebay basin is 57 mg/L.

4.7.2 TDS Existing Water Quality

TDS concentrations throughout the basin average approximately 1,000 mg/L, with a typical range between 800-1,200 mg/L (**Figure 4-19**). In the northern portion of the basin and across into Santa Paula basin's subarea west of Peck Road, an area of high TDS concentrations of up to 2,200 mg/L occurs west of the Saticoy recharge basins. Because this area is upgradient and cross-gradient of the recharge basins, the connate water thought to be responsible for the high concentrations has not been flushed by the cleaner recharge water.

Figure 4-19 summarizes several wells in the Oxnard Forebay that have decreasing TDS concentrations. These decreases are due to the managed aquifer recharge of SCR water diverted at the Freeman diversion by UWCD. There was only one well with an increasing trend in the basin which was located cross-gradient and southeast of the Saticoy recharge basins.

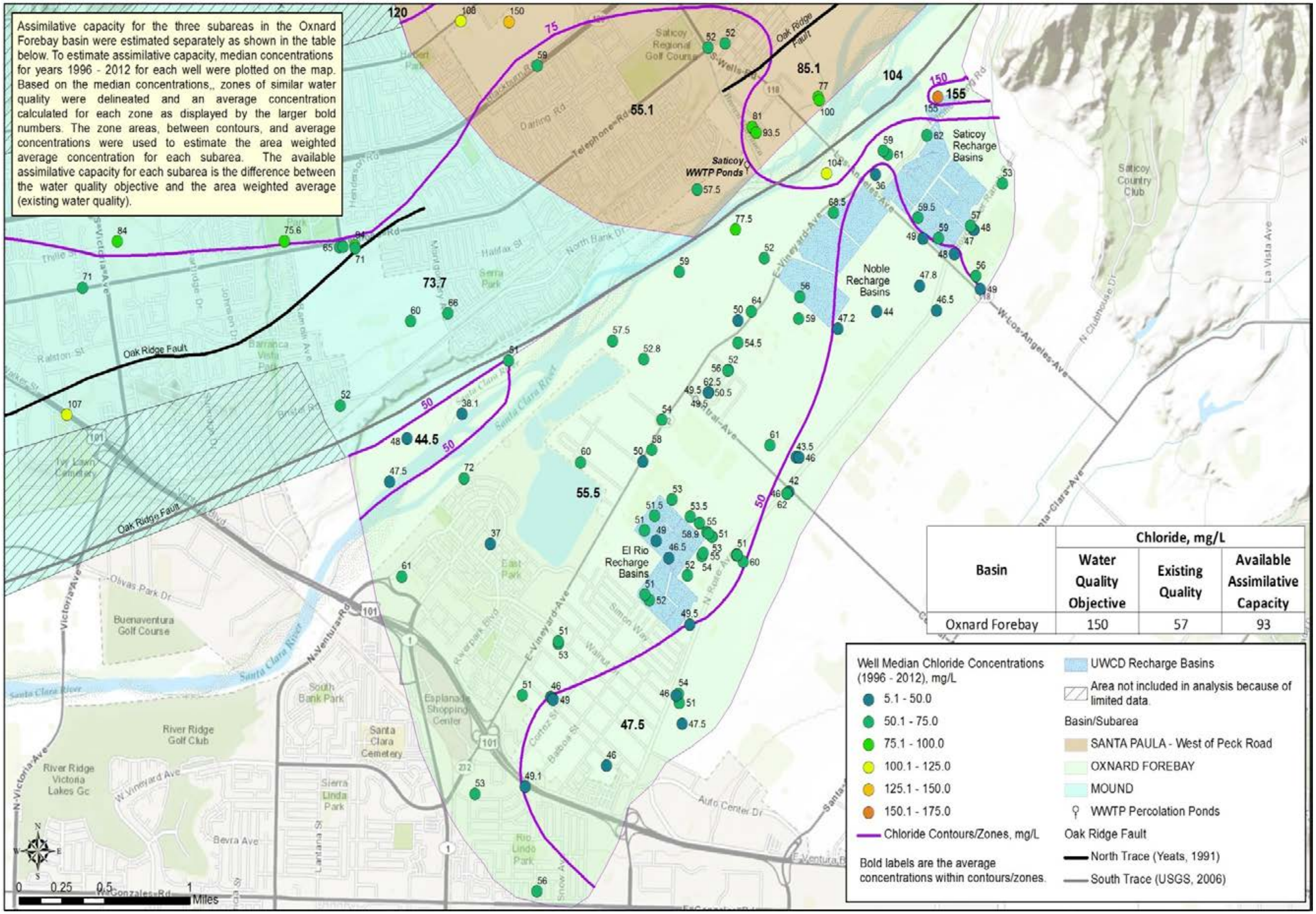
The estimated existing groundwater quality of TDS for the Oxnard Forebay basin is 1,059 mg/L.

4.7.3 Nitrate-N Existing Water Quality

Nitrate-N concentrations are lower (<2 mg/L) in the upgradient portion of the basin in areas influenced by natural recharge from the SCR and Saticoy and Noble recharge basins (**Figure 4-20**). Concentrations increase very slightly towards the south but generally do not exceed 4 mg/L. One area of elevated concentrations (average of 8 mg/L) occurs around the southern mining pits (**Figure 4-20**).

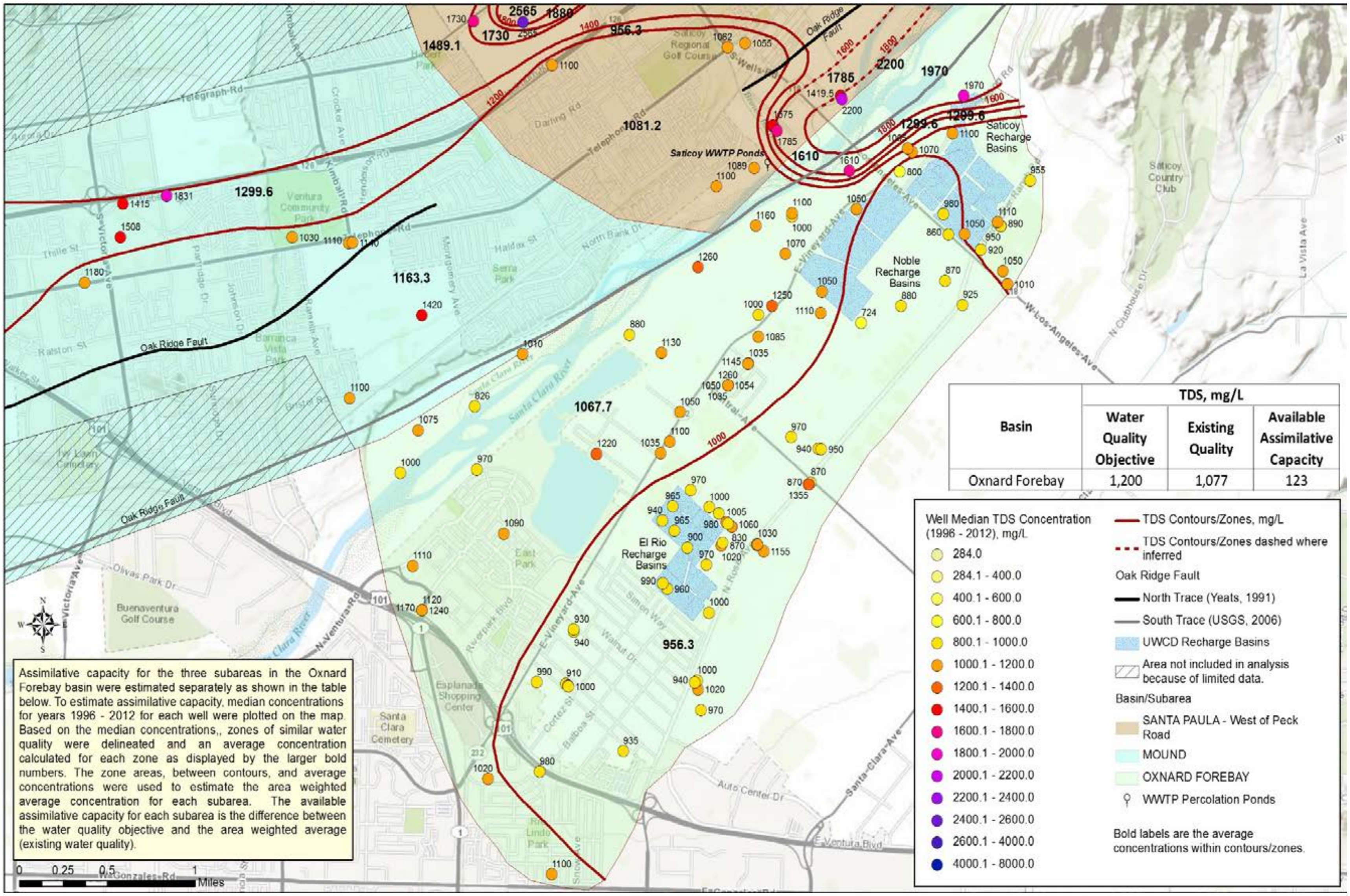
In 2008, UWCD published a report on nitrate observations from 1995-2006 in the Oxnard Forebay and vicinity. This report noted that there were some locations where increasing trends were observed in shallow wells (e.g., well 02N22W13N07S). Nitrate in groundwater is commonly highest when groundwater levels are low and there is less recharge to dilute nutrients in the basin (UWCD, 2008). **Figure 4-21** provides an example of this behavior. The UWCD report noted that nitrate concentrations in deeper wells are consistently low. **Figure 4-20** represents a combination of shallow and deep wells.

The estimated existing groundwater quality of nitrate-N for the Oxnard Forebay basin is 4.5 mg/L.



Basin	Chloride, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Oxnard Forebay	150	57	93

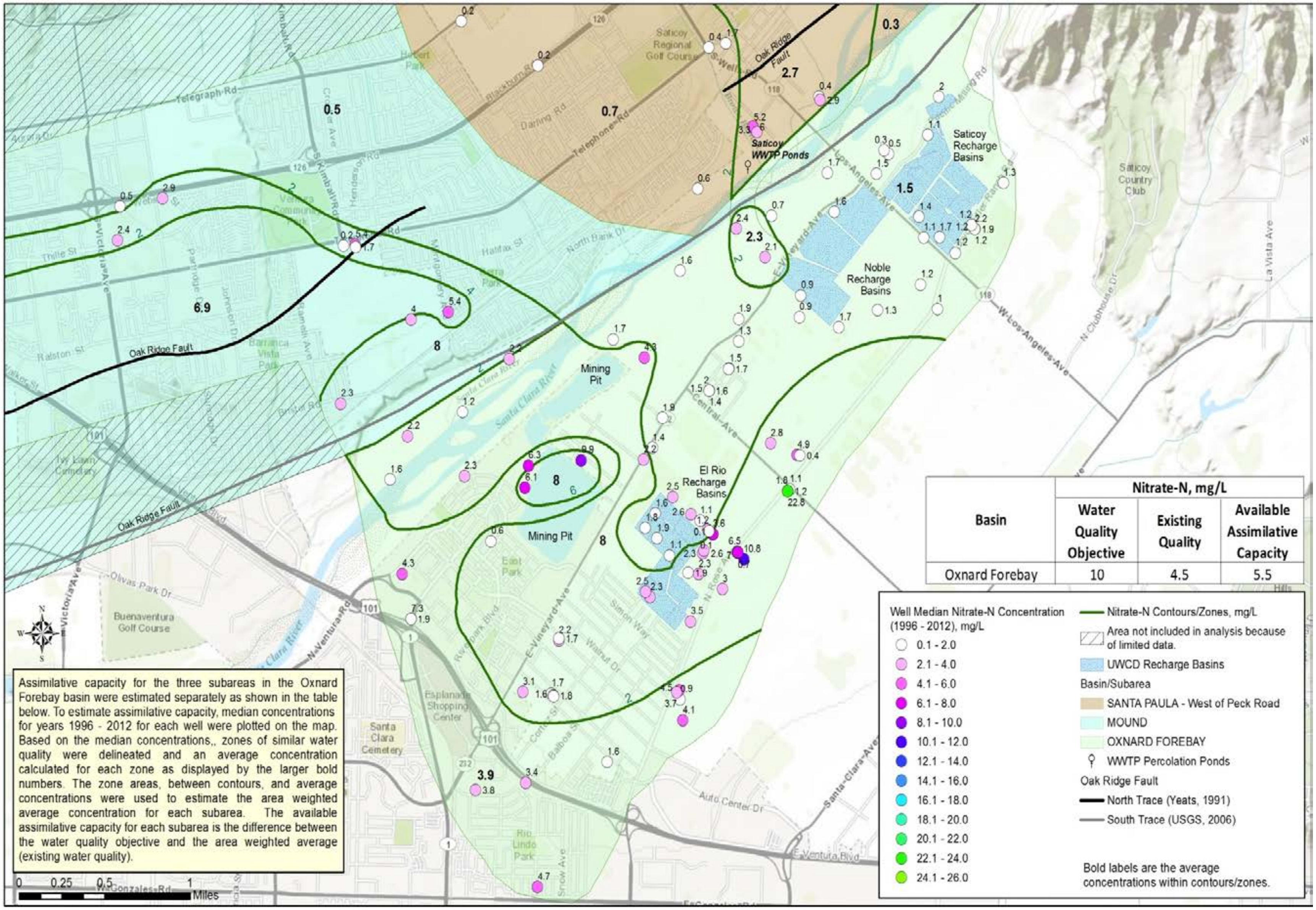
Figure 4-18 Chloride Existing Water Quality of Oxnard Forebay Basin



Basin	TDS, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Oxnard Forebay	1,200	1,077	123

Assimilative capacity for the three subareas in the Oxnard Forebay basin were estimated separately as shown in the table below. To estimate assimilative capacity, median concentrations for years 1996 - 2012 for each well were plotted on the map. Based on the median concentrations,, zones of similar water quality were delineated and an average concentration calculated for each zone as displayed by the larger bold numbers. The zone areas, between contours, and average concentrations were used to estimate the area weighted average concentration for each subarea. The available assimilative capacity for each subarea is the difference between the water quality objective and the area weighted average (existing water quality).

Figure 4-19 TDS Existing Water Quality of Oxnard Forebay Basin



Basin	Nitrate-N, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Oxnard Forebay	10	4.5	5.5

Figure 4-20 Nitrate-N Existing Water Quality of Oxnard Forebay Basin

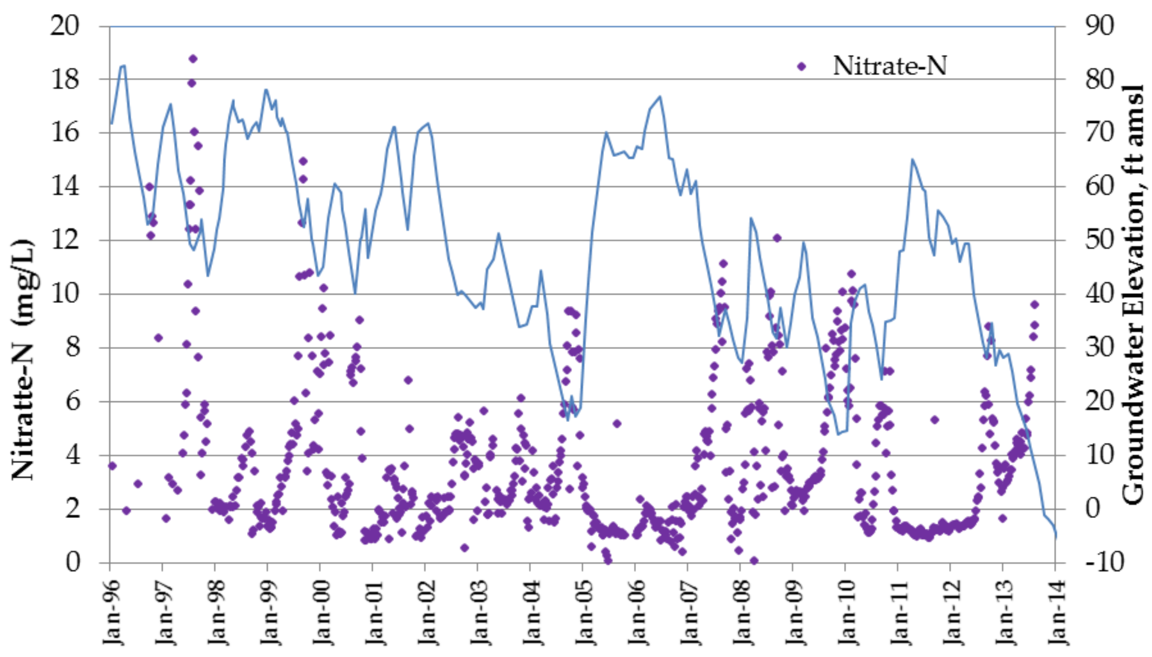


Figure 4-21 Example of Oxnard Forebay Nitrate-N Concentrations Relationship with Groundwater Elevations (02N22W23B02S)

4.8 MOUND BASIN

The Mound basin does not have any subareas. **Figure 4-22** through **Figure 4-24** provide maps of the groundwater quality of the Mound basin. A table listing the existing groundwater quality of the constituents is included on each map.

The dataset available for determining existing groundwater quality in the Mound basin is very limited. **Figure 4-22** through **Figure 4-24** show that there is well control in less than half of the basin. The scarcity of data is described in UWCD's hydrogeologic assessment of the Mound basin (UWCD, 2012). Areas where no well data exist are hatched in the water quality maps.

4.8.1 Chloride Existing Water Quality

Connate water trapped in marine sediments has been suggested as the source of higher chloride concentrations found in the Mound basin (Geotechnical Consultants, 1972). Complex structural deformation and the lenticular nature of the sediments limit the amount of flushing of these poorer quality waters compared to the other basins (UWCD, 2012). This hypothesis is supported by the fact that long-term well records show stable water quality, and that high variability between well locations is common (UWCD, 2012). Available well data do not indicate seawater intrusion (UWCD, 2012).

Chloride concentrations in the basin, except in the perched aquifer, range between 50 and 100 mg/L (**Figure 4-22**). The estimated existing groundwater quality of chloride for the Mound basin is 76 mg/L. One agricultural well in the south of the basin was excluded from the analysis because, although well completion data were not available, the high chloride concentration suggests this well is completed in the perched aquifer.

There are only three known monitoring wells that monitor the perched aquifer above the main water supply aquifers in the Mound basin (**Figure 4-25**). These wells were not included in the analysis of existing groundwater quality of chloride, TDS, or nitrate-N. The perched shallow aquifer is not used for groundwater production because its quality exceeds drinking water standards and many crop irrigation standards. These monitoring wells provide the only data on this perched zone as there are no production wells completed in this zone. The lateral extent of the perched zone has not been mapped because there are too few data points. The three wells on **Figure 4-25** do show however, that the perched zone may extend at least four miles across the basin, but it is unknown whether it is laterally continuous, like the perched zone in the Oxnard Plain basin. Chloride concentrations in the perched aquifer range from 100 to 480 mg/L.

4.8.2 TDS Existing Water Quality

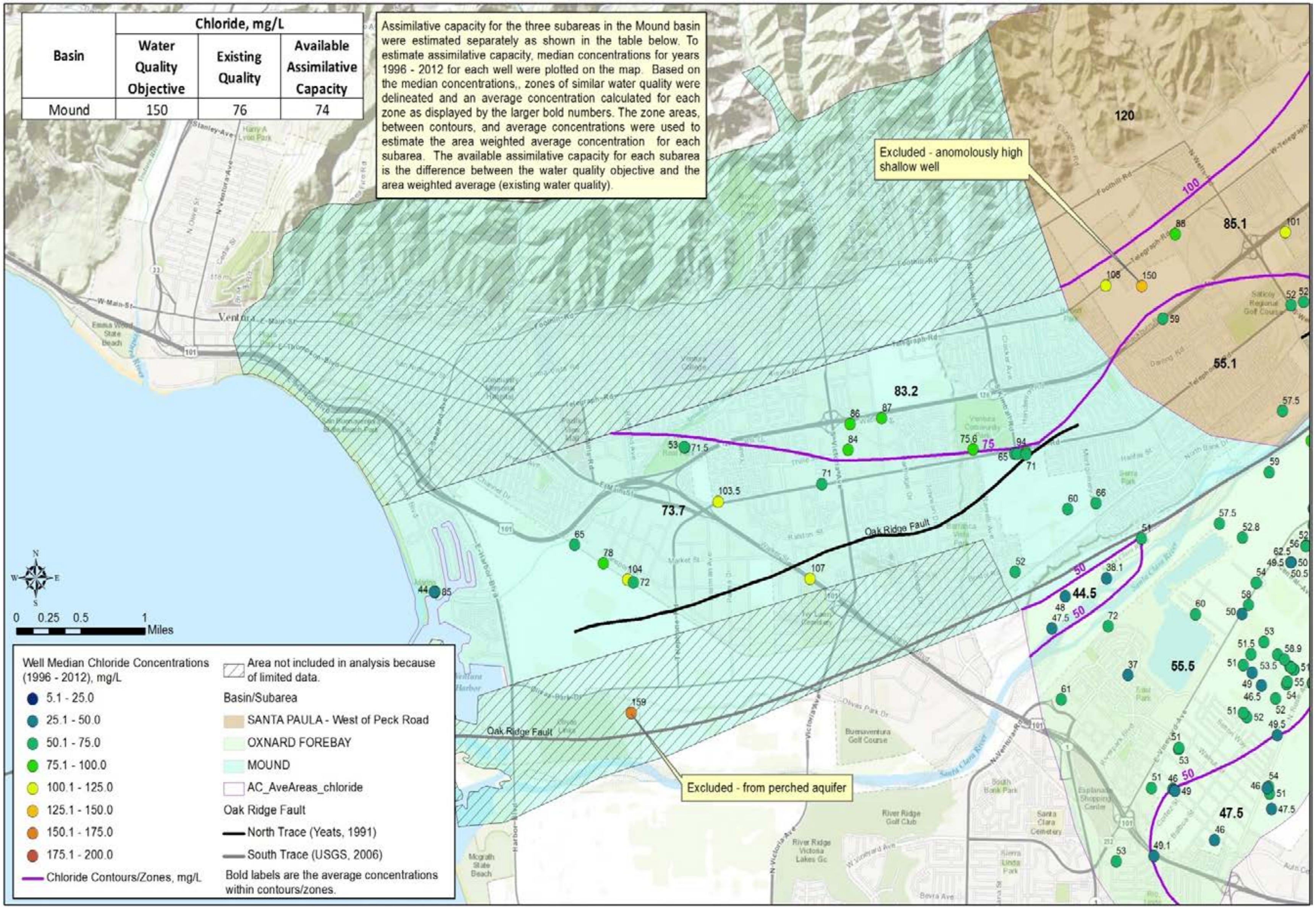
TDS concentrations in the Mound basin range between 910 and 1,830 mg/L (**Figure 4-23**). As described for chloride, connate water is thought to be the reason behind the higher TDS concentrations in the Mound basin. The estimated existing groundwater quality of TDS for the Mound basin is 1,230 mg/L.

4.8.3 Nitrate-N Existing Water Quality

For the areas where data are available in the Mound basin and excluding the perched aquifer wells, nitrate-N does not exceed 10 mg/L (**Figure 4-24**). Concentrations increase from north to south. The area south of Telegraph Road generally has the basin's highest average concentration of approximately 7 mg/L. The estimated existing groundwater quality of nitrate-N for the Mound basin is 4 mg/L.

4.9 METHOD LIMITATIONS

The method used in this report to estimate existing groundwater quality relies heavily on the spatial distribution of wells with groundwater quality data. As has been seen in the description of groundwater quality for individual subareas and basins, some areas have limited data. When more spatial locations with water quality data are added to the dataset in the future, maps of existing groundwater quality can be enhanced.



Basin	Chloride, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Mound	150	76	74

Figure 4-22 Chloride Existing Water Quality of Mound Basin

Basin	TDS, mg/L		
	Water Quality Objective	Existing Quality	Available Assimilative Capacity
Mound	1,200	1,230	-30

Assimilative capacity for the three subareas in the Mound basin were estimated separately as shown in the table below. To estimate assimilative capacity, median concentrations for years 1996 - 2012 for each well were plotted on the map. Based on the median concentrations,, zones of similar water quality were delineated and an average concentration calculated for each zone as displayed by the larger bold numbers. The zone areas, between contours, and average concentrations were used to estimate the area weighted average concentration for each subarea. The available assimilative capacity for each subarea is the difference between the water quality objective and the area weighted average (existing water quality).

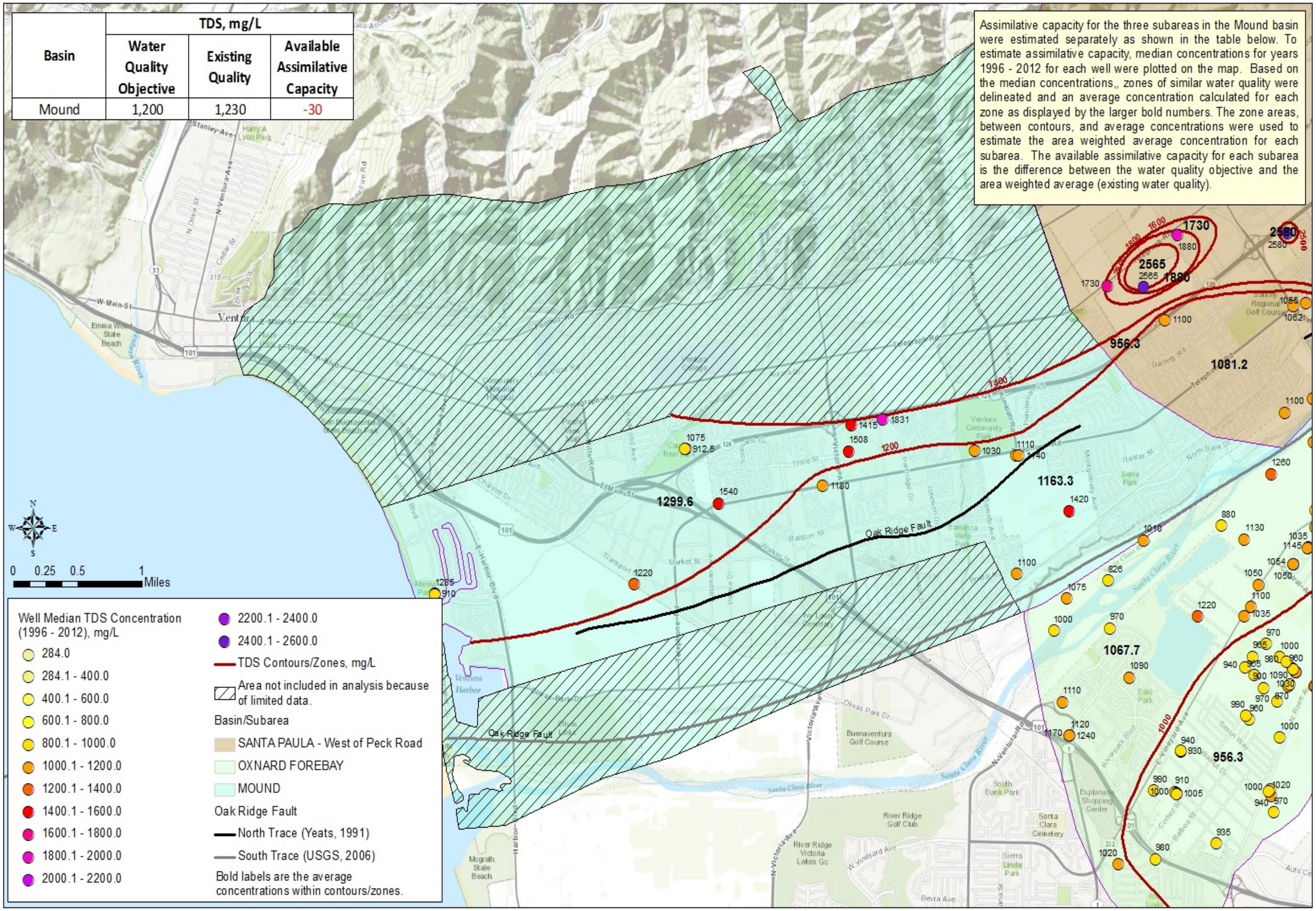


Figure 4-23: TDS Existing Water Quality of Mound Basin

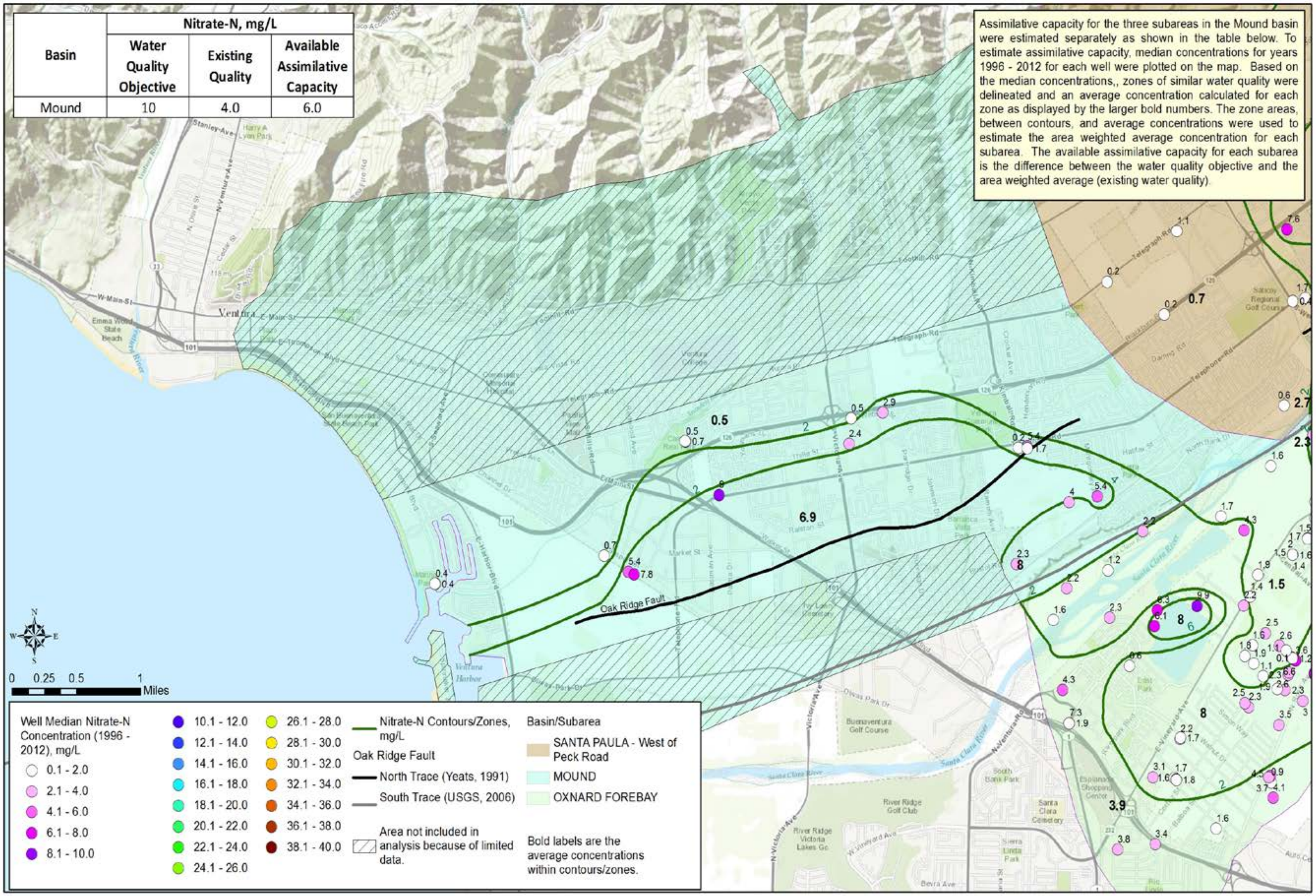


Figure 4-24: Nitrate-N Existing Water Quality of Mound Basin

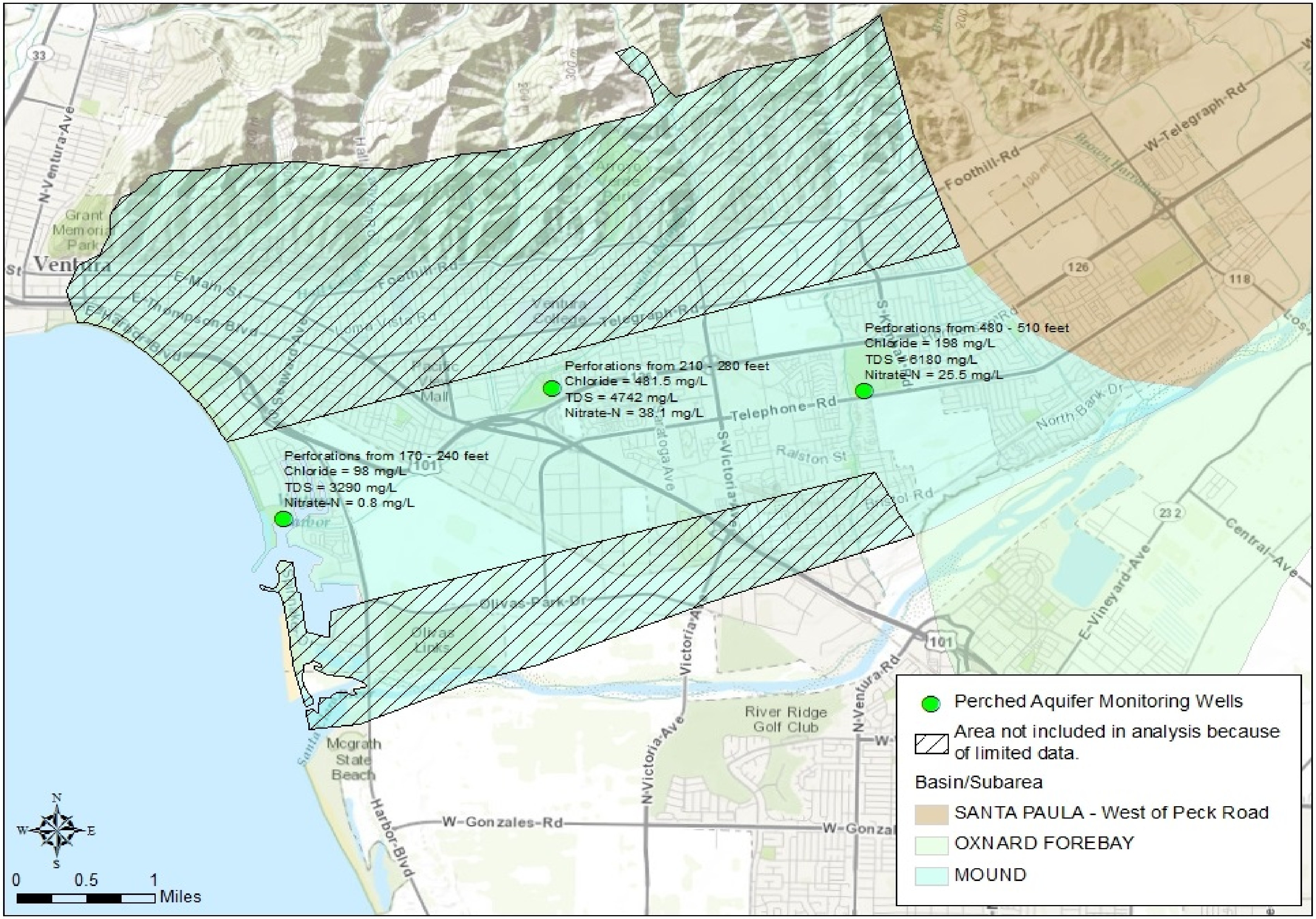


Figure 4-25: Perched Aquifer Wells and Groundwater Quality