San Jacinto Salt Offset and Dairy Impacts Report – 2016 Update

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Submitted to

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Contents

Introduction 1

Background 1

1.0 Methodology 4

1.1 Regional Mapping Evaluation 4

1.2 Hydrogeology of the San Jacinto Basin 4

1.3 Well Selection 6

1.4 Analytical Methods 9

1.5 Censored Data and Sampling Periods of Record 10

1.6 Uncertainties in Results 10

2.0 Impacts Analysis – Lakeview/Hemet North Management Zone 11

2.1 Group of Dairies (John & Margie Oostdam, Hettinga, and Oostdam) 11

2.2 Group of Dairies (Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2) – Analysis South of Fault 16

2.3 Group of Dairies (Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 (Old Vermeer Dairy)) 27

2.4 Goyenetche Dairy #2 (Old Cawston Dairy) 35

2.5 Group of Dairies (Albert Goyenetche Dairy #2 (Old Ferriera Dairy), John Bootsma Dairy, and Offinga Dairy) 37

2.6 Pastime Lakes Dairy 43

3.0 Impacts Analysis – San Jacinto Lower Pressure Management Zone 49

3.1 Van Ryn Dairy 49

3.2 Pair of Dairies (Jim Bootsma Jr. and Marvo Holsteins) 50

4.0 Impacts Analysis – Menifee Management Zone 55

4.1 Abacherli Dairy and Boere Dairy 55

4.2 E.L. Farms 57

5.0 Impacts Analysis – San Jacinto Upper Pressure Management Zone 59

5.1 Group of Dairies (Arie & Josh De Jong, CBJ, and Ed Vander Woude) 59

5.2 R & J Haringa Dairy 66

5.3 Art Oostdam Dairy 72

5.4 Scott Brothers Dairy 74

5.5 John & Margie Oostdam Heifer Ranch 78

6.0 Impacts Analysis – Elsinore Groundwater Management Zone 81
6.1 Herman De Jong Dairy 81
7.0 Conclusions and Recommendations 84
8.0 References 90

Tables

Table 1. Historical Averages and Water Quality Objectives 3
Table 2. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies 13
Table 3. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies 13
Table 4. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault 19
Table 5. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault 20
Table 6. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault 24
Table 7. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault 24
Table 8. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 30
Table 9. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 31
Table 10. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy 39
Table 11. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy 40
Table 12. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Pastime Lakes Dairy 46
Table 13. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Pastime Lakes Dairy 47
Table 14. Comparison of Upgradient and Facility Nitrate Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies 52
Table 15. Comparison of Upgradient and Facility TDS Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies 52

Table 16. Downgradient Nitrate Concentrations for E.L. Farms 58

Table 17. Downgradient TDS Concentrations for E.L. Farms 58

Table 18. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies 62

Table 19. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies 63

Table 20. Comparison of Nitrate Concentrations in Facility Wells vs. Downgradient Wells for R & J Haringa Dairy 68

Table 21. Comparison of TDS Concentrations in Facility Wells vs. Downgradient Wells for R & J Haringa Dairy 69

Table 22. Nitrate Concentrations for Art Oostdam Dairy 73

Table 23. TDS Concentrations for Art Oostdam Dairy 73

Table 24. Downgradient Nitrate Concentrations for Scott Brothers Dairy 76

Table 25. Downgradient TDS Concentrations for Scott Brothers Dairy 76

Table 26. Nitrate Concentrations for Herman De Jong Dairy 83

Table 27. TDS Concentrations for Herman De Jong Dairy 83

Table 28. Summary of Conclusions of Dairy Impacts on Groundwater Quality 86

Table 29. Recommended Locations for Additional Data Collection based on Screening Level Analysis 89

Figures

Figure 1. Example boxplot. 9

Figure 2. Location map of the vicinity of John & Margie Oostdam, Oostdam, and Hettinga Dairies 12

Figure 3. Boxplot of upgradient, facility, and downgradient nitrate concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies 15

Figure 4. Boxplot of upgradient, facility, and downgradient TDS concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies 15

Figure 5. Location map of the vicinity of Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies 18

Figure 6. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault 21

Figure 7. Boxplot of upgradient, facility, and cowngradient TDS concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault 22

Figure 8. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault 25

Figure 9. Boxplot of upgradient, facility, and downgradient TDS concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault 26

Figure 10. Location map of the vicinity of Dick Van Dam, Cottonwood Dairy and Bootsma-Silva Farms/Ramona Dairy #2 29

Figure 11. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 32

Figure 12. Boxplot of upgradient, facility, and downgradient TDS concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 33

Figure 13. Location map of the vicinity of Goyenetche Dairy #2 36

Figure 14. Location map of the vicinity of Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy 38

Figure 15. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy 41

Figure 16. Boxplot of upgradient, facility, and downgradient TDS concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy 42

Figure 17. Location map of the vicinity of Pastime Lakes Dairy 45

Figure 18. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Pastime Lakes Dairy 47

Figure 19. Boxplot of upgradient, facility, and downgradient TDS concentrations for Pastime Lakes Dairy 48

Figure 20. Location map of the vicinity of Jim Bootsma Jr. and Marvo Holsteins Dairies 51

Figure 21. Boxplot of upgradient and facility nitrate concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies 53

Figure 22. Boxplot of upgradient and facility TDS concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies 54

Figure 23. Location map of the vicinity of Abacherli, Boere and E.L. Farms Dairies 56

Figure 24. Location map of the vicinity of Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies 61

Figure 25. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies 64

Figure 26. Boxplot of upgradient, facility, and downgradient TDS concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies 64

Figure 27. Location map of the vicinity of R & J Haringa Dairy and Art Oostdam Dairy 67

Figure 28. Boxplot of nitrate concentrations for facility wells vs. downgradient wells for R & J Haringa Dairy 70

Figure 29. Boxplot of TDS concentrations for facility wells vs. downgradient wells for R & J Haringa Dairy 71
Figure 30. Location map of the vicinity of Scott Brothers Dairy 75
Figure 31. Boxplot of nitrate concentrations for upgradient and downgradient wells for Scott Brothers Dairy 77
Figure 32. Boxplot of TDS concentrations for upgradient and downgradient wells for Scott Brothers Dairy 77
Figure 33. Location map of the vicinity of John & Margie Oostdam Heifer Ranch 80
Figure 34. Location map of the vicinity of Herman De Jong Dairy 82

Introduction

This report presents updated analyses to support San Jacinto basin dairies' compliance with the requirements of National Pollutant Discharge Elimination System (NPDES) permit and Waste Discharge Requirements (WDRs) for Dairies and Related Facilities in the Santa Ana Region (Order R8-2013-0001) and the Santa Ana Regional Water Quality Control Board's (RWQCB) response to the Western Riverside County Agriculture Coalition's (WRCAC) November 2014 report, *San Jacinto Salt Offset and Dairy Impact Report* (Salt Report) (WRCAC 2014).

Updated groundwater monitoring data was received and all data was analyzed, consistent with the methodology described in the Salt Report and the *San Jacinto Dairy Salt Offset Groundwater Monitoring Annual Analysis Protocols*[1], using updated well groupings to support revised findings of "No Impact," "Potential Impact," or "Inconclusive" relative to groundwater total dissolved solids (TDS) and nitrate (NO_3-N) impacts from individual dairies or groups of dairies.

Background

Provisions included in the Order R8-2013-0001 require that, "Within 18 months of adoption of this Order, the Dischargers in the San Jacinto area shall collect and submit to the Regional Board [RWQCB] all groundwater monitoring data from wells within the Concentrated Animal Feeding Operations (CAFO) facilities and wells that are located within a five mile radius of the CAFO facilities to confirm that the CAFO discharges have not impacted the quality of groundwater~~s~~ in the area." All dairies in the San Jacinto River basin are members of the Western Riverside County Agriculture Coalition (WRCAC), which coordinates dairy activities to comply with the permit requirements.

In 2014, an analysis was completed to fulfill the permit requirement related to analysis of groundwater monitoring data and identify potential areas where elevated TDS and nitrate concentrations detected in groundwater could be caused by dairy operation activities in the San Jacinto area. The results of that analyses were reported in the 2014 Salt Report. This revision of the Salt Report is based on updated land use information regarding non-dairy sources of nitrate and TDS, refinements in understanding of groundwater flow characteristics, and groundwater quality data collected since the 2014 analyses. The 2014 analyses used all available groundwater quality data through 2012. The current updated analyses utilize groundwater quality data collected through 2015, for some wells (more recent data were not available for all wells). Extensive groundwater data are available from Eastern Municipal Water District (EMWD), including groundwater monitoring analytical data, groundwater levels, and well construction data for numerous wells throughout the San Jacinto area from as early as 1984 to the present. Groundwater data were provided by Elsinore Valley Municipal Water District (EVMWD) for a single dairy located within their district for the 2014 analysis. Updated groundwater quality data were not provided

[1] Dated January 29, 2016, on file with WRCAC.

by EVMWD and the current analysis for the facility located in that district, Herman De Jong Dairy, has not changed from the previous report.

Available monitoring data were used to identify, to the extent possible, wells that are representative of groundwater conditions not influenced by dairy activities (upgradient wells), wells that are representative of groundwater quality at the dairies (facility wells) and downgradient from the dairies, with respect to groundwater flow direction. A mapping exercise was completed by Tetra Tech for the 2014 report to establish the direction of groundwater flow and assess whether dairies overall have impacted regional groundwater TDS and nitrate levels (see WRCAC 2014, Appendix A). The current analysis is based on improved understanding of groundwater flow directions, as described in the *San Jacinto Dairy Salt Offset Groundwater Monitoring Annual Analysis Protocols*.

In addition, a more focused, dairy-level statistical analysis was conducted to identify whether individual dairies or groups of dairies have impacted local groundwater TDS and nitrate concentrations. The dairy-level analysis evaluated whether there have been significant changes in the groundwater TDS and nitrate levels in wells that could be attributable to dairies over the period of time covered by the available data. To the extent possible, the analysis also identified other potential influences on groundwater quality including non-dairy agricultural operations, irrigated land, backyard livestock areas, horse facilities, manure compost areas, poultry facilities, and septic system use. Recent groundwater TDS and nitrate concentrations were compared to long-term average groundwater quality identified for the periods 1954 to 1973, 1978 to 1997, and 1990 to 2009 in the San Jacinto area as presented in the *TIN/TDS Study - Phase 2A of the Santa Ana Watershed* (WEI 2000), *Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1990 to 2009* (WEI 2011) and *Recomputation of Ambient Water Quality in the Santa Ana Watershed for the Period 1993 to 2012* (WEI 2014) (Wildermuth reports). Table 1 lists the historical averages and water quality objectives (WQOs) for each applicable management zone. WQOs are established in the Santa Ana Regional Water Quality Control Board Basin Plan, and represent, "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area". The groundwater WQOs for each management zone were established based on ambient water quality determinations from the "historical" period (1954-1973) (WEI 2011) and represent the desirable levels of nitrate and TDS with which the historical and current averages are compared throughout this report.

Table 1. Historical Averages and Water Quality Objectives

Nitrate Average Concentration (mg/L)				TDS Average Concentration (mg/L)				Water Quality Objective		Dairies within Management Zone (start date)
1954-1973	1978-1997	1990-2009	1993-2012	1954-1973	1978-1997	1990-2009	1993-2012	Nitrate	TDS	
Lakeview/Hemet North Groundwater Management Zone										
1.8	2.7	2.6	2.5	519	830	890	860	1.8	520	• Boersma (Feb 1988) • Gerben Hettinga Expressway (Dec 1982) • Dick Van Dam (May 1980) • Albert Goyenetche #2 (Old Ferriera Dairy) (Aug 1978) • Hettinga (May 1976) • Hollandia (Nov 1978) • John Bootsma (Feb 1981) • John & Margie Oostdam (Nov 1988) • Offinga (Oct 1977) • Oostdam (Oct 1979) • Pastime Lakes (May 1980) • Marvo Holsteins #2 (Apr 1976) • Goyenetche Dairy #2 (Old Cawston Dairy) (Oct 1971) • Cottonwood (Apr 1981) • Bootsma-Silva Farms/Ramona Dairy #2 (Old Vermeer Dairy) (May 1973)
San Jacinto Lower Pressure Groundwater Management Zone										
1.0	1.9	1.1	1.1	520	730	800	800	1.0	520	• Van Ryn (1980/1981) • Jim Bootsma Jr. (May 1985) • Marvo Holsteins (Apr 1987)
Menifee Groundwater Management Zone										
2.8	5.4	4.4	4.6	1,021	3,360	2,050	2,030	2.8	1,020	• Abacherli (Apr 1980) • Boere (1978) • E.L. Farms (Feb 1988)
San Jacinto Upper Pressure Groundwater Management Zone										
1.4	1.9	1.5	1.4	321	370	350	350	1.4	320	• Arie & Josh De Jong (Nov 1987) • CBJ (1950's) • Ed Vander Woude (Oct 1971) • John Oostdam (Jun 1990) • R&J Haringa (May 1983) • Scott Brothers (Jun 1978) • John & Margie Oostdam Heifer Ranch (Aug 2012)
Elsinore Groundwater Management Zone										
1.0	2.6	2.2	2.1	476	480	470	490	1.0	480	Herman De Jong (Oct 1971)

1.0 Methodology

1.1 Regional Mapping Evaluation

A regional mapping evaluation was conducted to support the analyses in the 2014 report. That evaluation was not updated for the current analysis. The following description is from the 2014 report.

Depth to groundwater and groundwater quality data were used to generate time-series maps that display regional nitrate and TDS plumes. Land use data were also mapped to support general observations about potential sources of nitrate and TDS in groundwater. The wells used for the mapping study include both observation wells and agricultural production wells; sampling of the wells does not occur on a regular schedule.

Mapping reflects annual average constituent concentrations for each well for each year included in the evaluation to normalize seasonal variability in the data. Although the entire data set included well observations dating to the mid-1980s, the mapping evaluation excludes the earlier years because data were not available for most of the wells. Groundwater elevations and well information including screened intervals were used to determine groundwater flow based on data dating to 1995.

The maps and a technical memo providing additional detail on the evaluation are provided in Appendix A of the 2014 report. The evaluation resulted in the following general observations:

- TDS migration pathways appear to be different from nitrate and the two constituents might arise from different sources.
- TDS concentrations appear to be transient and could not be definitively associated with dairies, irrigated agriculture, or other potential agricultural sources.
- Areas with domestic livestock and equestrian activity appear to be most closely associated with nitrate concentrations.
- The association of septic systems with the nitrate plume indicates a possible relationship.
- In general, nitrate plumes mapped in the San Jacinto basin cannot be definitely correlated to dairy farming activity, but rather could be the result of other activity.
- A small sub-basin in the western portion of the study area (Lakeview Groundwater Management Zone in the vicinity of Albert Goyenetche Dairy #2, John Oostdam Dairy, and Offinga Dairy) may be influenced by dairy activity.

The remainder of this section details the data analysis conducted to identify potential groundwater impacts from individual dairies or groups of dairies and compares the results to the general observations from the mapping evaluation.

1.2 Hydrogeology of the San Jacinto Basin

The San Jacinto Groundwater Basin underlying the study area is located in western Riverside County, which includes the San Jacinto, Perris, Moreno, and Menifee Valleys. The groundwater basin is composed of sediments that have eroded from the surrounding mountains and filled the valleys formed

by erosion of the basement structures. The northwest-southeast oriented San Jacinto fault zone cuts through the eastern part of the basin and includes five distinct fault segments (San Jacinto, Claremont, Hot Springs, Park Hill, and Casa Loma). These active faults form barriers to groundwater movement. Thickness of the valley fill deposits is approximately 900 feet in the western and northern parts of the basin and may exceed 5,000 feet in the eastern part of the basin between the Casa Loma and Claremont faults. Most wells within the area west of the Casa Loma fault exist under water table conditions. Confined groundwater is found in the eastern part of the basin between the Casa Loma and Claremont fault due to the existence of finer grained layers within the stratigraphy (DWR 2006, WEI 2000).

Numerous hot springs occur along the base of the San Jacinto Mountains on the north side of the San Jacinto Upper Pressure management zone, and mineral-rich groundwater occurs naturally in areas downgradient of these hot springs. High mineral content as well as methane in the groundwater in some areas of the San Jacinto Lower Pressure management zone has resulted in groundwater quality unfit for human or livestock use. In addition, continued subsidence of Mystic Lake can lead to flooding of wells near the lake and in the adjacent wildlife area through unprotected well casings. Flooding might explain some of the variability in nitrate and TDS concentrations in those wells in the dataset used for this analysis (Scott 2014, personal communication).

Over the period of time studied since dairies began operating in the San Jacinto area, the direction of groundwater flow has changed due to numerous influences. DWR (2006) describes the groundwater level trends in the San Jacinto Groundwater Basin that have influenced the changes in direction of groundwater flow[2]:

> "Prior to the extraction of groundwater from the basin, groundwater flow was generally toward the course of the San Jacinto River and westward out of the basin. High extraction rates have produced groundwater depressions and locally reversed the historical flow pattern... During the 1970s through the 1990s, groundwater levels declined about 20 to 40 feet in the northern and southeastern parts of the basin [San Jacinto Upper Pressure and Lower Pressure management zones] and were relatively stable in the southern part of the basin [Hemet, Perris South and Menifee management zones]. During the 1970s through the 1980s, groundwater levels rose 80 to 200 feet in the western part of the basin [Lakeview, Perris North and Perris South management zones] because of infiltration from Lake Perris. During 2001 and 2002, groundwater levels generally rose in the central part of the basin [Hemet North, and portions of the Lakeview and San Jacinto Upper Pressure management zones] and declined in the northeastern and southern parts of the basin [northeast portion San Jacinto Upper Pressure and southeast portion of San Jacinto Lower Pressure management zones]" (DWR 2006).

[2] The bracketed text in the quoted passage is not part of the original text but has been added to roughly correlate the areas described in the text with the groundwater management zones identified throughout the report.

The primary sources for establishing recent and historical groundwater flow direction for these analyses are Figures 3-6 and 3-7 (Fall 1973 and Fall 1997 groundwater elevation contours, respectively) from the Wildermuth report (WEI 2000); Figure 9-6 (Spring 2012 Groundwater Elevation Contours) from the *Hemet/San Jacinto Groundwater Management Area Water Management Plan, 2012 Annual Report* (EMWD 2013) and the regional mapping evaluation (see WRCAC 2014, Appendix A).

Before pumping and artificial recharge began in this area, groundwater flow mimicked surface drainage patterns, flowing down from the surrounding mountains and following the flow of the San Jacinto River. Groundwater production and artificial recharge has significantly modified the groundwater flow systems within much of the region, in particular west of the Casa Loma Fault. For example, a groundwater sink has reversed the original westward flow of groundwater in the Hemet area. Westward flow of groundwater in the Lakeview area evident in 1973 groundwater contours has also reversed to its current eastward flow direction as a result of groundwater overdraft in the Lakeview area and artificial recharge and returns from agricultural use in the Perris area. Groundwater flow directions within the San Jacinto Upper and Lower Pressure zones have generally been stable over the study period. However, groundwater production has altered flow directions in small localized areas (WEI 2000).

Many of the dairies began operating in the 1970s, with the majority operating before 1985 (see Table 1), and in some cases significant changes in the groundwater flow direction have occurred during the period of record for this study. In particular, changes to the groundwater flow direction have occurred in areas surrounding six facilities located in the San Jacinto Upper Pressure management zone (R & J Haringa, John Oostdam, John & Margie Oostdam Heifer Ranch, Arie & Josh De Jong, CBJ, and Ed Vander Woude), and five facilities located east-northeast of Lakeview within the Lakeview and San Jacinto Lower Pressure management zones (Albert Goyenetche #2, John Bootsma, Offinga, Jim Bootsma Jr., and Marvo Holsteins). The changes in groundwater flow direction during the time of the dairy operations and the time period covered by many of the groundwater samples makes it challenging to assess, with a high degree of certainty, the upgradient versus downgradient areas for these dairies. Variability in the historical groundwater flow direction is discussed in more detail in the analysis for each of the facilities.

1.3 Well Selection

To the extent possible, wells were selected that best represent groundwater quality within the footprint of each dairy's production area ("facility wells"), as well as groundwater quality in areas that are upgradient and downgradient of each dairy. Privately owned wells that participate in the groundwater monitoring programs are protected from public identification and are therefore referred to by well number only, which were assigned randomly for purposes of this report[3].

To facilitate the selection of appropriate wells to use in the analysis, dairy locations and all available well locations were plotted in the Google Earth™ mapping service. Land use layers displaying dairy

[3] A table cross-referencing the well numbers used for this report with the well identifications used by EMWD and EVMWD is included in the *Annual Analysis Protocols* report, on file with WRCAC, and may not be released publicly without permission of the well owners.

production areas (dairy intensive and non-intensive), irrigated land, backyard livestock areas, horse facilities, manure compost areas, poultry facilities, and septic system use in the study area were created to facilitate the analysis. The land use layers are based on the geographical information systems (GIS) dataset created by Aerial Information Systems, Inc. (AIS). Under contract to WRCAC, AIS cataloged the agricultural land uses mapped in 2007 within the San Jacinto River watershed (AIS 2009). For the revised analysis, a land use map created by AIS displaying 2014 data was reviewed to update the dairy-specific land use discussions; however, the land uses shown in the facility maps displayed in this report are based on the previous land use data layer.

Groundwater flow direction for the 2014 analysis was established primarily using the results of the groundwater flow mapping effort in the Wildermuth reports and the *2012 Annual Report* (EMWD 2013), and supplemented by mapping static groundwater levels using data provided by EMWD. During a series of dairy site visits conducted in September, 2015, EMWD provided additional information on localized groundwater flow direction specific to individual dairies or groups or dairies, which resulted in better identification of upgradient and downgradient wells for the current analysis. Updated well selection based on improved understanding of localized groundwater flow direction is reflected in the site-specific "Impacts Analysis" descriptions in sections 2 – 6 of this report.

For most facilities, the groundwater flow direction has remained relatively stable during the period of the study. Selecting upgradient and downgradient well locations was straightforward. However, for some facilities the groundwater flow direction was variable over the study period and selecting upgradient and downgradient wells with a high degree of confidence was not possible. In some cases, it was necessary to limit the groundwater quality data to certain periods of time based on historic changes in the groundwater flow direction to ensure that upgradient, facility and downgradient well selections are representative of the current groundwater flow. Variability in the historical groundwater flow patterns and the impact on well selection is discussed in the individual analysis sections for those facilities.

To assess the options for well selection, the locations of available facility, upgradient, and downgradient wells were reviewed. The review indicated that some dairies lack facility, upgradient, and/or downgradient wells. Of the dairies to be evaluated, four dairies have no available facility wells, three have no available upgradient wells, and two have no available downgradient wells.

This review also revealed several groups of several adjacent dairies that must be analyzed as a group because the individual impact of a particular dairy cannot be determined by this screening analysis. Because close proximity to other dairies does not allow for establishing upgradient, downgradient, and in some cases even facility groundwater conditions for a specific dairy, the selected wells were used to represent upgradient, downgradient, and facility conditions for the entire group of dairies. The analysis of these groups of dairies combined all facility well data.

1.3.1 Facility Well Selection

To the extent possible, all available facility wells that are located within or immediately downgradient from the dairy production area were used to represent the groundwater quality at the dairy or group of dairies. When available, facility well data were compared to upgradient and downgradient well data.

1.3.2 Upgradient Well Selection

Based on the groundwater flow direction, wells were selected for each dairy that are located upgradient from the dairy production area and any land application fields associated with that dairy. To the extent possible, upgradient wells were selected that were not likely to be influenced by other dairy or non-dairy operations. All selected upgradient wells were located within 1.5 miles of the facility. The permit called for wells within a 5 mile radius of the facilities to be used in the study; however, a pre-analysis review of the distribution of available wells in the vicinity of each dairy revealed that selection of upgradient wells within a radius of 1.5 miles of each facility would result in the greatest number of wells while still being representative of upgradient conditions, and would most often result in a dataset that meets the data quality goal of having at least 10 samples and less than 20 percent non-detects; the minimum dataset necessary to complete a quantitative statistical analysis (see section 1.3). This approach was agreed upon in a discussion with RWQCB staff on January 13, 2014 (SARWQCB 2014) and documented in a memorandum submitted to the RWQCB on March 7, 2014 (Tetra Tech 2014).

1.3.3 Downgradient Well Selection

Based on the groundwater flow direction, wells were selected that are located downgradient from the dairy production area and land application fields. To the extent possible, downgradient wells were selected that were not likely to be influenced by other dairy or non-dairy operations. Selected downgradient wells are located within 1.5 miles of the facility. As discussed above for upgradient well selection, a review of the distribution of available wells in the vicinity of each dairy revealed that downgradient well selection within a radius of 1.5 miles of each facility resulted in the greatest number of wells while still being representative of downgradient conditions, and will most often result in a dataset that meets the goal of having at least 10 samples and less than 20 percent non-detects; the minimum necessary to complete a quantitative statistical analysis.

1.3.4 Protocols for Incomplete or Unavailable Well Data

In some cases, no facility wells were present within the dairy production area. In those cases, the analysis compared upgradient well concentrations to downgradient well concentrations only. One of the dairies without facility wells also has no upgradient wells and historical averages from the Wildermuth reports were used to represent pre-dairy conditions. It is important to note that in this case, confidence in conclusions might not be high and further investigation might be necessary.

Some dairies (e.g., those located along the eastern flank of the Lakeview Mountains) have no upgradient or downgradient wells. In those cases the only wells available are located near the facility, but not in the direct groundwater flow path across the facility. Selecting these “crossgradient” wells allowed for establishing groundwater conditions in close proximity to the subject dairy but without the influence of other upgradient dairies. A review of the distribution of available wells in the vicinity of these dairies reveals that crossgradient well selection within a radius of 1.5 miles of each facility would result in the

greatest number of wells while still being representative, and would most often result in a dataset that meets the goal of having at least 10 samples and less than 20 percent non-detects; the minimum necessary to complete quantitative statistical analysis. For these facilities, the analysis was limited to a comparison of the crossgradient well concentrations to the facility well concentrations only.

1.4 Analytical Methods

For both individual dairies and groups of dairies evaluated together, information was tabulated for each well, including the perforated interval of the wells; sample dates; number of samples and number of non-detects; the mean, minimum, maximum, and standard deviation of TDS and nitrate concentrations in samples from each well; and a combined average concentration for all wells within each group of upgradient, downgradient, and facility wells.

Using combined data from wells representing upgradient, downgradient, and facility groundwater quality, boxplots (also termed "box and whisker" plots) were created using JMP statistical software (Version 10). A boxplot is a graphic display of the median, 25th percentile, and 75th percentile values in a dataset (the box), the highest value within the upper limit and the lowest value within the lower limit (the whiskers), and any observations beyond the whiskers (outliers) as indicated in Figure 1.

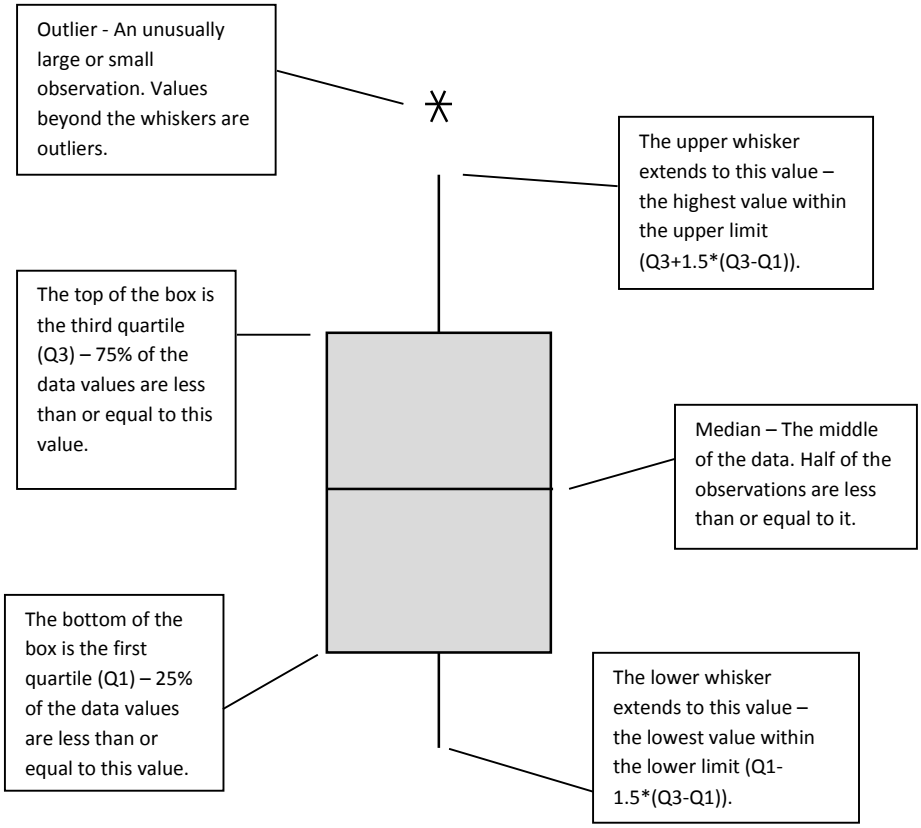


Figure 1. Example boxplot.

If possible, a quantitative statistical analysis of the groundwater quality data was performed to determine if the groundwater quality differed significantly between the groups (upgradient, facility, and downgradient wells). A Student's t-Test can be used to determine the probability that mean groundwater TDS or nitrate concentrations differ significantly between two groups of wells, e.g., upgradient vs. downgradient. Where data are available, one-way Analysis of Variance (ANOVA) can be used to test for significant differences among mean TDS or nitrate concentrations from more than two well groups, e.g. upgradient vs. facility vs. down gradient. Where significant differences among group means are indicated by ANOVA, one or more multiple range tests could be used to identify specifically which group means differ. Given the numerous sources of nutrients in groundwater (both dairy and non-dairy), significant differences in sample dates and number of samples, variation in screened intervals in the wells, and unknown groundwater sample depths, an alpha of 0.10 was used in the statistical analyses; thus, differences between well groups was reported with 90 percent confidence. Actual significance levels (*P* values) are reported for all analyses. JMP statistical software (v. 10) was used to perform all statistical analysis.

1.5 Censored Data and Sampling Periods of Record

Approximately 15 percent of the available nitrate data were reported as non-detects, i.e., the true concentration in the sample was below the lower detection limit of the laboratory analysis. For these censored data, a value of one-half the detection limit was used for the calculation of mean and standard deviation, as well as in the creation of boxplots. Datasets with more than 20 percent non-detects were not used for quantitative statistical inference. In addition, data sets with fewer than 10 samples were not used for quantitative analysis.

In some cases the datasets used to assess the connection between dairy operations and groundwater quality have sample dates with variable overlap between the upgradient, facility, and downgradient wells. Under such conditions, lack of time alignment might add uncertainty to any conclusions because samples were collected under potentially different conditions and influences. To address this uncertainty, sample periods of record for the upgradient, facility and downgradient groups were limited so that the sample date periods of record for the three groups were concurrent. The facility well group period of record was used to establish the years of concurrence. For example, if the available well data were from 1996 to 2015, 2001 to 2015 and 1998 to 2015 for upgradient, facility and downgradient wells, respectively, only upgradient and downgradient data from 2001 to 2015 were used in the comparative analysis.

1.6 Uncertainties in Results

Sections 2 – 6 describe the dairy-level analyses and conclusions for each dairy or group of dairies. However, it should be noted that numerous uncertainties in the data and analyses reduce the level of confidence in conclusions of either no impact or significant impact. The conclusions section for each individual analysis identifies some of the general uncertainties included in the findings. A more detailed description of the uncertainties for the overall dairy-level analyses and for each individual analysis is included in Section 7.0, Conclusions and Recommendations.

2.0 Impacts Analysis – Lakeview/Hemet North Management Zone

2.1 Group of Dairies (John & Margie Oostdam, Hettinga, and Oostdam)

Three dairies identified as John & Margie Oostdam Dairy, Oostdam Dairy, and Hettinga Dairy[4] are located just south of the intersection of Ramona Expressway and Warren Road. Land identified as dairy intensive for these facilities is less than 700 feet apart, and dairy non-intensive land for each dairy is either directly adjacent or separated only by Warren Road (see Figure 2). The three dairies were analyzed as a group because the close proximity of the dairies makes it infeasible to determine the impact of each individual dairy with any degree of confidence.

The dairies were reported to have started operations between May 1976 (Hettinga) and November 1988 (John & Margie Oostdam). The resources used to assess the groundwater flow direction WRCAC 2014, WEI 2000, EMWD 2013) indicate the flow is generally from southeast to northwest and no changes have occurred in the groundwater flow regime in the vicinity of these dairies. Because no change in the groundwater flow direction is documented over the period of dairy operation and the sample dates generally cover the latter period of time of dairy operation, there is no reason to eliminate any of the samples from the dataset based on changes in direction of groundwater flow.

This group of dairies is located immediately north-northwest, and downgradient, of a series of buildings identified as poultry facilities with associated manure composting operations. Other potential impacts to groundwater quality in the vicinity include irrigated fields, septic systems, and an abandoned dairy. The group of dairies is bordered on the east and west by fault zones.

The analysis for this group of dairies includes 10 upgradient wells with a total of 77 nitrate and 79 TDS samples collected from 2/23/1994 to 5/12/2015, five facility wells with a total of 59 nitrate and 58 TDS samples collected from 3/3/1994 to 9/1/2015, and three downgradient wells with a total of 31 nitrate and TDS samples collected from 10/5/2000 to 5/12/2015.

[4] Table 4 of the *Salt Offset Options for the San Jacinto River Basin Dairies* (WEI 2008), listed Hettinga Dairy in the San Jacinto Upper Pressure Management Zone.

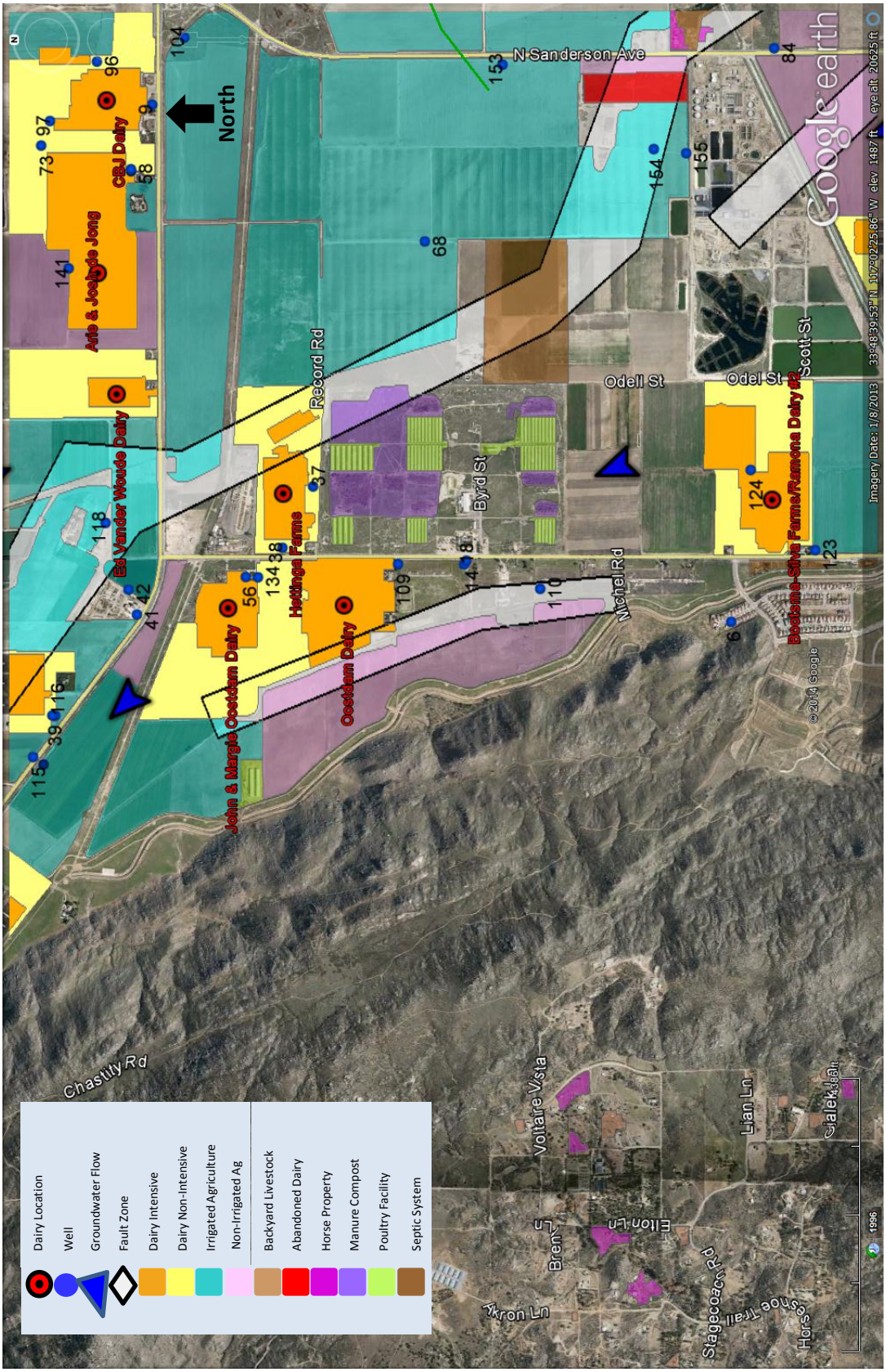


Figure 2. Location map of the vicinity of John & Margie Oostdam, Oostdam, and Hettinga Dairies

2.1.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 2. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
6	-	9/3/08-5/12/15	7	0	0	3.1	3.4	2.3 – 3.6	0.51
14	876 – 1332	2/23/94-5/28/14	17	0	0	1.8	1.8	0.5 – 2.9	0.58
18	698 – 1078	7/25/95-2/24/14	19	0	5%	1.1	1.0	<0.1 – 2.0	0.48
68	684 - 1085	12/18/06-10/28/14	8	8	100%	0.06	0.05	<0.1 – 0.1	0.03
110	-	3/3/94-9/26/95	2	0	0	0.3	0.3	0.1 – 0.5	0.28
123	-	10/9/02-5/12/15	10	0	0	4.4	5.4	0.7 – 6.8	2.35
124	1112 – 1302	9/23/04-12/16/05	2	0	0	3.8	3.8	3.7 – 3.9	0.14
153	657 – 1094	6/21/96-10/10/02	5	3	60%	0.1	0.1	<0.1 – 0.1	0.27
154	1228 – 1438	9/27/95-7/15/04	4	3	75%	0.2	0.1	<0.1 – 0.4	0.17
155	-	5/24/00-4/1/02	3	2	67%	0.4	0.1	<0.1 – 1.0	0.53
Upgradient Group Summary			**77**	**17**	**22%**	**1.6**	**1.4**	**<0.1 – 6.8**	**1.69**
Facility Group									
37	923 – 1198	6/19/02-12/21/15	16	0	0	2.7	2.3	0.2 – 5.3	1.45
38	893 – 1213	6/19/02-5/14/15	15	0	0	3.3	3.4	0.3 – 5.6	1.41
56	910 – 1270	6/9/02-12/21/15	11	0	0	1.3	1.0	0.4 – 3.0	1.00
109	950 – 1154	3/3/94-12/16/06	6	0	0	2.1	2.2	0.5 – 3.3	1.07
134	-	10/9/02-9/1/15	11	0	0	1.7	1.4	0.7 – 3.3	0.92
Facility Group Summary			**59**	**0**	**0**	**2.4**	**2.1**	**0.2 – 5.6**	**1.41**
Downgradient Group									
41	643 – 1162	6/11/01-5/12/15	13	12	92%	<0.1	<0.1	<0.1 – 0.2	0.06
42	934 - 1154	6/22/01-2/24/14	14	14	100%	0.1	<0.1	<0.1 – 0.1	0.02
118	738 - 1058	10/5/00-2/21/06	4	4	100%	<0.1	<0.1	<0.1 – 0.1	0.02
Downgradient Group Summary			**31**	**30**	**97%**	**<0.1**	**<0.1**	**<0.1 – 0.2**	**0.05**

Notes: Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there does not appear to be an increase in nitrate concentrations downgradient from the facility and the average facility well concentration is approximately equal to or lower than the historical average nitrate concentrations for the Lakeview/Hemet North management zone for the periods1954 to 1973 (1.8 mg/L), 1978 to 1997 (2.7 mg/L), 1990 to 2009 (2.6 mg/L), and 1993 to 2012 (2.5 mg/L) (WEI 2000, 2011, 2014).

Table 3. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									

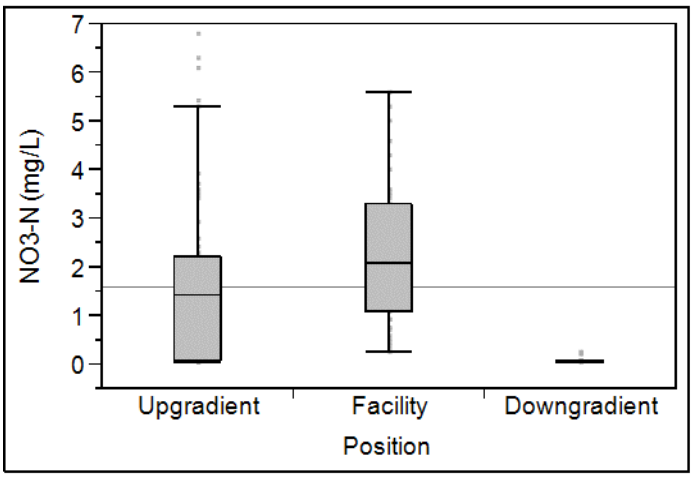
6	-	9/3/08-5/12/15	7	0	0	620	640	490 - 690	76.2
14	876 – 1332	2/23/94-5/28/14	19	0	0	542	450	400 - 987	207.9
18	698 – 1078	7/25/95-2/24/14	19	0	0	991	990	830 - 1200	97.4
68	684 - 1085	12/18/06-10/28/14	8	0	0	348	280	230 - 880	215.8
110	-	3/3/94-9/26/95	2	0	0	504	504	372 - 635	186.0
123	-	10/9/02-5/12/15	10	0	0	786	890	520 - 1010	191.1
124	1112 – 1302	9/23/04-12/16/05	2	0	0	620	620	590 - 650	42.4
153	657 – 1094	6/21/96-10/10/02	5	0	0	244	240	220 - 280	23.0
154	1228 – 1438	3/27/95-7/15/04	4	0	0	427	424	380 - 480	50.2
155	-	5/24/00-4/1/02	3	0	0	547	550	530 - 560	15.3
Upgradient Group Summary			**79**	**0**	**0**	**645**	**580**	**220 - 1200**	**280.6**
Facility Group									
37	923 – 1198	6/19/02-12/21/15	16	0	0	568	600	460 - 650	67.3
38	893 – 1213	6/19/02-5/14/15	15	0	0	469	467	420 - 580	37.1
56	910 – 1270	6/19/02-12/21/15	11	0	0	447	440	420 - 480	18.5
109	950 – 1154	4/30/96-12/16/06	5	0	0	428	430	380 - 460	29.5
134	-	10/9/02-9/1/15	11	0	0	435	440	420 - 460	12.9
Facility Group Summary			**58**	**0**	**0**	**482**	**460**	**380 - 650**	**68.4**
Downgradient Group									
41	643 – 1162	6/11/01-5/12/15	13	0	0	417	420	380 - 480	26.9
42	738 – 1058	6/22/01-2/24/14	14	0	0	558	560	530 - 580	15.6
118	934 - 1154	10/5/00-2/21/06	4	0	0	372	370	350 - 400	20.6
Downgradient Group Summary			**31**	**0**	**0**	**475**	**440**	**350 - 580**	**81.0**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table suggests that the average TDS concentration in facility wells is lower than that in upgradient wells, and that there is not a substantial difference in mean TDS concentrations between facility and downgradient well groups. The facility well concentrations are lower than the average TDS concentrations for the Lakeview/Hemet North management zone for the periods 1954 to 1973 (519 mg/L), 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L), and 1993 to 2012 (860 mg/L) (WEI 2000, 2011, 2014).

2.1.2 Boxplots

Boxplots using combined data from wells representing upgradient, downgradient, and facility groundwater quality are shown in Figures 3 and 4 for nitrate and TDS concentrations, respectively.



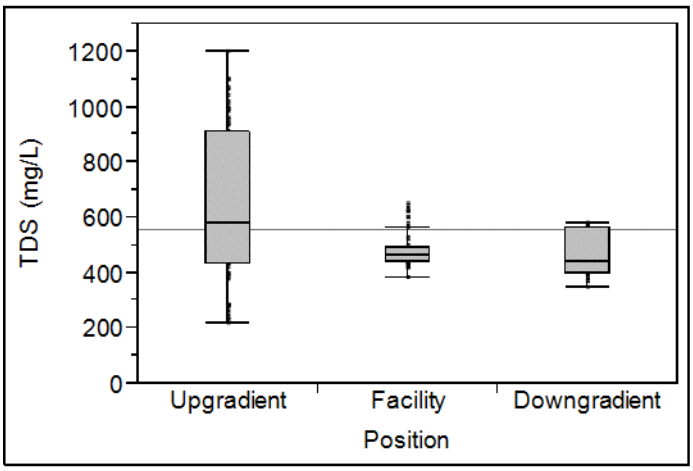
Historic Average Nitrate Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 2.5 mg/L

- 1990 to 2009 - 2.6 mg/L
- 1978 to 1997 - 2.7 mg/L
- 1954 to 1973 - 1.8 mg/L

Figure 3. Boxplot of upgradient, facility, and downgradient nitrate concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies

The boxplots indicate that the distributions of nitrate concentrations in the facility wells have been somewhat higher than those measured in the upgradient wells and that the downgradient nitrate concentrations have been lower (in fact often less than the detection limit) than either upgradient or facility concentrations. In this case it could be inferred that although elevated nitrate levels in facility wells suggest the possibility of dairy influence on local groundwater quality, this influence does not extend to the downgradient groundwater.



Historic Average TDS Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 860 mg/L
- 1990 to 2009 - 890 mg/L
- 1978 to 1997 - 830 mg/L
- 1954 to 1973 - 519 mg/L

Figure 4. Boxplot of upgradient, facility, and downgradient TDS concentrations for John & Margie Oostdam, Oostdam, and Hettinga Dairies

The boxplots indicate that TDS concentrations in the facility wells have been lower and less variable than the upgradient wells and comparable to the downgradient well concentrations. However, the fact that the distribution of TDS concentrations in facility and downgradient wells has occurred within the range of those observed upgradient suggests that the dairy facilities have not contributed to increased groundwater TDS concentrations.

2.1.3 Quantitative Statistical Analysis

Because the nitrate datasets for upgradient and downgradient wells both contain greater than 20 percent non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and an ANOVA was used to test for significant differences among TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient).

Upgradient	Mean TDS (mg/L) Facility	Downgradient	F value	*P* value
645 a	482 b	475 b	14.23	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). ANOVA results indicate that a significant difference exists between the three well groups. In this case the facility and downgradient groundwater has significantly lower mean TDS concentrations compared to the upgradient, but facility and downgradient groundwater mean TDS levels do not differ.

2.1.4 Conclusions

Based on the available data, it appears that the combined dairy operations at John & Margie Oostdam, Oostdam, and Hettinga dairies have not increased nitrate or TDS concentrations in groundwater downgradient from the dairy operations. The following specific observations were made which support the conclusion:

- There is no increase in nitrate concentrations downgradient from the facility and the average facility well concentration is approximately equal to or lower than the historical averages for the Hemet North management zone.
- The boxplots of nitrate concentrations indicate downgradient well concentrations are lower than either upgradient or facility concentrations.
- The average TDS concentration in downgradient wells is slightly lower than facility wells.
- TDS concentrations in facility wells are lower than the average historical TDS concentrations for the Lakeview/Hemet North management zone.
- The boxplot of nitrate concentrations indicates no significant increase in downgradient wells compared to facility wells.
- The ANOVA results indicate that TDS concentrations are significantly lower in facility and downgradient wells compared to upgradient wells.

However, the observation that nitrate concentrations in facility wells have tended to be higher than those in upgradient wells (Figure 3) suggest that continued monitoring and further investigation of facility influence on groundwater nitrate levels might be warranted in this case.

2.2 Group of Dairies (Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2) – Analysis South of Fault

Four dairies identified as Hollandia Dairy, Gerben Hettinga Expressway Dairy, Boersma Dairy, and Marvo Holsteins Dairy #2 are located along Ramona Expressway, northwest of Warren Road and southeast of Pico Road. Areas identified as dairy intensive for these facilities are either directly adjacent or less than 900 feet apart, and dairy non-intensive land for each dairy is either directly adjacent or separated only by Ramona Expressway (see Figure 5). These four dairies are analyzed as a group because the close proximity of the dairies does not make it feasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping (WRCAC 2014), published reports (WEI 2000, EMWD 2013), and field verification by EMWD during site visits conducted in September, 2015, the groundwater flow in the vicinity of the dairies is generally from the southeast to northwest, as indicated by the generalized groundwater flow arrows in Figure 5. Wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located immediately north-northwest of, and downgradient from, the group of dairies identified in the previous section (John & Margie Oostdam Dairy, Oostdam Dairy, and Hettinga Dairy), so the upgradient groundwater quality is, in part, best represented by the wells from the upgradient facilities. Other potential impacts to groundwater quality in the vicinity include irrigated fields and a poultry facility. All of the downgradient wells used in the analysis for this group are located within or immediately adjacent to irrigated agriculture fields. The Casa Loma fault zone, located northeast of Boersma Dairy and running through the Hollandia, Gerben Hettinga Expressway, and Marvo Holsteins #2 dairies, is a barrier to groundwater flow in this area. Therefore, separate analyses are required to evaluate impacts south and north of the fault, in the Lakeview/Hemet North GMZ and Upper Pressure GMZ, respectively. These separate analyses are presented below for the areas south and north of the Casa Loma fault zone, in Sections 2a and 2b, respectively.

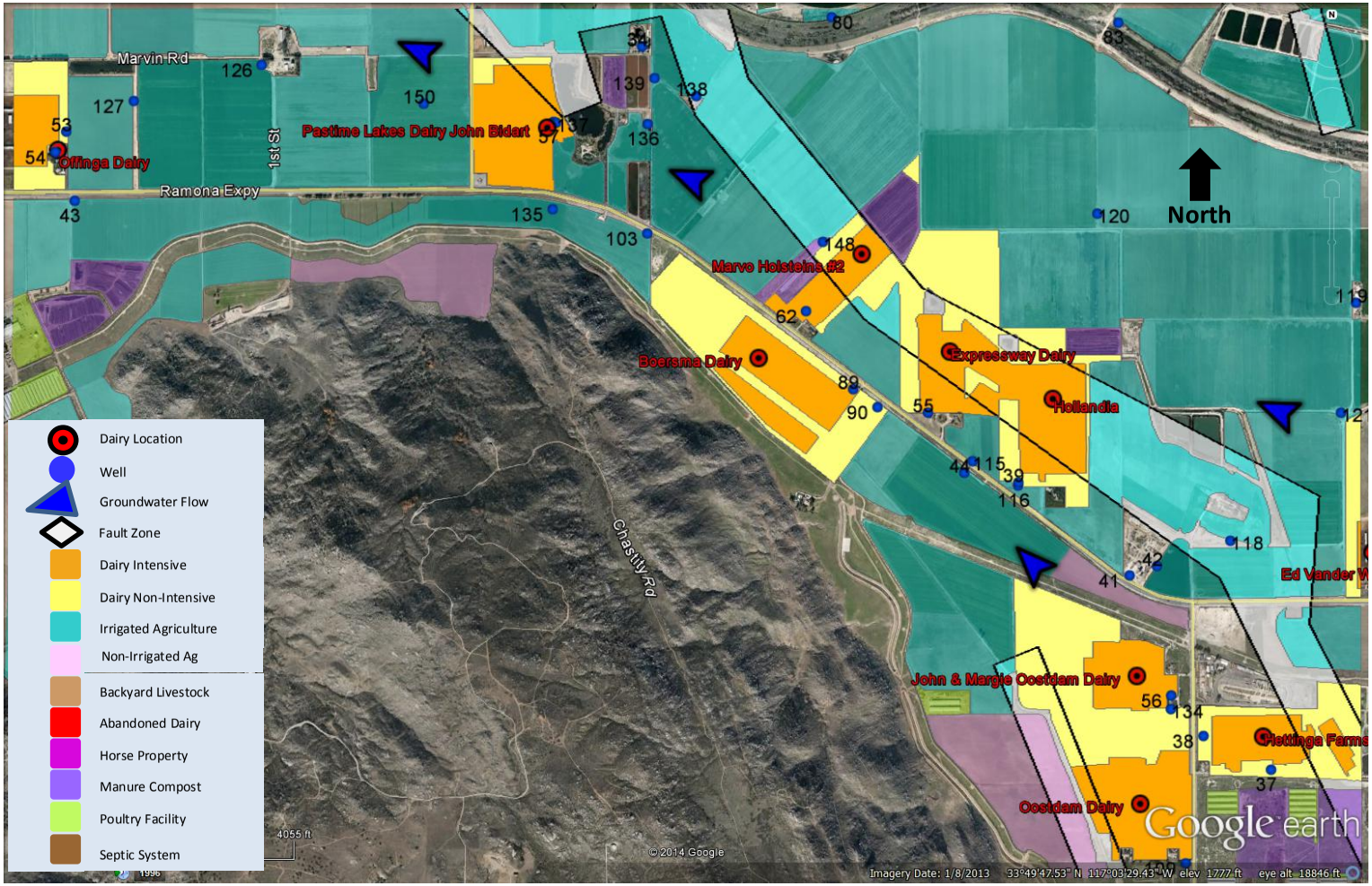


Figure 5. Location map of the vicinity of Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies

2.2a.1 Summary Data for the Analyses South of the Casa Loma Fault

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells located south of the Casa Loma fault. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 4. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
37	923 – 1198	6/19/02-12/21/15	16	0	0%	2.7	2.3	0.2 – 5.3	1.45
38	893 – 1213	6/19/02-5/14/15	15	0	0%	3.3	3.4	0.3 – 5.6	1.41
41	643 – 1162	6/11/01-5/12/15	13	12	92%	<0.1	<0.1	<0.1 – 0.2	0.06
42	934 – 1154	6/22/01-2/24/14	14	14	100%	<0.1	<0.1	-	0.02
56	910 – 1270	6/19/02-12/21/15	11	0	0%	1.3	0.9	0.4 – 3.0	1.00
134	-	10/9/02-9/1/15	11	0	0%	1.7	1.4	0.7 – 3.3	0.92
Upgradient Group Summary			**80**	**26**	**32%**	**1.6**	**1.1**	**<0.1 – 5.6**	**1.60**
Facility Group									
39	1011 - 1236	6/18/02-6/9/15	13	9	69%	0.1	0.1	<0.1 – 0.8	0.20
44	-	8/13/99-3/12/13	14	12	86%	<0.1	<0.1	<0.1 – 0.3	0.06
55	-	6/7/02-9/1/15	14	0	0%	0.4	0.4	0.2 – 0.8	0.21
62	-	8/25/03-5/12/15	13	0	0%	1.5	1.7	0.1 – 2.1	0.60
89	-	6/18/02-9/1/15	13	1	8%	0.4	0.4	<0.1 – 0.6	0.14
90	-	5/24/96-5/12/15	6	0	0%	1.0	1.1	0.1 – 1.8	0.73
115	-	6/24/02-5/12/15	10	0	0%	0.6	0.6	0.4 – 0.7	0.11
116	-	6/23/08-3/31/09	2	1	50%	0.1	0.1	<0.1 – 0.2	0.11
Facility Group Summary			**85**	**23**	**27%**	**0.5**	**0.3**	**<0.1 – 2.1**	**0.56**
Downgradient Group									
103	899 – 1251	5/23/96-5/4/04	10	0	0%	1.2	1.2	0.6 – 1.7	0.33
Downgradient Group Summary			**10**	**0**	**0%**	**1.2**	**1.2**	**0.6 – 1.7**	**0.33**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that although there appears to be a slight increase in nitrate concentrations downgradient from the facilities, both facility and downgradient concentrations are lower than upgradient concentrations. This pattern, coupled with the lower nitrate levels in facility wells compared to upgradient, suggests that the facility has not had significant impact on groundwater nitrate concentrations. The average facility well concentrations are lower than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973 (1.8 mg/L), 1978 to 1997 (2.7mg/L), 1990 to 2009 (2.6 mg/L), and 1993 to 2012 (2.5 mg/L) (WEI 2000, 2011, 2014).

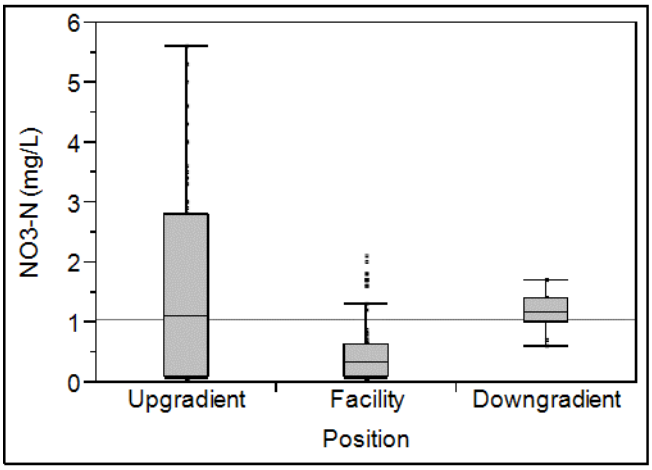
Table 5. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
37	923 – 1198	6/19/02-12/21/15	16	0	0%	568	600	460 - 650	67.3
38	893 – 1213	6/19/02-5/14/15	15	0	0%	469	467	420 - 580	37.1
41	643 – 1162	6/11/01-5/12/15	13	0	0%	417	420	380 - 480	26.9
42	934 – 1154	6/22/01-2/24/14	14	0	0%	558	560	530 - 580	15.6
56	910 – 1270	6/19/02-12/21/15	11	0	0%	447	440	420 - 480	18.5
134	-	10/9/02-9/1/15	11	0	0%	435	440	420 - 460	12.9
Upgradient Group Summary			**80**	**0**	**0%**	**488**	**460**	**380 - 650**	**70.7**
Facility Group									
39	1011 - 1236	6/18/02-6/9/15	13	0	0%	517	520	440 - 570	44..0
44	-	8/13/99-3/12/13	14	0	0%	496	495	450 - 540	29.5
55	-	6/7/02-9/1/15	14	0	0%	521	520	500 - 540	14.9
62	-	8/25/03-5/12/15	13	0	0%	617	610	360 - 720	88.1
89	-	6/18/02-9/1/15	13	0	0%	632	630	620 - 640	8.3
90	-	5/24/96-5/12/15	6	0	0%	598	600	590 - 600	4.1
115	-	6/24/02-5/12/15	10	0	0%	559	550	530 - 590	22.3
116	-	6/23/08-3/31/09	2	0	0%	415	415	400 - 430	21.2
Facility Group Summary			**85**	**0**	**0%**	**555**	**550**	**360 - 720**	**68.8**
Downgradient Group									
103	899 – 1251	5/23/96-5/4/04	10	0	0%	565	568	490 - 620	39.4
Downgradient Group Summary			**10**	**0**	**0%**	**565**	**568**	**490 - 620**	**39.4**

The above summary table indicates that the average TDS concentration is greater in the facility wells compared to upgradient wells and there is a slight increase in average TDS concentrations downgradient from the dairy facilities. The average facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for the 1954 to 1973 period of 519 mg/L, but less than the average for the periods 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L), and 1993 to 2012 (860 mg/L) (WEI 2000, 2011, 2014).

2.2a.2 Boxplots – South of Fault

Boxplots were created using combined data from wells representing upgradient, downgradient, and facility groundwater quality (Figures 6 and 7).

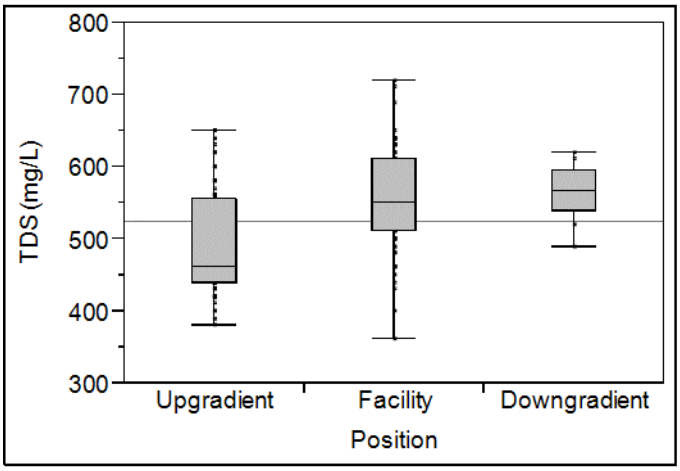


Historic Average Nitrate Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 2.5 mg/L
- 1990 to 2009 - 2.6 mg/L
- 1978 to 1997 - 2.7 mg/L
- 1954 to 1973 - 1.8 mg/L

Figure 6. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault

The boxplots indicate that although the distribution of nitrate concentrations in the facility and downgradient well groups fall within the overall range of concentrations in the upgradient wells, nitrate levels in the facility wells tend to be lower than in the upgradient wells, and the downgradient well nitrate concentrations are slightly higher than the facility concentrations. Averages for all groups are lower than historic averages for the Lakeview/Hemet North management zone.



Historic Average TDS Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 860 mg/L
- 1990 to 2009 - 890 mg/L
- 1978 to 1997 - 830 mg/L
- 1954 to 1973 - 519 mg/L

Figure 7. Boxplot of upgradient, facility, and cowngradient TDS concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – South of Fault

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tend to be higher than those recorded in the upgradient wells. This could suggest a facility influence on downgradient groundwater quality, though the average facility and downgradient concentrations are less than the average TDS for the periods 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L) (WEI 2000, 2011, 2014).

2.2a.3 Quantitative Statistical Analysis – South of Fault

Because the nitrate datasets for all three well groups contain greater than 20 percent non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and an ANOVA was used to test for significant differences among mean TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient).

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
488 a	555 b	565 b	20.6	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results indicate that a significant difference exists among the three well groups. Mean TDS levels in both facility and downgradient groundwater have been significantly higher than that observed in upgradient wells.

2.2a.4 Conclusions – South of Fault

Based on the available data, it appears that the combined dairy operations at Hollandia Dairy, Gerben Hettinga Expressway Dairy, Boersma Dairy, and Marvo Holsteins Dairy #2 south of the Casa Loma fault zone have not increased observed groundwater nitrate concentrations. The combined operations could

be responsible for contributing to increased TDS concentrations in groundwater in the vicinity of the facilities and downgradient from the dairy operations. The following specific observations support these conclusions:

- There is a slight increase in nitrate concentrations downgradient from the facilities; however, average facility and downgradient well concentrations are both lower than the upgradient concentrations.
- Average nitrate concentrations for all groups are lower than Lakeview/Hemet North management zone historical averages.
- The boxplot of nitrate concentrations indicates no significant increase in downgradient wells compared to facility wells.
- There are higher average TDS concentrations in facility and downgradient groundwater compared to upgradient.
- The average TDS concentration for facility and downgradient wells is less than the Lakeview/Hemet North management zone averages for 1978 to 1997, 1990 to 2009 and 1993 to 2012.
- The boxplot of TDS concentrations shows an increase between upgradient and facility wells, but no appreciable increase between facility and downgradient wells.
- The statistical analysis of TDS concentrations indicates that facility and downgradient wells have significantly higher concentrations compared to upgradient wells; however, there is no significant increase between facility and downgradient wells.

Based on available information, it is not feasible to determine the source of elevated TDS concentrations or the individual contribution of each dairy in the potential impacts to downgradient groundwater quality. Numerous non-dairy sources of nitrate and TDS exist in the vicinity of the dairies. All of the downgradient wells used in the analysis for this group are located within or immediately adjacent to irrigated agriculture fields. Additionally, variations in sample dates, unknown or dissimilar perforated intervals, the impact of fault zones, and the close proximity of individual wells make it infeasible to determine the direct TDS contribution for each dairy with a high degree of confidence. In this case, further study is needed to more accurately determine the individual impact of each dairy.

2.2b.1 Summary Data for the Analyses North of the Casa Loma Fault

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells located north of the Casa Loma fault. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 6. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
121		6/11/01-7/9/09	9	9	100%	<0.1	<0.1	<0.1 – 0.1	0.03
Upgradient Group Summary			**9**	**9**	**100%**	**<0.1**	**<0.1**	**<0.1 – 0.1**	**0.03**
Facility Group									
148	-	10/5/00-5/19/15	14	12	86%	0.3	<0.1	<0.1 – 1.9	0.67
Facility Group Summary			**14**	**12**	**86%**	**0.3**	**<0.1**	**<0.1 – 1.9**	**0.67**
Downgradient Group									
136	-	5/10/04-8/28/14	4	0	0%	0.6	0.6	0.4 – 1.0	0.26
138	845 - 1245	9/12/00-6/25/03	5	5	100%	<0.1	<0.1	-	0.03
139	636 - 1234	6/30/00-6/23/08	8	6	75%	0.1	0.1	<0.1 – 0.2	0.05
Downgradient Group Summary			**17**	**11**	**65%**	**0.2**	**0.1**	**<0.1 – 1.0**	**0.27**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there might be a slight increase in nitrate concentrations in facility and downgradient wells; however, both facility and downgradient concentrations are lower than upgradient concentrations. The fact that nearly all reported values are below detection limits makes it difficult to attach much confidence to the apparent slight differences in mean nitrate levels. The average facility and downgradient well concentrations are lower than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973 (1.8 mg/L), 1978 to 1997 (2.7 mg/L), 1990 to 2009 (2.6 mg/L), and 1993 to 2012 (2.5 mg/L) (WEI 2000, 2011, 2014).

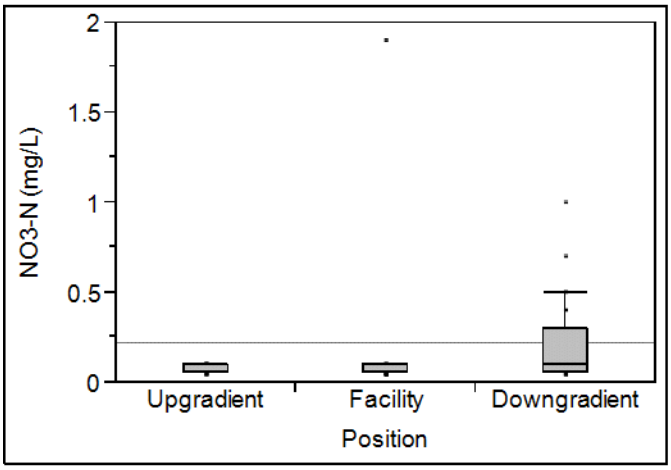
Table 7. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
121		6/11/01-7/9/09	8	0	0%	236	238	220 - 250	9.0
Upgradient Group Summary			**8**	**0**	**0%**	**236**	**238**	**220 - 250**	**9.0**
Facility Group									
148	-	10/5/00-5/19/15	14	0	0%	583	585	540 - 620	26.1
Facility Group Summary			**14**	**0**	**0%**	**583**	**585**	**540 - 620**	**26.1**
Downgradient Group									
136	-	5/10/04-8/28/14	4	0	0%	542	550	510 - 560	22.2
138	845 - 1245	9/12/00-6/25/03	5	0	0%	514	520	440 - 550	43.4
139	636 - 1234	6/30/00-6/23/08	8	0	0%	568	585	500 - 610	42.0
Downgradient Group Summary			**17**	**0**	**0%**	**546**	**550**	**440 - 610**	**43.4**

The above summary table indicates that the average TDS concentration is greater in the facility wells compared to upgradient wells and there does not appear to be an increase in average TDS concentrations downgradient from the dairy facilities. The average facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for the 1954 to 1973 period of 519 mg/L, but less than the 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L). (WEI 2000, 2011, 2014).

2.2b.2 Boxplots – North of Fault

Boxplots were created using combined data from wells representing upgradient, downgradient, and facility groundwater quality (Figures 8 and 9).

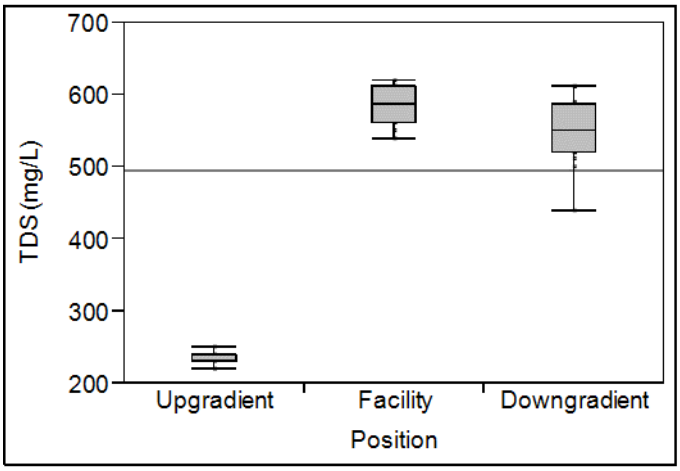


Historic Average Nitrate Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 2.5 mg/L
- 1990 to 2009 - 2.6 mg/L
- 1978 to 1997 - 2.7 mg/L
- 1954 to 1973 - 1.8 mg/L

Figure 8. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault

The boxplots indicate that the distribution of nitrate concentrations in downgradient wells tends to be higher than upgradient and facility well groups; fewer samples from downgradient wells showed nitrate below detection limits than for upgradient or facility wells. Regardless of these slight apparent differences, the data do not seem to indicate a facility influence on downgradient nitrate levels.



Historic Average TDS Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 860 mg/L
- 1990 to 2009 - 890 mg/L
- 1978 to 1997 - 830 mg/L
- 1954 to 1973 - 519 mg/L

Figure 9. Boxplot of upgradient, facility, and downgradient TDS concentrations for Hollandia, Gerben Hettinga Expressway, Boersma, and Marvo Holsteins #2 Dairies – North of Fault

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tend to be dramatically higher than those recorded in the upgradient wells. This could suggest a facility influence on downgradient groundwater quality, though the average facility and downgradient concentrations are less than the historic averages for the periods 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L) (WEI 2000, 2011, 2014).

2.2b.3 Quantitative Statistical Analysis – North of Fault

Because the nitrate datasets for all three well groups contain greater than 20 percent non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and an ANOVA was used to test for significant differences among mean TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient).

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
236 a	583 b	546 c	24.7	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results indicate that a significant difference exists among the three well groups. Mean TDS levels in both facility and downgradient groundwater have been significantly higher than that observed in upgradient wells and the downgradient mean TDS concentrations are significantly lower than facility concentrations.

2.2b.4 Conclusions – North of Fault

Based on the available data, it appears that the combined dairy operations at Hollandia Dairy, Gerben Hettinga Expressway Dairy, Boersma Dairy, and Marvo Holsteins Dairy #2 north of the Casa Loma fault

zone have not increased observed groundwater nitrate concentrations. The combined operations could be responsible for contributing to increased TDS concentrations in groundwater in the vicinity of the facilities and downgradient from the dairy operations. The following specific observations support these conclusions:

- There is a slight increase in nitrate concentrations downgradient from the facilities compared to upgradient and facility concentrations.
- Average nitrate concentrations for all groups are lower than Lakeview/Hemet North management zone historical averages.
- The boxplot of nitrate concentrations indicates no significant increase in downgradient wells compared to facility wells.
- There are higher average TDS concentrations in facility and downgradient groundwater compared to upgradient.
- The average TDS concentration for facility and downgradient wells is less than the Lakeview/Hemet North management zone averages for 1978 to 1997, 1990 to 2009 and 1993 to 2012.
- The boxplot of TDS concentrations shows an increase between upgradient and facility wells, but no increase between facility and downgradient wells.
- The statistical analysis of TDS concentrations indicates that facility and downgradient wells have significantly higher concentrations compared to upgradient wells.

Based on available information, it is not feasible to determine the source of elevated TDS concentrations or the individual contribution of each dairy in the potential impacts to downgradient groundwater quality. Numerous non-dairy sources of nitrate and TDS, variations in sample dates, unknown or dissimilar perforated intervals, the impact of fault zones, and the close proximity of individual wells make it infeasible to determine the direct TDS contribution for each dairy with a high degree of confidence. In this case, further study is needed to more accurately determine the individual impact of each dairy.

2.3 Group of Dairies (Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 (Old Vermeer Dairy))

Three dairies identified as Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 are located north of West 7th Street between Warren Road and North Sanderson Avenue. Land use areas identified as dairy intensive for Dick Van Dam Dairy and Cottonwood Dairy are less than 750 feet apart. The area identified as dairy intensive for Bootsma-Silva Farms/Ramona Dairy #2 is less than 3,000 feet north-northwest of Dick Van Dam Dairy and Cottonwood Dairy, and no non-facility wells exist between the three dairies (see Figure 10). These three dairies are analyzed as a group because the close proximity of the dairies and lack of non-facility wells makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

Based on groundwater mapping (WRCAC 2014), published reports (WEI 2000, EMWD 2013), and field verification by EMWD during site visits conducted in September, 2015, the groundwater flow in the

vicinity of the dairies is generally from the east-southeast to west-northwest, as indicated by the generalized groundwater flow arrows in Figure 10. The dairies were reported to have started operations between May 1973 (Bootsma-Silva Farms/Ramona #2) and April 1981 (Cottonwood). The resources used to assess the groundwater flow direction indicate that no changes have occurred in the groundwater flow regime in the vicinity of these dairies. Because no change in the groundwater flow direction is documented over the period of dairy operation and the sample dates generally cover the period of time of dairy operation, there is no reason to eliminate any of the samples from the dataset.

Wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located south-southeast, and upgradient, from a group of dairies (John & Margie Oostdam Dairy, Oostdam Dairy, and Hettinga Dairy), so the downgradient groundwater quality is, in part, best represented by the wells located near the downgradient facilities. Other downgradient groundwater quality influences include poultry operations and manure compost as well as potential impacts from recycled water ponds located at the San Jacinto Valley Regional Water Reclamation Facility. Upgradient influences include irrigated fields, septic systems and horse properties. Fault zones are located to the east and northwest of this group of dairies.

The analysis for this group of dairies includes four upgradient wells with a total of 10 samples collected from 7/11/1990 to 4/4/2012, six facility wells with a total of 43 samples collected from 10/9/2002 to 5/12/2015, and three downgradient wells with a total of 27 samples collected from 7/8/2003 to 5/28/2014.

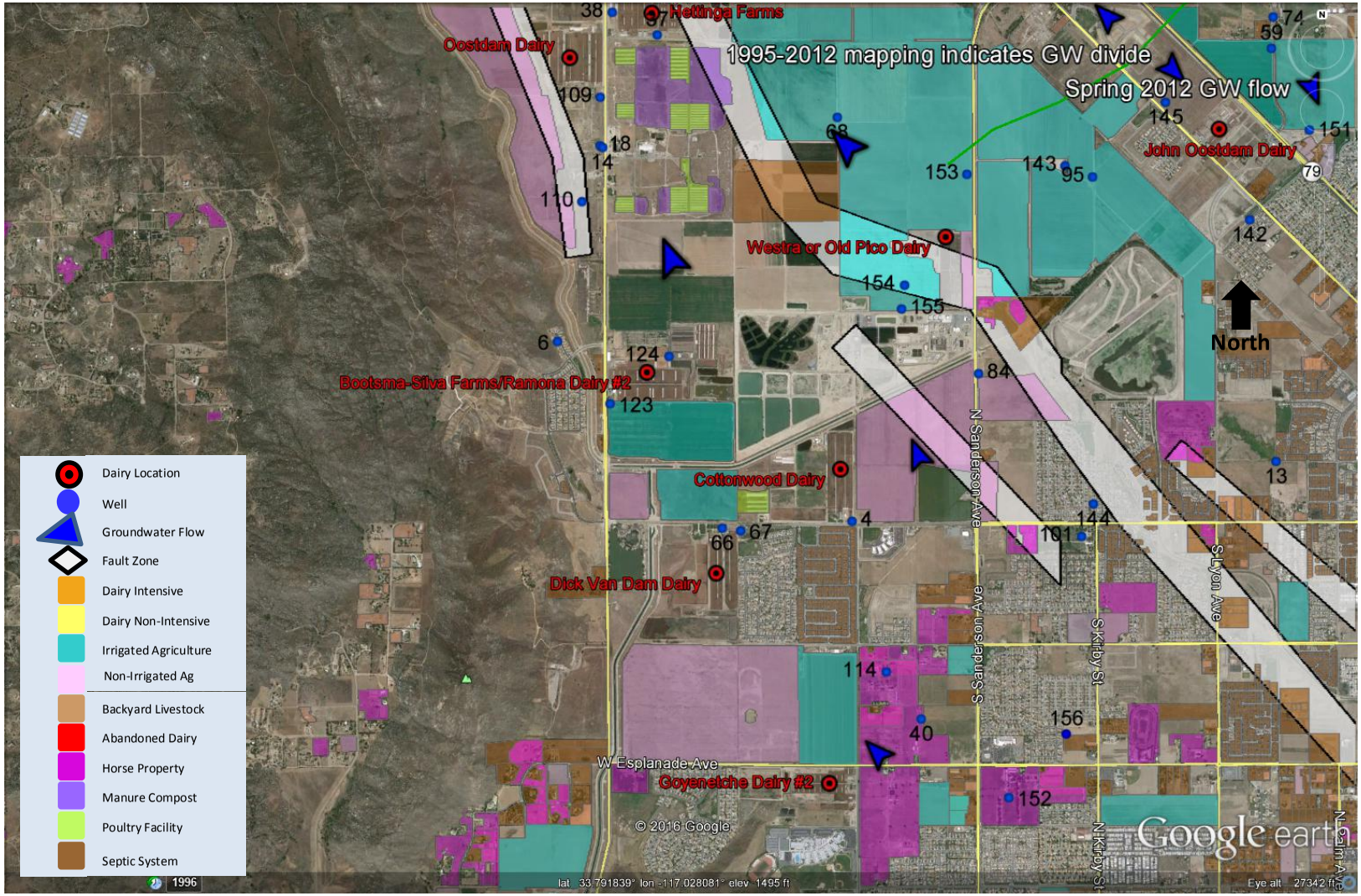


Figure 10. Location map of the vicinity of Dick Van Dam, Cottonwood Dairy and Bootsma-Silva Farms/Ramona Dairy #2

2.3.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 8. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
40	-	7/15/05-4/4/12	7	0	0%	2.3	2.3	2.0 – 2.8	0.28
114	-	4/24/09	1	0	0%	4.0	4.0	-	-
152	-	7/11/90	1	0	0%	2.3	2.3	-	-
156	-	4/15/91	1	0	0%	7.7	7.7	-	-
Upgradient Group Summary			**10**	**0**	**0%**	**3.0**	**2.4**	**2.0 – 7.7**	**1.75**
Facility Group									
4	1193 - 1303	5/4/04-5/12/15	10	0	0%	2.7	2.5	1.8 – 4.7	0.93
6	-	9/3/08-5/12/15	7	0	0%	3.1	3.4	2.3 – 3.6	0.51
66	-	8/2/07-1/29/14	8	0	0%	8.9	8.4	2.8 – 14.0	4.18
67	-	8/2/07-5/12/15	6	0	0%	5.9	6.2	0.8 – 9.4	3.18
123	-	10/9/02-5/12/15	10	0	0%	4.4	5.4	0.7 – 6.8	2.35
124	1112 - 1302	9/23/04-12/16/05	2	0	0%	3.8	3.8	3.7 – 3.9	0.14
Facility Group Summary			**43**	**0**	**0%**	**4.8**	**3.6**	**0.7 – 14.0**	**3.24**
Downgradient Group									
14	876 - 1332	7/18/03-5/28/14	12	0	0%	2.0	2.0	1.7 – 2.9	0.35
18	698 – 1078	8/4/03-2/24/14	12	1	8%	1.1	1.2	<0.1 – 2.0	0.54
109	950 - 1154	12/14/04-12/16/06	3	0	0%	3.0	2.9	2.9 – 3.3	0.23
Downgradient Group Summary			**27**	**1**	**4%**	**1.7**	**1.8**	**<0.1 – 3.3**	**0.77**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there is an increase in average nitrate concentration in facility wells compared to upgradient wells and average facility well concentrations are higher than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973 (1.8 mg/L), 1978 to 1997 (2.7 mg/L), 1990 to 2009 (2.6 mg/L), and 1993 to 2012 (2.5 mg/L) (WEI 2000, 2011, 2014). However, there does not appear to be an increase in downgradient well concentrations and the average nitrate concentrations in downgradient wells are lower than historical averages for the Lakeview/Hemet North management zone.

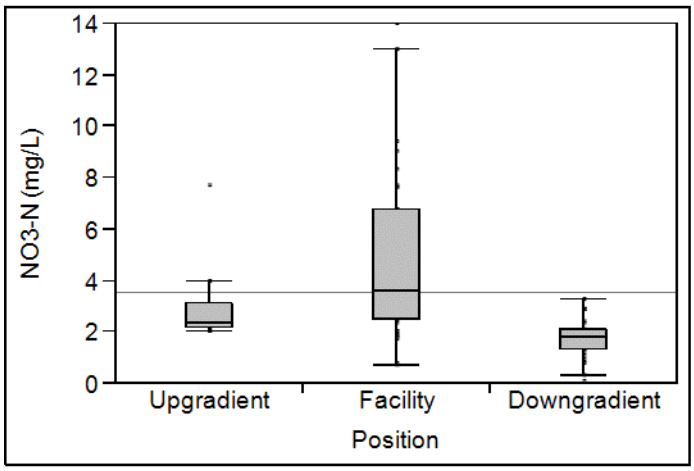
Table 9. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
40	-	7/15/05-4/4/12	7	0	0%	544	550	520 - 570	19.0
114	-	4/24/09	1	0	0%	590	590	-	-
152	-	7/11/90	1	0	0%	670	670	-	-
156	-	4/15/91	1	0	0%	940	940	-	-
Upgradient Group Summary			**10**	**0**	**0%**	**604**	**555**	**520 - 940**	**126.7**
Facility Group									
4	1193 - 1303	5/4/04-5/12/15	10	0	0%	498	490	480 - 540	19.9
6	-	9/3/08-5/12/15	7	0	0%	620	640	490 - 690	76.2
66	-	8/2/07-1/29/14	8	0	0%	868	920	570 - 1030	167.7
67	-	8/2/07-5/12/15	6	0	0%	820	825	610 - 970	126.2
123	-	10/9/02-5/12/15	10	0	0%	786	890	520 - 1010	191.1
124	1112 - 1302	9/23/04-12/16/05	2	0	0%	620	620	590 - 650	42.4
Facility Group Summary			**43**	**0**	**0%**	**704**	**650**	**480 - 1030**	**188.7**
Downgradient Group									
14	876 - 1332	7/18/03-5/28/14	12	0	0%	436	440	400 - 470	21.7
18	698 – 1078	8/4/03-2/24/14	12	0	0%	1037	1050	870 - 1200	90.9
109	950 - 1154	12/14/04-12/16/06	3	0	0%	423	430	380 - 460	40.4
Downgradient Group Summary			**27**	**0**	**0%**	**702**	**460**	**380 - 1200**	**311.8**

The above summary table indicates that the average TDS concentration is greater in the facility and downgradient wells compared to upgradient wells. The average upgradient, facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for the 1954 to 1973 (519 mg/L), but less than those observed during the periods 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L) (WEI 2000, 2011, 2014).

2.3.2 Boxplots

Boxplots were created using combined data from wells representing upgradient, downgradient, and facility groundwater quality (Figures 11 and 12).

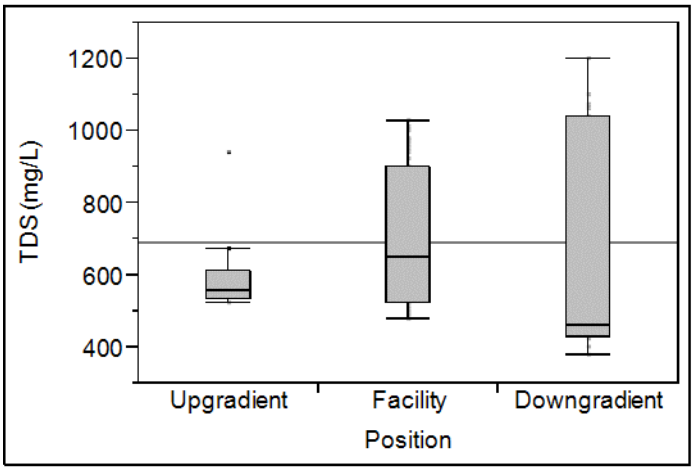


Historic Average Nitrate Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 2.5 mg/L
- 1990 to 2009 - 2.6 mg/L
- 1978 to 1997 - 2.7 mg/L
- 1954 to 1973 - 1.8 mg/L

Figure 11. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

The boxplots indicate that although the distribution of nitrate concentrations in the facility wells is higher than upgradient wells, nitrate levels are lower than either of these well groups in the downgradient wells. In this case dairy influence on nitrate levels in facility wells might be inferred, but any influence does not appear to extend to the downgradient wells. This pattern could result from dilution of nitrate added from the facility by groundwater reaching the downgradient wells from areas beyond the facility (e.g., potential recharge from the recycled water ponds). Average facility well nitrate concentrations are higher and average downgradient nitrate concentrations are lower than historic averages for the Lakeview/Hemet North management zone.



Historic Average TDS Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 860 mg/L
- 1990 to 2009 - 890 mg/L
- 1978 to 1997 - 830 mg/L
- 1954 to 1973 - 519 mg/L

Figure 12. Boxplot of upgradient, facility, and downgradient TDS concentrations for Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2

The boxplots indicate that the overall distribution of TDS levels in both facility and downgradient wells tends to be higher than those recorded in the upgradient wells. Although the median TDS concentration in downgradient wells appears to be substantially lower than that among facility wells, the increased variability of TDS and the occurrence of several TDS values considerably higher than the range recorded upgradient may suggest some influence of the dairy on TDS in downgradient groundwater. The average upgradient, facility and downgradient concentrations are greater than the historic averages for the Lakeview/Hemet North management zone for the period 1954 to 1973 (519 mg/L), but less than the averages for the periods 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L) (WEI 2000, 2011, 2014).

2.3.3 Quantitative Statistical Analysis

ANOVA was used to test for significant differences among mean nitrate and TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient).

	Mean Nitrate (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
3.0 a	4.8 b	1.7 a	12.66	<0.001

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
601 a	704 a	701 a	0.85	0.433

In each of the tables above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results indicate that a significant difference in mean nitrate concentrations exists

among the three well groups. Mean nitrate levels in facility groundwater have been significantly higher than those observed in either upgradient or downgradient wells. Mean TDS concentrations in facility and downgradient wells do not differ significantly from those observed in upgradient groundwater.

2.3.4 Conclusions

Based on the available data, it appears that the combined dairy operations at Dick Van Dam, Cottonwood Dairy, and Bootsma-Silva Farms/Ramona Dairy #2 have elevated nitrate concentrations in facility groundwater, but no increases in downgradient nitrate concentrations are apparent. The combined operations could be responsible for increased TDS concentrations in groundwater in the vicinity of the facilities and downgradient from the dairy operations, but there are no statistically significant differences among the three groups of data. The following specific observations support these conclusions:

- Average nitrate concentrations in facility wells are higher than upgradient wells and the average facility well concentrations are higher than the historical averages for the Lakeview/Hemet North management zone.
- The boxplots indicate the distribution of nitrate concentrations in the facility wells are higher than upgradient wells, but nitrate levels are lower in the downgradient wells.
- The statistical analysis for nitrate found that facility groundwater has significantly higher nitrate concentrations compared to the upgradient groundwater.
- The average TDS concentration is greater in the facility and downgradient wells compared to upgradient wells.
- The average upgradient, facility and downgradient well concentrations for TDS are greater than averages for the period of 1954 to 1973 (519 mg/L), but less than the 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993-2012 (860 mg/L).
- The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells tend to be higher than those recorded in the upgradient wells.
- Although not statistically significant, the higher TDS concentrations in facility and downgradient wells compared to those in upgradient wells, coupled with the elevated nitrate levels in facility groundwater, suggest the possibility of facility impact on groundwater quality.

Based on available information, it is not feasible to determine the source of elevated TDS concentrations or the individual contribution of each dairy for the potential impacts to downgradient groundwater quality. Numerous non-dairy sources of nitrate and TDS including upgradient irrigated fields, septic systems and horse properties; downgradient poultry operations and manure compost; variations in sample dates, unknown or non-similar perforated intervals in the wells, the impact of fault zones, and the close proximity of individual wells make it infeasible to determine the impact of the group of dairies with a high degree of confidence. In this case, further study is needed to more accurately determine the impact of the group of dairies and the individual impact of each dairy including additional groundwater monitoring.

2.4 Goyenetche Dairy #2 (Old Cawston Dairy)

Goyenetche Dairy #2 is located southwest of the intersection of West Esplanade Avenue and Cawston Avenue, and just north of Tahquitz High School. The area identified as dairy-intensive at Goyenetche Dairy #2 is located approximately 0.7 miles southeast of Dick Van Dam Dairy (see Figure 10).

Based on groundwater mapping (WRCAC 2014), published reports (WEI 2000, EMWD 2013), and field verification by EMWD during site visits conducted in September, 2015, the groundwater flow in the vicinity of the dairy is generally from southeast to northwest, as indicated by the generalized groundwater flow arrows in Figure 13. The dataset did not include any facility wells or any wells within 1.5 miles upgradient of the facility. The nearest downgradient wells are located approximately 1 mile to the north-northwest and are located within the dairy-intensive areas of Dick Van Dam Dairy and Cottonwood Dairy. The nearest well of any kind is located approximately 0.35 miles northeast and is not located along the assumed groundwater flow path. Potential non-dairy impacts to groundwater quality in the vicinity include irrigated fields, septic systems and horse properties. Northwest-southeast oriented fault zones are located to the east and northeast of this dairy.

The lack of available information of this dairy makes it infeasible to determine the potential impact on groundwater quality and further study is needed, including collecting upgradient, downgradient and facility groundwater samples.

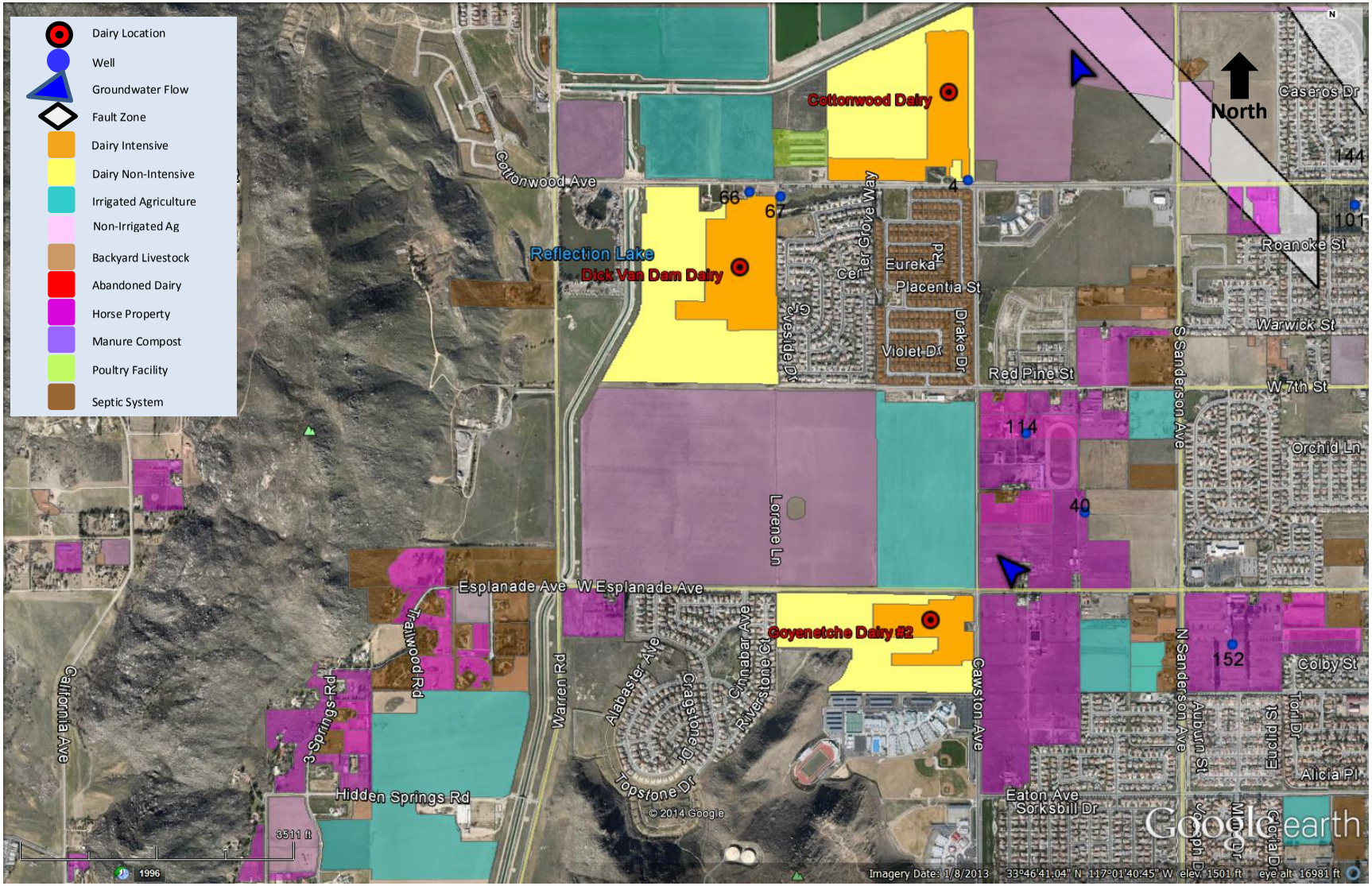


Figure 13. Location map of the vicinity of Goyenetche Dairy #2

2.5 Group of Dairies (Albert Goyenetche Dairy #2 (Old Ferriera Dairy), John Bootsma Dairy, and Offinga Dairy)

Three dairies identified as Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy are located north of Ramona Expressway between First and Sixth Streets. Land identified as dairy intensive for these facilities is either adjacent or less than less than 150 feet apart, and all dairy non-intensive land for each dairy is side-by-side (see Figure 13). The three dairies were analyzed as a group because the close proximity of the dairies makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

The dairies were reported to have started operations between October 1977 (Offinga) and February 1981 (John Bootsma). Based on groundwater mapping (WRCAC 2014) and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairies has been variable. The groundwater elevation contour map from 1973 (WEI 2000) indicates groundwater flow to the southwest in the vicinity of this group of dairies; however, groundwater contours published in the Wildermuth report (WEI 2000, Figure 3-7, Fall 1997 Water Level Elevation Contours) indicate a groundwater low in this area, with groundwater flow from the south, southwest, and northwest all converging into a groundwater low. Therefore, a change in groundwater flow direction from generally southwestern to generally north-northwestern occurred sometime between 1973 and 1997. Unfortunately, the spring 2012 groundwater elevation map (EMWD 2013) does not show this area completely and it is difficult to draw any strong conclusions regarding flow direction. The current flow direction has been reported to be generally to the northeast toward a pumping depression located at Bridge Street. To ensure that only data collected since the change in flow direction occurred, the analysis utilizes only data collected in 1997, and thereafter. A southeast-northwest oriented fault zone is located northeast of the dairies and appears to form a barrier to groundwater flow. The groundwater flow arrows shown on Figure 13 are based on the available information, including average 2012 groundwater elevations from the database.

Wells were selected from those available in the vicinity of the dairies that best represent upgradient, downgradient, and facility groundwater conditions. This group of dairies is located downgradient of a residential area utilizing septic systems, poultry operations, irrigated fields, horse properties.

The analysis for this group of dairies includes seven upgradient wells with a total of 57 nitrate and 59 TDS samples collected from 3/25/1997 to 11/16/2015, five facility wells with a total of 57 nitrate samples and 78 TDS samples collected from 3/27/1997 to 11/26/2015, and two downgradient wells with a total of 20 samples collected from 4/22/1997 to 6/10/2015.

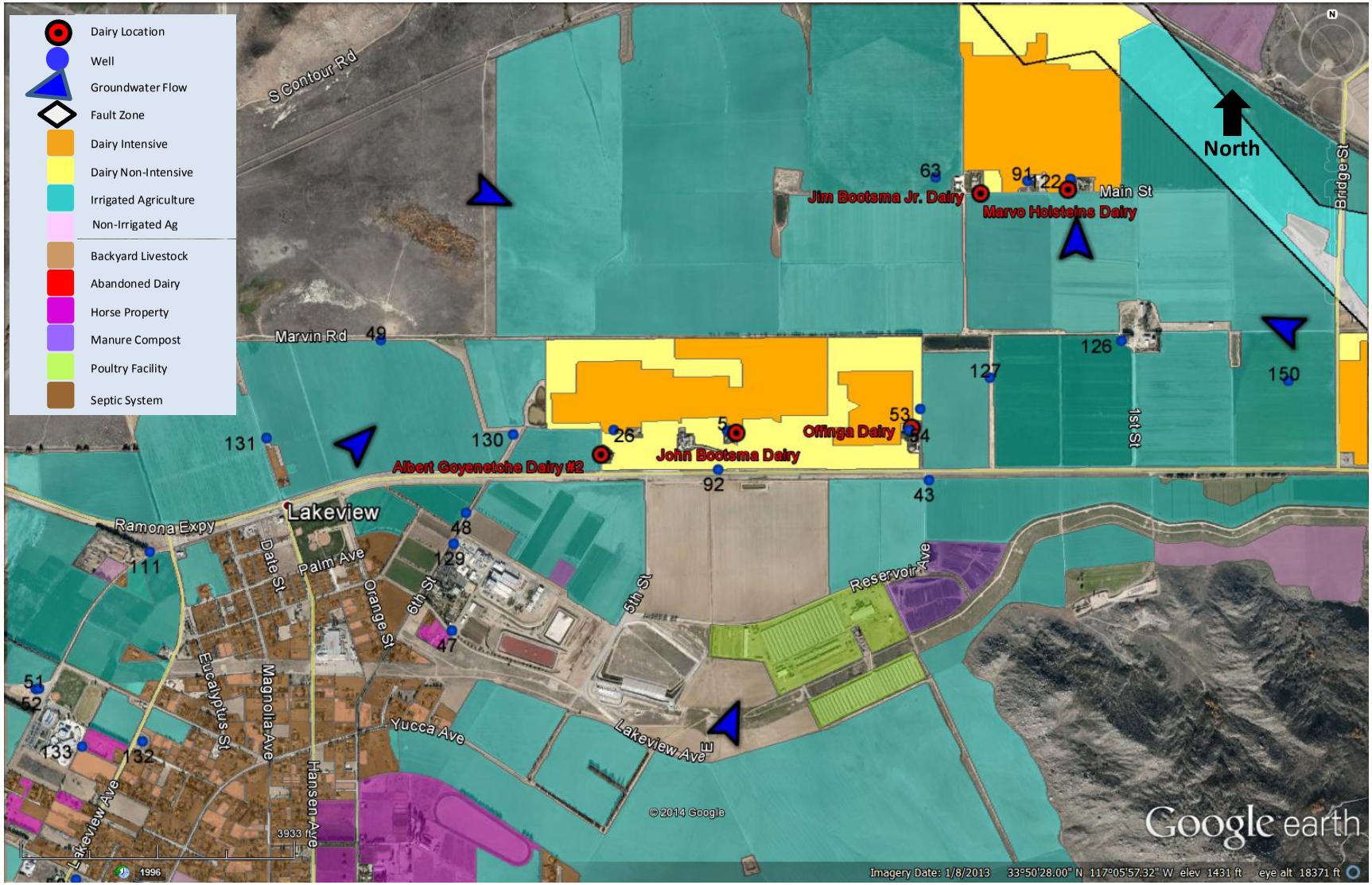


Figure 14. Location map of the vicinity of Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

2.5.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the combined data for each group of wells (upgradient, downgradient, and facility).

Table 10. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
47	-	7/23/98-6/10/14	13	0	0%	17.9	18.0	9.2 – 22.0	3.31
48	966 – 1276	5/11/04-11/16/15	12	0	0%	4.8	5.4	0.7 – 6.8	1.65
49	-	4/11/97-5/17/12	7	4	57%	0.1	0.1	<0.1 – 0.4	0.12
111	854 – 1189	3/26/97-7/17/00	4	0	0%	0.6	0.6	0.0 – 1.0	0.39
129	971 – 1281	3/27/97-5/6/08	3	0	0%	5.4	5.0	3.5 – 7.8	2.18
130	735 – 1042	3/25/97-6/28/13	10	1	10%	1.3	1.4	<0.1 – 1.9	0.48
131	-	4/22/97-6/17/14	8	7	88%	0.1	0.1	<0.1 – 0.1	0.02
Upgradient Group Summary			**57**	**12**	**21%**	**5.7**	**1.6**	**<0.1 – 22.0**	**7.19**
Facility Group									
5	1273 – 1573	6/24/02-11/6/15	13	1	8%	0.9	1.0	<0.1 – 1.5	0.42
26	-	7/7/99-11/16/15	18	1	6%	2.8	3.2	<0.1 – 7.1	1.65
53	905 - 1265	6/5/02-3/12/12	9	0	0%	1.1	0.9	0.6 – 2.4	0.57
54	787 - 1069	3/27/97-11/16/15	12	0	0%	2.4	2.8	0.5 – 4.0	1.36
92	-	6/6/02-5/25/06	5	0	0%	1.6	1.1	0.6 – 4.3	1.52
Facility Group Summary			**57**	**2**	**4%**	**1.9**	**1.4**	**<0.1 – 7.1**	**1.45**
Downgradient Group									
126	796 – 1139	4/22/97-6/10/15	17	15	88%	<0.1	<0.1	<0.1 – 0.2	0.04
127	963 - 1323	7/9/97-7/25/06	3	2	67%	<0.1	<0.1	<0.1 – 0.1	0.03
Downgradient Group Summary			**20**	**17**	**85%**	**<0.1**	**<0.1**	**<0.1 – 0.2**	**0.04**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there is a decrease in average nitrate concentrations in facility wells compared to upgradient wells and that average downgradient well concentrations are lower than either upgradient or facility wells. Average upgradient nitrate concentrations are higher than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973 (1.8 mg/L), 1978 to 1997 (2.7 mg/L), 1990 to 2009 (2.6 mg/L) and 1993 to 2012 (2.5 mg/L) (WEI 2000, 2011, 2014). There does not appear to be an increase in facility and downgradient well concentrations and the average nitrate concentrations in facility wells are lower than or approximately equal to historical averages for the management zone for the 1954 to 1973, and lower than historical averages for the Lakeview/Hemet North management zone, for the 1978 to 1997, 1990 to 2009 and 1993 to 2012 periods.

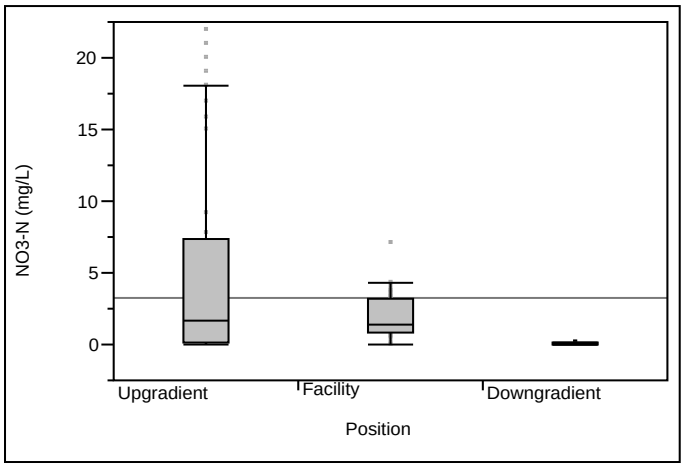
Table 11. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
47	-	7/23/98-6/10/14	13	0	0%	517	520	480 - 570	24.3
48	966 – 1276	5/11/04-11/16/15	14	0	0%	518	520	470 - 550	24.7
49	-	4/11/97-5/17/12	7	0	0%	689	690	480 - 840	112.9
111	854 – 1189	3/26/97-7/17/00	4	0	0%	750	750	670 - 830	65.8
129	970 – 1281	3/27/97-5/6/08	3	0	0%	547	510	500 - 630	72.3
130	735 – 1042	3/25/97-6/28/13	10	0	0%	581	555	490 - 860	101.9
131	-	4/22/97-6/17/14	8	0	0%	801	840	500 - 970	145.2
Upgradient Group Summary			**59**	**0**	**0%**	**604**	**550**	**470 - 970**	**132.5**
Facility Group									
5	1273 – 1573	6/24/02-11/6/15	20	0	0%	474	475	410 - 510	23.0
26	-	7/7/99-11/16/15	32	0	0%	537	530	460 - 640	30.9
53	905 - 1265	6/5/02-3/12/12	9	0	0%	458	460	400 - 520	38.3
54	787 - 1069	3/27/97-11/16/15	12	0	0%	483	480	450 - 520	23.1
92	-	6/6/02-5/25/06	5	0	0%	514	520	460 - 580	45.0
Facility Group Summary			**78**	**0**	**0%**	**502**	**500**	**400 - 640**	**43.2**
Downgradient Group									
126	796 – 1139	4/22/97-6/10/15	17	0	0%	573	580	520 - 610	24.2
127	963 - 1323	7/9/97-7/25/06	3	0	0%	567	530	530 - 640	63.5
Downgradient Group Summary			**20**	**0**	**0%**	**572**	**580**	**520 - 640**	**30.4**

The above summary table indicates that average TDS concentration is greater in the upgradient compared to facility and downgradient wells. Average facility well concentrations are less than the average TDS concentrations for the Lakeview/Hemet North management zone for 1954 to 1973 (519 mg/L), 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L). The average downgradient TDS concentrations are greater than the 1954 to 1973 period averages, but lower than the 1978 to 1997 and 1990 to 2009 period averages.

2.5.2 Boxplots

Boxplots were created using combined data from wells representing upgradient, downgradient, and facility groundwater quality (Figures 15 and 16).

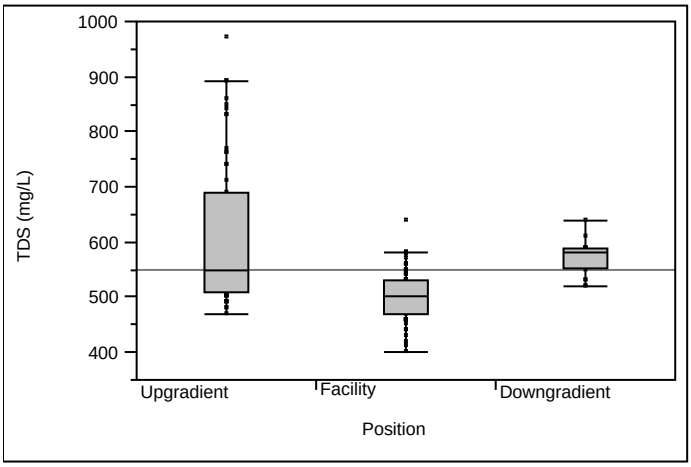


Historic Average Nitrate Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 2.5 mg/L
- 1990 to 2009 - 2.6 mg/L
- 1978 to 1997 - 2.7 mg/L
- 1954 to 1973 - 1.8 mg/L

Figure 15. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

The boxplots indicate that the distribution of nitrate concentrations in the facility wells is lower than upgradient wells, and downgradient well concentrations are nearly all at non-detected levels. Median facility and downgradient well nitrate concentrations are lower than the historic averages for the Lakeview/Hemet North management zone.



Historic Average TDS Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 860 mg/L
- 1990 to 2009 - 890 mg/L
- 1978 to 1997 - 830 mg/L
- 1954 to 1973 - 519 mg/L

Figure 16. Boxplot of upgradient, facility, and downgradient TDS concentrations for Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy

The boxplots indicate that the distribution of TDS levels in facility wells tends to be lower than that recorded in the upgradient wells, and average facility concentrations are approximately equal to the 1954 to 1973 historic averages and lower than the 1978 to 1997, 1990 to 2009 and 1993 to 2012 historic averages for the Lakeview/Hemet North management zone.

2.5.3 Quantitative Statistical Analysis

Because the nitrate dataset for upgradient and downgradient wells contains greater than 20 percent non-detects an ANOVA is not appropriate. However, upgradient and facility mean nitrate concentrations were compared with a t-Test at the 90% confidence interval with the results as follows:

Mean Nitrate (mg/L)			
Upgradient	Facility	t value	*P* value
5.7 a	1.9 b	-3.85	< 0.001

The mean nitrate concentration in upgradient wells was significantly higher than the mean nitrate concentration in facility wells.

All of the TDS data represent detected concentrations, and ANOVA was used to test for significant differences among mean TDS concentrations from all three well groups.

Mean TDS (mg/L)				
Upgradient	Facility	Downgradient	F value	*P* value
604 a	502 b	572 a	5.3	0.006

In the preceding table, group means followed by the same letter do not differ significantly ($P \leq 0.10$). The ANOVA results confirm that a significant difference exists among the three well groups. Mean TDS levels in facility groundwater have been significantly lower than that observed in upgradient groundwater; the mean TDS levels in downgradient groundwater are significantly higher than facility groundwater, but do not differ significantly from upgradient groundwater.

2.5.4 Conclusions

Based on the available data, it appears that the combined dairy operations at Albert Goyenetche Dairy #2, John Bootsma Dairy, and Offinga Dairy have not increased nitrate or TDS concentrations in facility groundwater or groundwater downgradient from the dairy operations. The regional mapping evaluation found evidence of a nitrate plume upgradient of the Albert Goyenetche Dairy #2 and John Bootsma Dairy wells; however, the focused evaluation completed here indicates that the dairies have not impacted nitrate in groundwater in the vicinity of the dairy. The following specific observations were made which support the conclusion:

- There is no increase in nitrate concentrations downgradient from the facility and the median facility well concentrations are lower than the historical averages for the Lakeview/Hemet North management zone.
- The boxplots of nitrate concentrations indicate downgradient well concentrations are lower than either upgradient or facility concentrations.
- Average TDS concentrations in facility and downgradient wells is lower than upgradient wells.
- TDS concentrations in facility wells are lower than the average historical TDS concentrations for the Lakeview/Hemet North management zone.
- The ANOVA results indicate that TDS concentrations are significantly lower in facility wells compared to upgradient wells.
- The t-Test results indicate that mean nitrate concentrations in facility wells were significantly lower than those of upgradient wells.

2.6 Pastime Lakes Dairy

Pastime Lakes Dairy is located northeast of the intersection of Ramona Expressway and Bridge Street. The area identified as dairy-intensive at Pastime Lakes Dairy is located approximately 0.7 miles northeast of Marvo Holsteins Dairy #2 and Boersma Dairy, and 1.1 miles east of Offinga Dairy (see Figure 17).

Based on groundwater mapping (WRCAC 2014) and published reports (WEI 2000, EMWD 2013) the groundwater flow in the vicinity of the dairy is generally from the southeast to northwest, as indicated by the generalized groundwater flow arrows in Figure 17. The pumping depression at Bridge Street is located immediately northwest of the dairy and although groundwater was not expected to flow in this location, the groundwater levels for the period of record indicate no changes have occurred in the groundwater flow regime in the vicinity of this dairy. Potential expansion of the cone of depression over time could affect groundwater flow in the vicinity of the dairy. However, because no change in the

groundwater flow direction is documented over the period of dairy operation, the available dataset was not edited to reflect changes in groundwater flow direction.

Wells were selected from those available in the vicinity of the dairy that best represent upgradient, downgradient, and facility groundwater conditions. This dairy is located immediately northwest, and downgradient, from the group of dairies identified in a previous section (Hollandia Dairy, Boersma Dairy, and Marvo Holsteins #2 Dairy), so the upgradient groundwater quality is, in part, best represented by the wells from the upgradient facilities. The wells selected to represent downgradient groundwater quality also flow toward the Bridge Street pumping depression. The downgradient wells are included based on consultation with EMWD; however, as advised by EMWD they may not best represent downgradient water quality and conclusions based on the downgradient well group are not made with a high degree of confidence. Potential outside impacts to groundwater quality in the vicinity include upgradient and downgradient irrigated fields, manure compost storage, and the dairy operations located to the southeast. A northwest-southeast oriented fault zone is located to the east and north of this dairy.

The analysis of this dairy includes four upgradient wells with a total of 43 samples collected from 8/4/1995 to 5/12/2015, three facility wells with a total of 16 samples collected from 3/16/1994 to 5/14/2015, and two downgradient wells with a total of 23 samples collected from 4/25/1994 to 6/10/2015.

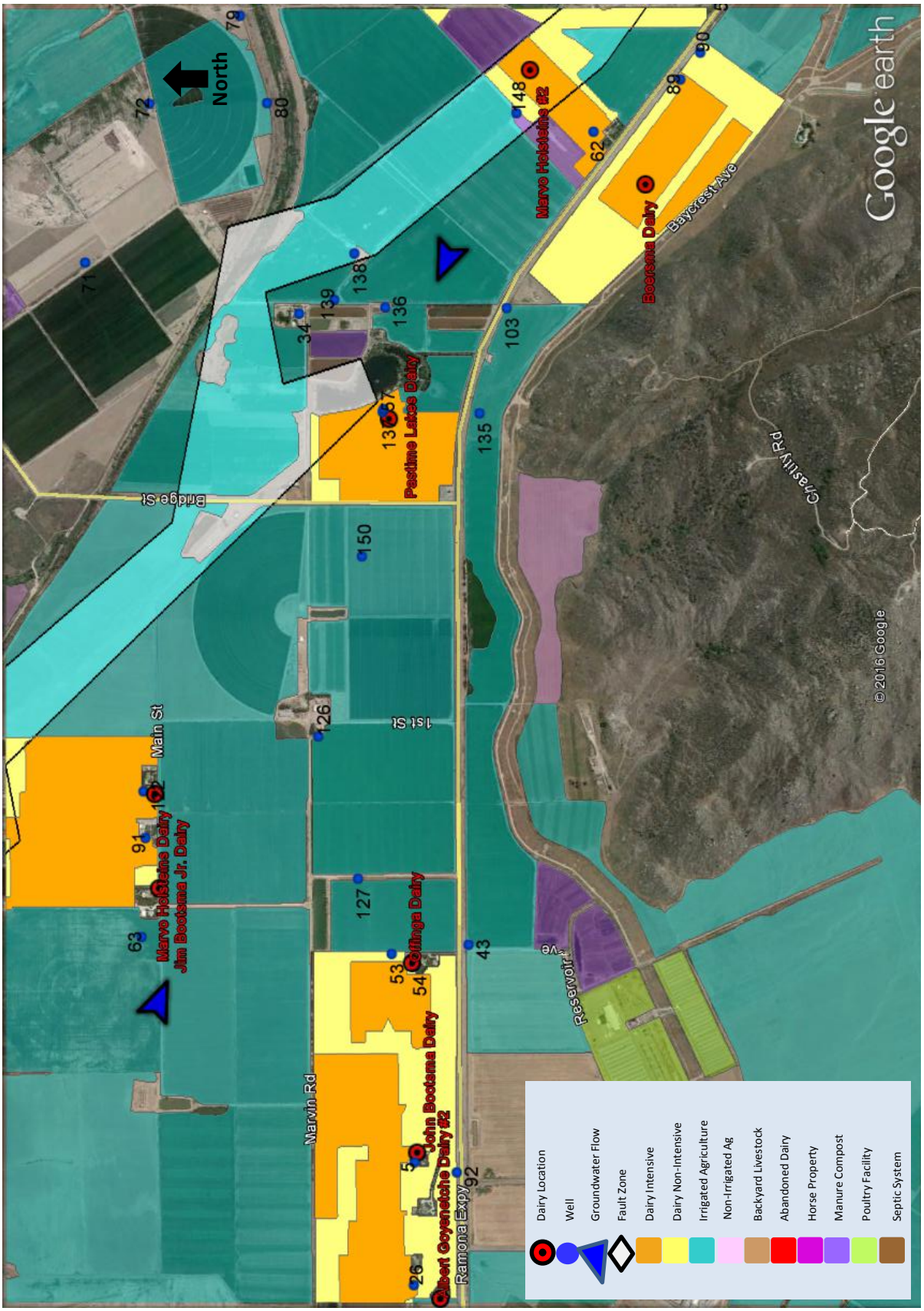


Figure 17. Location map of the vicinity of Pastime Lakes Dairy

2.6.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 12. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Pastime Lakes Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
62	-	8/25/03-5/12/15	13	1	8%	1.5	1.7	<0.1 – 2.1	0.60
89	-	6/18/02-9/1/15	13	1	8%	0.4	0.4	<0.1 – 0.6	0.14
90	-	5/24/96-5/12/15	6	0	0%	1.0	1.1	0.1 – 1.8	0.73
103	899 - 1251	8/4/95-5/4/04	11	0	0%	1.2	1.2	0.6 – 1.7	0.32
Upgradient Group Summary			**43**	**2**	**5%**	**1.0**	**1.1**	**<0.1 – 2.1**	**0.62**
Facility Group									
57	-	6/19/02-4/5/12	7	0	0%	1.0	0.9	0.5 – 1.6	0.34
135	-	3/16/94	1	0	0%	0.7	0.7	-	-
137	-	11/19/07-5/14/15	8	0	0%	0.9	0.9	0.2 – 1.9	0.56
Facility Group Summary			**16**	**0**	**0%**	**0.9**	**0.9**	**0.2 – 1.9**	**0.44**
Downgradient Group									
126	796 - 1139	4/25/94-6/10/15	19	15	79%	0.08	0.05	<0.1 – 0.2	0.04
127	-	4/25/94-7/25/06	4	2	50%	0.06	0.05	<0.1 – 0.1	0.02
Downgradient Group Summary			**23**	**17**	**74%**	**0.07**	**0.05**	**<0.1 – 0.2**	**0.04**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there is a decrease in average nitrate concentrations in facility wells compared to upgradient wells and average downgradient well concentrations are lower than either upgradient or facility wells. All nitrate concentrations are lower than the historical averages for the Lakeview/Hemet North management zone for the periods 1954 to 1973 (1.8 mg/L), 1978 to 1997 (2.7 mg/L), 1990 to 2009 (2.6 mg/L) and 1993 to 2012 (2.5 mg/L) (WEI 2000, 2011, 2014).

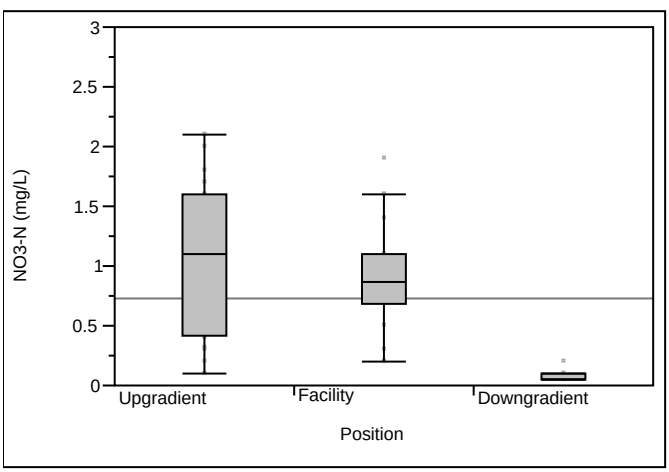
Table 13. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Pastime Lakes Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
62	-	8/25/03-5/12/15	13	0	0%	617	610	360 - 720	88.1
89	-	6/18/02-9/1/15	13	0	0%	632	630	620 - 640	8.3
90	-	5/24/96-5/12/15	6	0	0%	598	600	590 - 600	4.1
103	899 - 1251	8/4/95-5/4/04	11	0	0%	564	565	490 - 620	37.4
Upgradient Group Summary			**43**	**0**	**0%**	**606**	**310**	**360 - 720**	**57.3**
Facility Group									
57	-	6/19/02-4/5/12	7	0	0%	524	530	480 - 570	28.8
135	-	3/16/94	1	0	0%	530	530	-	-
137	-	11/19/07-5/14/15	8	0	0%	555	560	530 - 580	17.7
Facility Group Summary			**16**	**0**	**0%**	**540**	**535**	**480 – 580**	**26.8**
Downgradient Group									
126	796 - 1139	4/25/94-6/10/15	19	0	0%	571	580	520 - 610	23.2
127	-	4/25/94-7/25/06	4	0	0%	568	550	530 - 640	51.9
Downgradient Group Summary			**23**	**0**	**0%**	**571**	**570**	**520 - 640**	**28.4**

The above summary table indicates that the average TDS concentration is greater in the upgradient compared to facility and downgradient wells. The average facility and downgradient well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for 1954 to 1973 (519 mg/L), but less than the 1978 to 1997 (830 mg/L), 1990 to 2009 (890 mg/L) and 1993 to 2012 (860 mg/L).

2.6.2 Boxplots

Boxplots were created using data from wells representing upgradient, downgradient, and facility groundwater quality (Figures 18 and 19).

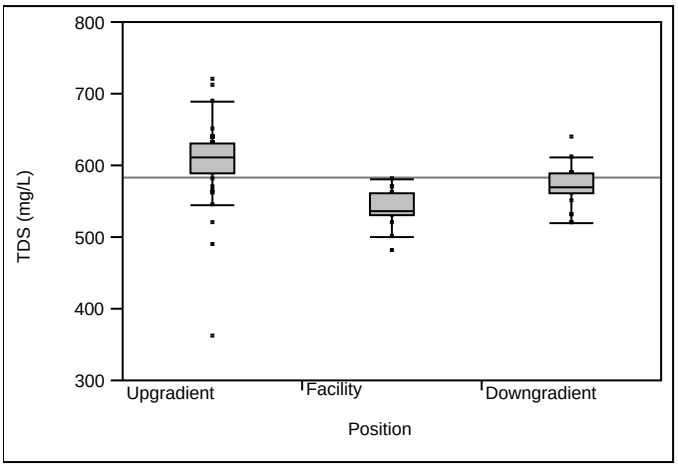


Historic Average Nitrate Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 2.5 mg/L
- 1990 to 2009 - 2.6 mg/L
- 1978 to 1997 - 2.7 mg/L
- 1954 to 1973 - 1.8 mg/L

Figure 18. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Pastime Lakes Dairy

The boxplots indicate that the median value for facility wells is lower than the upgradient median. Downgradient well concentrations were nearly all below the detection limit.



Historic Average TDS Concentrations for Lakeview/Hemet North Management Zone

- 1993 to 2012 - 860 mg/L
- 1990 to 2009 - 890 mg/L
- 1978 to 1997 - 830 mg/L
- 1954 to 1973 - 519 mg/L

Figure 19. Boxplot of upgradient, facility, and downgradient TDS concentrations for Pastime Lakes Dairy

The boxplots indicate that the distribution of TDS levels in both facility and downgradient wells are lower than upgradient wells. All three group median concentrations are greater than the 1954 to 1973 historic averages and lower than the 1978 to 1997, 1990 to 2009 and 1993 to 2012 averages for the Lakeview/Hemet North management zone.

2.6.3 Quantitative Statistical Analysis

Because the nitrate dataset for downgradient wells contains greater than 20 percent non-detects an ANOVA is not appropriate. However, upgradient and facility mean nitrate concentrations were compared with a t-Test at the 90% confidence interval with the results as follows:

Mean Nitrate (mg/L)			
Upgradient	Facility	t value	*P* value
1.0 a	0.9 a	-0.46	0.644

The *P* value indicates that the mean nitrate concentration in upgradient wells does not differ significantly from the mean nitrate concentration in facility wells.

ANOVA was used to test for significant differences among TDS concentrations from all three well groups.

Mean TDS (mg/L)				
Upgradient	Facility	Downgradient	F value	*P* value
606 a	540 b	571 c	13.1	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results confirm that a significant difference exists among the three well groups. Mean TDS levels in facility and downgradient groundwater have been significantly lower than that observed in upgradient groundwater; mean TDS concentrations in downgradient wells have been significantly higher than that observed in facility groundwater.

2.6.4 Conclusions

Based on the available data, it appears that Pastime Lakes Dairy has not increased nitrate or TDS concentrations in facility groundwater or groundwater downgradient from the dairy operations. The following specific observations were made which support the conclusion:

- The median facility well nitrate concentrations are lower than the historical averages for the Lakeview/Hemet North management zone.
- The boxplots of nitrate concentrations indicate facility well concentrations are within the range of those for upgradient wells.
- Average TDS concentrations in facility wells are lower than upgradient wells.
- Median TDS concentrations in facility wells are lower than the average historical TDS concentrations for the periods 1978 to 1997, 1990 to 2009 and 1993 to 2012 for the Lakeview/Hemet North management zone.
- The t-test results indicate that the mean nitrate concentrations in upgradient wells do not differ significantly from mean nitrate concentrations in facility wells.
- The ANOVA results indicate that TDS concentrations are significantly lower in facility wells compared to upgradient wells.

3.0 Impacts Analysis – San Jacinto Lower Pressure Management Zone

3.1 Van Ryn Dairy

Van Ryn Dairy is located south of Gilman Springs Road between Curtis Street and Central Avenue, east and north of Mystic Lake within the San Jacinto Lower Pressure management zone. This dairy was reported vacant for the 2014 analysis and, as of the date of this report, is still vacant. No analysis has been conducted. However, if in the future dairy operations commence at this location, the dairy operator will be responsible for compliance with the applicable groundwater data monitoring or analysis requirements in place at that time.

3.2 Pair of Dairies (Jim Bootsma Jr. and Marvo Holsteins)

Two dairies identified as Jim Bootsma Jr. Dairy and Marvo Holsteins Dairy are located approximately 1 mile northwest of the intersection of Bridge Street and Main Street. Land identified as dairy intensive for the two facilities is located side-by-side (see Figure 20). The two dairies were analyzed together because the close proximity of the dairies makes it infeasible to determine with any degree of confidence the impact of each individual dairy.

The dairies were reported to have started operations in May 1985 and April 1987. Based on groundwater mapping (WRCAC 2014), published reports (WEI 2000, EMWD 2013), and field verification by EMWD during site visits conducted in September, 2015, the groundwater flow in the vicinity of the dairies has been variable. The groundwater elevation contour map from 1973 (WEI 2000) indicates groundwater flow to the southwest in the vicinity of this group of dairies; however, groundwater contours published in the Wildermuth report (WEI 2000, Figure 3-7, Fall 1997 Water Level Elevation Contours) indicate a groundwater low in this area, with groundwater flow from the south, southwest, and northwest all converging into a groundwater low. Therefore, a change in groundwater flow direction occurred sometime between 1973 and 1997. Unfortunately, the spring 2012 groundwater elevation map (EMWD 2013) does not show this area completely and it is difficult to draw any strong conclusions regarding flow direction. The current flow direction has been reported to be generally to the east toward the Bridge Street pumping depression, as indicated by the general groundwater flow direction arrows in Figure 20. To ensure that only data collected since the change in flow direction occurred, the analysis utilizes only data collected in 1997 and thereafter. A southeast-northwest oriented fault zone is located northeast of the dairies and appears to form a barrier to groundwater flow.

Wells were selected from those available in the vicinity of the dairies that best represent upgradient and facility groundwater conditions. Potential non-dairy impacts to groundwater quality for this group of dairies are primarily from irrigated fields to the west, south, and east.

The analysis for this group of dairies includes one upgradient well with a total of 8 nitrate and TDS samples collected from 5/29/1997 to 12/11/2012, and two facility wells with a total of 24 nitrate and 33 TDS samples collected from 5/17/2002 to 11/16/2015. No downgradient wells are available for these dairies.

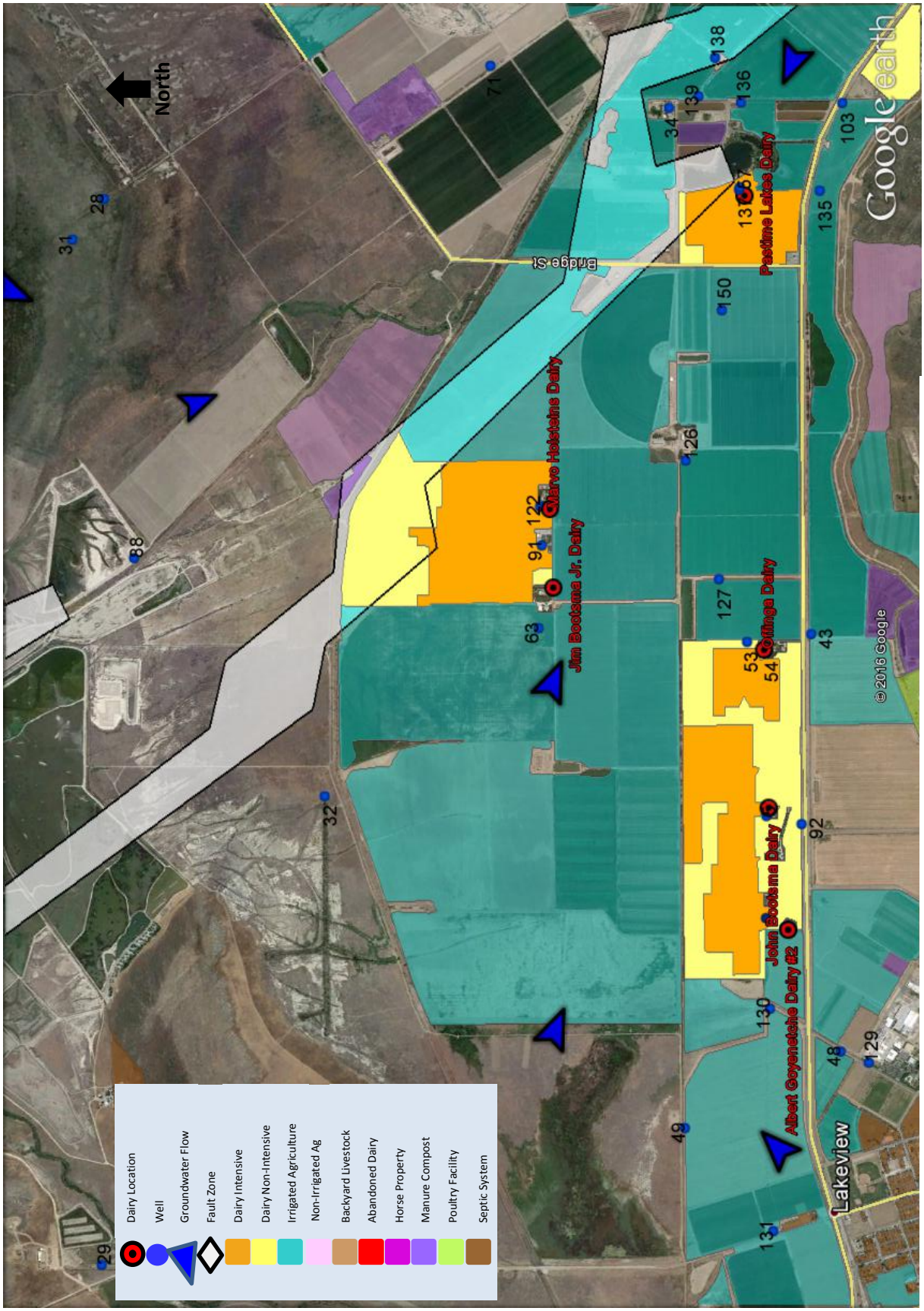


Figure 20. Location map of the vicinity of Jim Bootsma Jr. and Marvo Holsteins Dairies

3.2.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 14. Comparison of Upgradient and Facility Nitrate Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
63	832 - 1062	5/29/97-12/11/12	8	7	88%	<0.1	<0.1	<0.1 – 0.1	0.03
Upgradient Group Summary			**8**	**7**	**88%**	**<0.1**	**<0.1**	**<0.1 – 0.1**	**0.03**
Facility Group									
91	-	5/17/02-11/18/14	11	9	82%	<0.1	<0.1	<0.1 – 0.3	0.08
122	-	6/5/02-11/16/15	13	12	92%	<0.1	<0.1	<0.1 – 0.2	0.04
Facility Group Summary			**24**	**21**	**88%**	<0.1	<0.1	<0.1 – 0.3	**0.06**
Downgradient Group									
None available									

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

Although it is difficult to draw conclusions when nearly 90 percent of observations have been below the nitrate detection limit, the above summary table suggests that there is no change in the very low average nitrate concentrations in facility wells compared to upgradient wells. Average upgradient and facility nitrate concentrations are less than the historical averages for the San Jacinto Lower Pressure management zone for the periods 1954 to 1973 (1.0 mg/L), 1978 to 1997 (1.9 mg/L), 1990 to 2009 (1.1 mg/L) and 1993 to 2012 (1.1 mg/L) (WEI 2000, 2011, 2014).

Table 15. Comparison of Upgradient and Facility TDS Concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

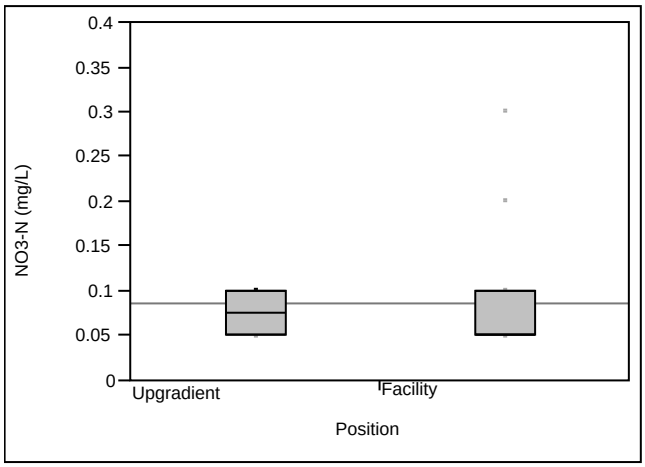
Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
63	832 - 1062	5/29/97-12/11/12	8	0	0%	618	610	590 - 660	24.9
Upgradient Group Summary			**8**	**0**	**0%**	**618**	**610**	**590 - 660**	**24.9**
Facility Group									
91	-	5/17/02-11/18/14	20	0	0%	589	590	560 - 654	24.2
122	-	6/5/02-11/16/15	13	0	0%	616	620	550 - 680	32.0
Facility Group Summary			**33**	**0**	**0%**	**599**	**590**	**550 - 680**	**30.3**
Downgradient Group									
None available									

The above summary table indicates that the average TDS concentration is slightly greater in the upgradient wells compared to facility wells. The average upgradient and facility well concentrations are less than the average TDS concentrations for the San Jacinto Lower Pressure management zone for the

periods 1978 to 1997 (730 mg/L), 1990 to 2009 (800 mg/L) and 1993 to 2012 (800 mg/L) (WEI 2000, 2011, 2014).

3.2.2 Boxplots

Boxplots were created using data from wells representing upgradient and facility groundwater quality (Figures 21 and 22).

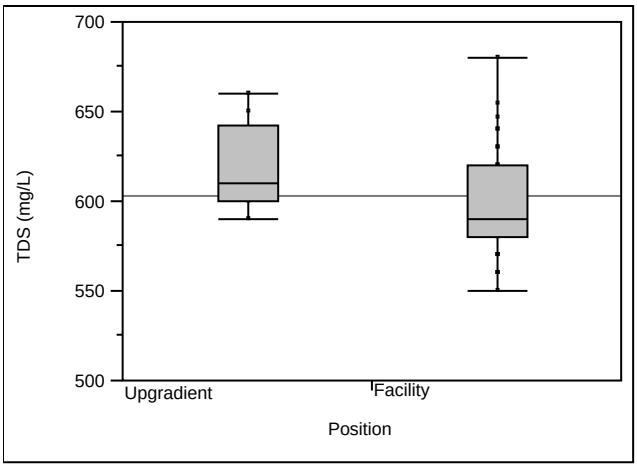


Average Nitrate Concentration San Jacinto Lower Pressure management zone

- 1993 to 2012 - 1.1 mg/L
- 1990 to 2009 - 1.1 mg/L
- 1978 to 1997 - 1.9 mg/L
- 1954 to 1973 - 1.0 mg/L

Figure 21. Boxplot of upgradient and facility nitrate concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

The boxplots indicate that the distribution of nitrate concentrations in the facility wells is approximately the same as upgradient wells. Median facility and downgradient well nitrate concentrations are lower than the historic averages for the Lakeview/Hemet North management zone.



Average TDS concentration San Jacinto Lower Pressure management zone

- 1993 to 2012 - 800 mg/L
- 1990 to 2009 - 800 mg/L
- 1978 to 1997 - 730 mg/L
- 1954 to 1973 - 520 mg/L

Figure 22. Boxplot of upgradient and facility TDS concentrations for Jim Bootsma Jr. and Marvo Holsteins Dairies

The boxplots indicate that the distribution of TDS levels in upgradient wells is greater than that in facility wells and the median concentrations are less than the 1978 to 1997, 1990 to 2009 and 1993 to 2012 historic averages but greater than the 1954 to 1973 historic average for the San Jacinto Lower Pressure management zone.

3.2.3 Quantitative Statistical Analysis

The percentage of censored data was too high to support quantitative analysis for nitrate levels in groundwater. Mean TDS concentrations in upgradient and facility groundwater were compared using a t-Test.

Mean TDS (mg/L)			
Upgradient	Facility	t value	*P* value
618 a	599 a	-1.56	0.127

The *P* value indicates that the mean TDS concentrations in wells located upgradient do not differ significantly from mean TDS concentrations in facility wells.

3.2.4 Conclusions

Based on the available data, it appears that the combined dairy operations at Jim Bootsma Jr. and Marvo Holsteins dairies have not increased observed groundwater nitrate and TDS concentrations. Average TDS concentrations in facility wells are less than the historic average for the periods 1978 to 1997, 1990 to 2009 and 1993 to 2012 and no downgradient well information is available to determine if

the combined operations have impacted downgradient groundwater quality. The following observations support the conclusion:

- Average nitrate concentrations in facility wells are the same as upgradient wells.
- The boxplots for nitrate indicate that the distribution of nitrate concentrations in the facility wells is approximately the same as upgradient wells and that both groups include a high percentage of non-detects.
- The average TDS concentration is less in the facility wells compared to upgradient wells.
- The average upgradient and facility well concentrations are greater than the average TDS concentrations for the Lakeview/Hemet North management zone for 1954 to 1973 of 520 mg/L, but less than the 1978 to 1997 (730 mg/L), 1990 to 2009 (800 mg/L), and 1993 to 2012 (800 mg/L).
- The t-Test results indicate that facility well mean TDS concentrations do not differ significantly from upgradient well mean TDS concentrations.

Based on the available information, it is not feasible to determine if the combined dairy operations have impacted downgradient nitrate and TDS concentrations, because no groundwater wells are available. It is also not feasible to determine the individual contribution of each dairy in the potential impacts to groundwater quality because the dairies are adjacent. Numerous non-dairy sources of nitrate and TDS, variations in sample dates, unknown or dissimilar perforated intervals, the impact of fault zones, the absence of downgradient wells, and the close proximity of individual wells make it infeasible to determine the impact of the dairies with a high degree of confidence. In this case, further study is needed to more accurately determine the combined dairy operation impacts and the individual impact of each dairy.

4.0 Impacts Analysis – Menifee Management Zone

4.1 Abacherli Dairy and Boere Dairy

Abacherli Dairy and Boere Dairy are now closed but were previously located east of Menifee, California, southwest of the intersection of Briggs Road and Gold Crest Drive (see Figure 23). Dense residential developments with a golf course within Salt Creek surround the dairies on the north, west, and south sides. Other potential impacts to groundwater quality in the vicinity include irrigated fields, septic systems, and poultry facilities adjacent to both dairies. These dairies were reported vacant for the 2014 analysis and, as of the date of this report, are still vacant. No analysis has been conducted. However, if in the future dairy operations commence either of these locations, the dairy operator(s) will be responsible for compliance with the applicable groundwater data monitoring or analysis requirements in place at that time.

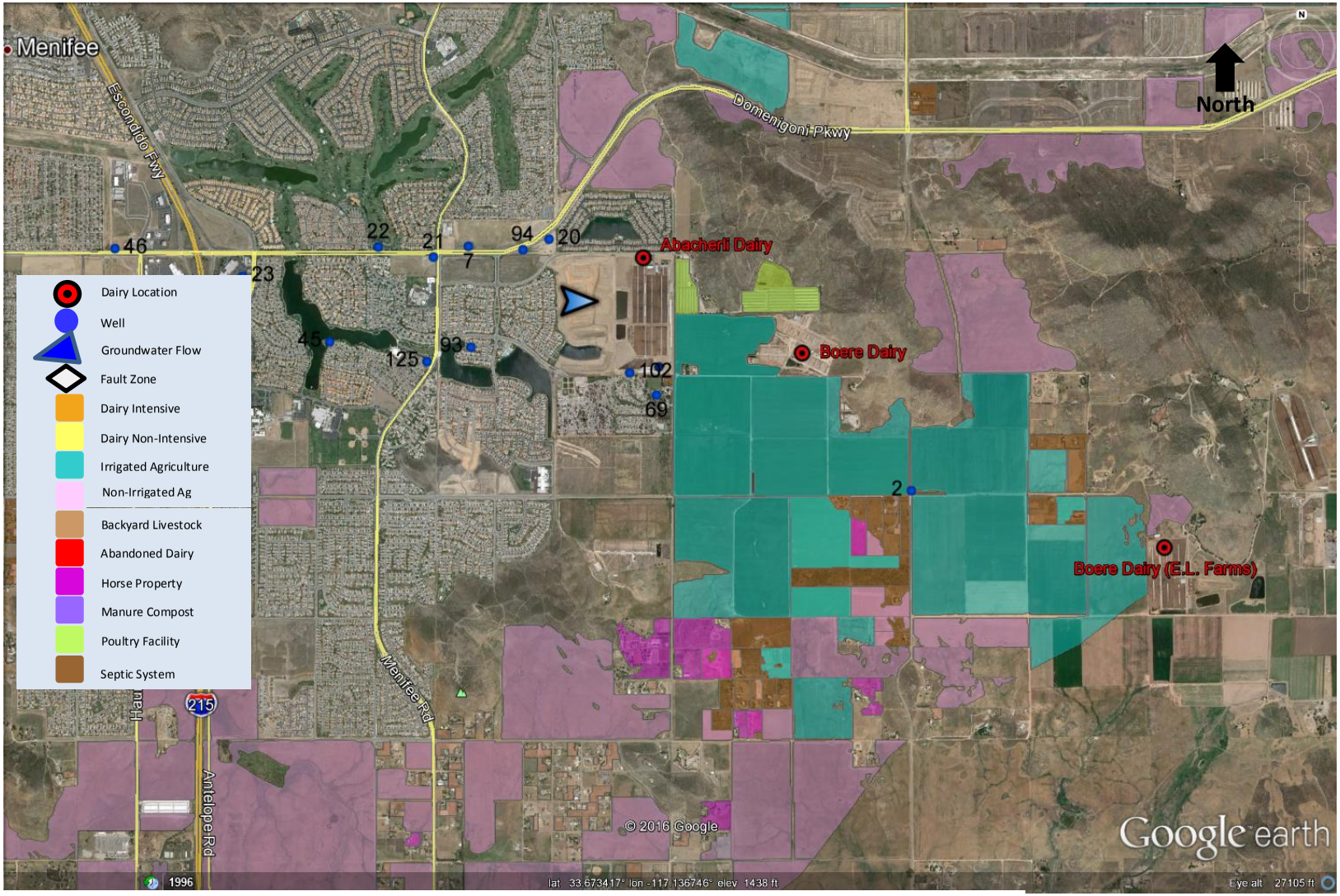


Figure 23. Location map of the vicinity of Abacherli, Boere and E.L. Farms Dairies

4.2 E.L. Farms

E.L. Farms is located approximately 1.8 miles east-southeast of the location of the former Boere Dairy, northeast of the intersection of Craig Avenue and Beeler Road (see Figure 23). The E.L. Farms property is located in both Region 8 (Santa Ana Region) and 9 (San Diego Region). The northwestern most corral area of E.L. Farms is the only portion in Region 8. The southeast corrals and all the wastewater ponds are in Region 9. The facility was closed on March 1, 2016. However, if in the future dairy operations commence at this location, the dairy operator will be responsible for compliance with the applicable groundwater data monitoring or analysis requirements in place at that time and compliance considerations should include the results of the analysis described below.

The groundwater flow in the vicinity of the dairy does not appear to be well understood, but is thought to be generally from the northeast to the southwest. Groundwater flow is obstructed by a bedrock lip located south of the dairy, and only continues to the south when groundwater levels are high enough to overtop the lip, based on information received from representatives of the facility and EMWD during a site visit in September, 2015. The refilling of Diamond Valley Lake, located to the east of the dairy, is expected to alter the direction of groundwater flow, pushing groundwater in the vicinity of the lake in a more northerly direction (Bruce Scott 2016, personal communication); it is not clear how this might influence groundwater flow in the area immediately surrounding the dairy. Limited historic data suggest that regional groundwater flow in the past may have been from the west to the east.

The dataset includes three facility wells that are all located near the southwest corner facility within Region 9. The nearest monitored well is located approximately 1.1 miles to the west in an area surrounded by irrigated fields. Site investigations concluded that the use of a single downgradient well could support comparison of downgradient water quality to historical ambient water quality for the Menifee Groundwater Management Zone. According to Metropolitan Water District, no additional wells in the vicinity are monitored for groundwater quality. Potential non-dairy impacts to groundwater quality in the vicinity include residential development and upgradient dairy operations and irrigated fields located within the Santa Margarita River watershed. The presence of septic systems associated with those upgradient operations and residences is unknown, but possible.

The analysis for this dairy consists of comparison of the data from one downgradient well to historic averages. In this case, further study is needed to more accurately determine the dairy operation impacts, including facility and downgradient groundwater quality information.

4.2.1 Summary Data

The following tables summarize the available nitrate and TDS data used in the analysis of this dairy for wells located outside of the dairy only. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for the downgradient well.

Table 16. Downgradient Nitrate Concentrations for E.L. Farms

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
No upgradient wells									
Facility Group									
No facility wells									
Downgradient Group									
2	-	7/28/98-6/24/14	17	0	0%	8.1	7.4	2.2 – 14.0	3.53
Downgradient Group Summary			**17**	**0**	**0%**	**8.1**	**7.4**	**2.2 – 14.0**	**3.53**

Average nitrate concentration Menifee management zone

- 1993 to 2012 – 2.8 mg/L
- 1990 to 2009 – 5.4 mg/L
- 1978 to 1997 – 4.4 mg/L
- 1954 to 1973 – 4.6 mg/L

The available data consists of a single downgradient well so no comparison to upgradient or facility well concentrations is possible. Average downgradient nitrate concentrations are higher than the historical averages for the Menifee management zone for the periods 1954 to 1973 (4.6 mg/L), 1978 to 1997 (4.4 mg/L), 1990 to 2009 (5.4 mg/L) and 1993 to 2012 (2.8 mg/L) (WEI 2000, 2011, 2014).

Table 17. Downgradient TDS Concentrations for E.L. Farms

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
No upgradient wells									
Facility Group									
No facility wells									
Downgradient Group									
2		7/28/98-6/24/14	16	0	0%	923	875	770 - 1200	125.6
Downgradient Group Summary			**16**	**0**	**0%**	**923**	**875**	**770 - 1200**	**125.6**

Average TDS concentration Menifee management zone

- 1993 to 2012 – 1,021 mg/L
- 1990 to 2009 – 3,360 mg/L
- 1978 to 1997 – 2,050 mg/L
- 1954 to 1973 – 2,030 mg/L

The available data consists of a single downgradient well so no comparison to upgradient or facility well concentrations is possible. Average downgradient TDS concentrations are lower than the historical averages for the Menifee management zone for the periods 1954 to 1973 (2,030 mg/L), 1978 to 1997 (2,050 mg/L), 1990 to 2009 (3,360 mg/L) and 1993 to 2012 (1,021 mg/L) (WEI 2000, 2011, 2014).

4.2.2 Boxplots

Boxplots are not applicable for this analysis.

4.2.3 Quantitative Statistical Analysis

A quantitative statistical analysis is not possible with one dataset.

4.2.4 Conclusions

Based on groundwater monitoring samples collected in one well located downgradient of the facility, it appears that the dairy may have impacted offsite nitrate groundwater quality in excess of average concentrations reported for the Menifee management zone; however, the degree of confidence in this conclusion is low because it is based solely on a single well located approximately one mile northwest of the facility that is located at the edge of an irrigated agriculture field. The facility does not appear to have impacted downgradient TDS concentrations. The following specific observations were made which support the conclusion:

- Average nitrate concentrations in the downgradient well are higher than historical concentrations for the Menifee management zone, which are much higher than historical averages for the other management zones.
- Average TDS concentrations in the downgradient well are lower than historical concentrations for the Menifee management zone.

To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary, including upgradient and facility groundwater quality data and further study to determine groundwater flow direction in the vicinity of the dairy.

5.0 Impacts Analysis – San Jacinto Upper Pressure Management Zone

5.1 Group of Dairies (Arie & Josh De Jong, CBJ, and Ed Vander Woude)

Three dairies identified as Arie & Josh De Jong, CBJ, and Ed Vander Woude are located northwest of the intersection of Ramona Expressway and North Sanderson Avenue. Land identified as dairy intensive for these facilities is less than 700 feet apart, and dairy non-intensive land for each dairy is either directly adjacent or separated only by a narrow strip of irrigated field (see Figure 24). The three dairies were analyzed as a group because the close proximity of the dairies makes it infeasible to determine with any degree of confidence the impact of each individual dairy. As of the date of this report, CBJ Dairy is closed; however, the conclusions of the analysis for this group of dairies applies to CBJ Dairy and should be considered in any future compliance activities undertaken by a dairy operator at this site.

The dairies were reported to have started operations in the 1950s (CBJ), 1971 (Ed Vander Woude) and 1987 (Arie & Josh De Jong). Based on groundwater mapping (WRCAC 2014) and published reports (WEI 2000, EMWD 2013), and field verification by EMWD during site visits conducted in September, 2015, the groundwater flow direction in the vicinity of the dairies is east-southeast to west-northwest, as identified by the generalized groundwater flow arrows in Figure 24. The Spring 2012 groundwater elevation contours from the EMWD report indicates that a groundwater divide is located somewhere between the intersection of Ramona Expressway and North Sanderson Avenue, and the vicinity of R&J Haringa and John Oostdam dairies, located to the east-southeast. Because no change in the groundwater flow direction is clearly documented over the period of dairy operation and the sample dates generally cover the period of time of dairy operation, there is no reason to eliminate any of the samples from the dataset based on historic changes in groundwater flow direction. The potential non-

dairy impacts to groundwater quality in the vicinity are primarily irrigated fields. Both upgradient wells are located within irrigated fields and dairy non-intensive areas associated with R&J Haringa dairy are immediately upgradient. All downgradient wells are also located within irrigated fields. Fault zones are located west and east of the group of dairies.

The analysis for this group of dairies includes two upgradient wells with a total of 14 samples collected from 3/5/2002 to 6/17/2014, seven facility wells with a total of 51 samples collected from 4/16/2002 to 6/9/2015, and three downgradient wells with a total of 20 samples collected from 4/8/2002 to 6/3/2014.

Ed Vander Woude Dairy does not have any monitored wells within or near the dairy intensive or non-intensive areas, although on-site wells exist that could be monitored.

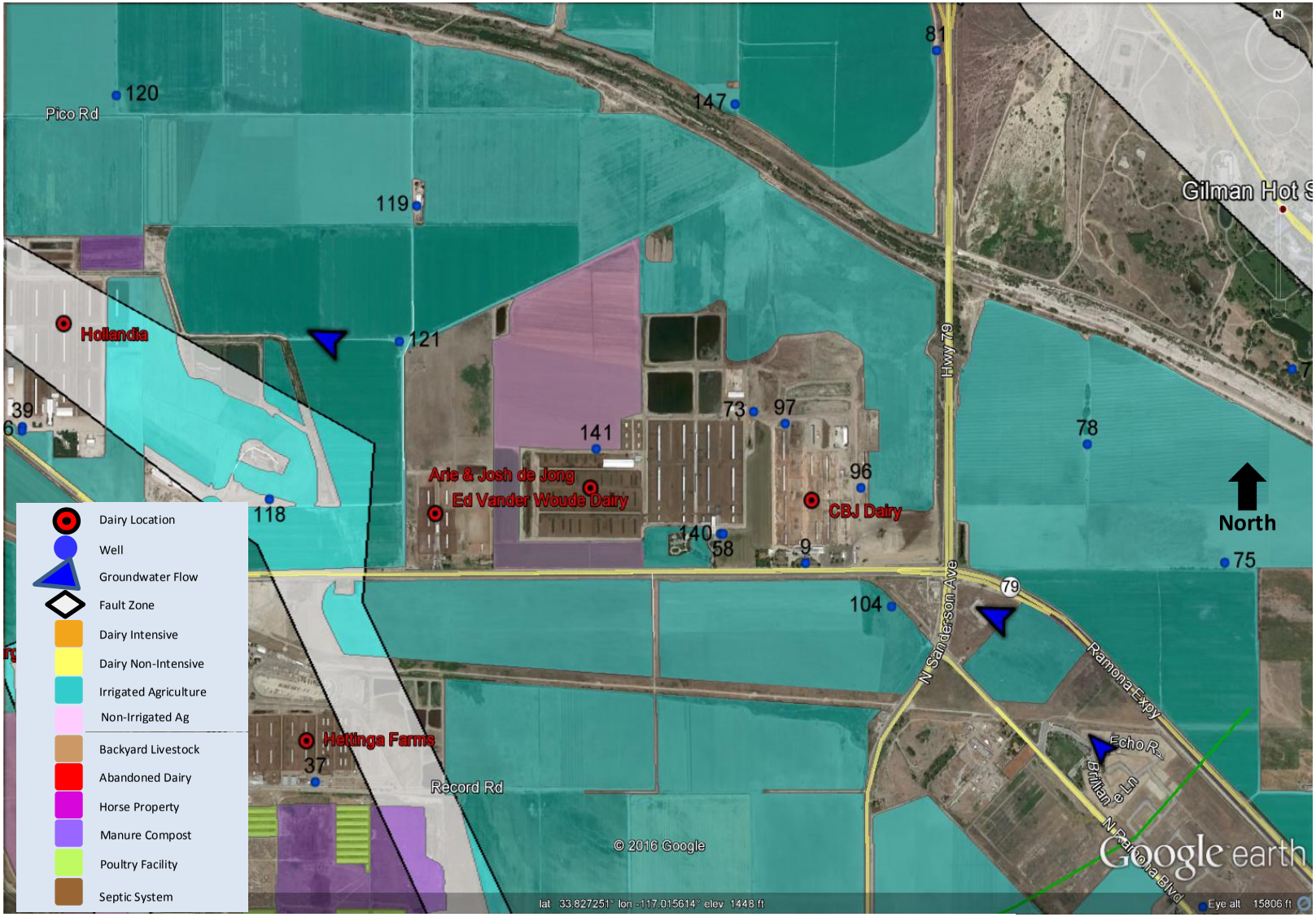


Figure 24. Location map of the vicinity of Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies

5.1.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for upgradient, downgradient, and facility wells. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 18. Comparison of Upgradient, Facility, and Downgradient Nitrate Concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
75	680 - 1270	3/5/02-7/17/14	7	7	100%	<0.1	<0.1	<0.1 – 0.1	0.02
78		12/9/04-6/17/14	7	7	100%	<0.1	<0.1	<0.1 – 0.1	0.02
Upgradient Group Summary			**14**	**14**	**100%**	**<0.1**	**<0.1**	**<0.1 – 0.1**	**0.02**
Facility Group									
9		8/28/03-6/4/14	15	12	80%	<0.1	<0.1	<0.1 – 0.2	0.05
58	-	11/19/07-6/9/15	10	10	100%	<0.1	<0.1	<0.1 – 0.1	0.02
73		8/28/03-6/23/10	8	8	100%	<0.1	<0.1	<0.1 – 0.1	0.02
96	928 - 1158	4/2/09	1	1	100%	<0.1	<0.1	-	-
97	853 - 1253	4/15/07	1	1	100%	<0.1	<0.1	-	-
140	-	4/16/02-3/11/13	6	6	100%	<0.1	<0.1	<0.1 – 0.1	0.02
141	-	8/28/03-6/9/15	10	10	100%	<0.1	<0.1	<0.1 – 0.1	0.02
Facility Group Summary			**51**	**48**	**94%**	**<0.1**	**<0.1**	**<0.1 – 0.2**	**0.04**
Downgradient Group									
118		11/5/03-2/21/06	3	3	100%	<0.1	<0.1	<0.1 – 0.1	0.03
120		4/8/02-6/3/14	10	10	100%	<0.1	<0.1	<0.1 – 0.1	0.02
121	605 - 1025	6/6/02-7/9/09	7	7	100%	<0.1	<0.1	<0.1 – 0.1	0.02
Downgradient Group Summary			**20**	**20**	**100%**	**<0.1**	**<0.1**	**<0.1 – 0.1**	**0.02**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there does not appear to be an increase in nitrate concentrations in facility or downgradient wells compared to upgradient wells. All group averages are lower than the average nitrate concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (1.4 mg/L), 1978 to 1997 (1.9 mg/L) and 1990 to 2009 (1.5 mg/L) (WEI 2000, 2011, 2014).

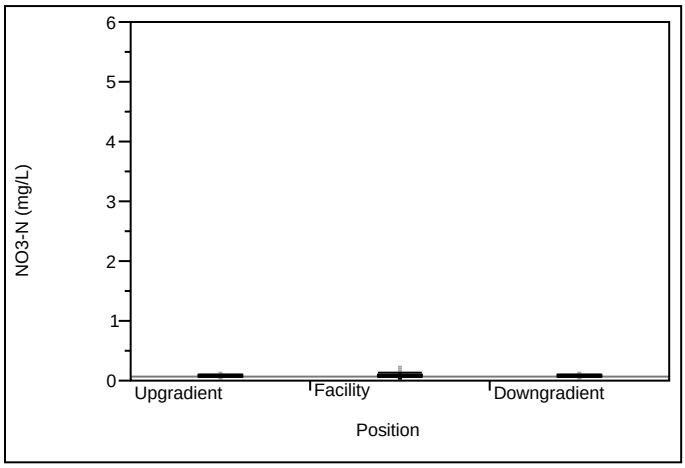
Table 19. Comparison of Upgradient, Facility, and Downgradient TDS Concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
75	680 - 1270	3/5/02-7/17/14	7	0	0%	196	200	160 - 220	25.6
78		12/9/04-6/17/14	7	0	0%	205	216	170 - 230	22.6
Upgradient Group Summary			**14**	**0**	**0%**	**200**	**208**	**160 - 230**	**23.7**
Facility Group									
9		8/28/03-6/4/14	15	0	0%	223	220	210 - 240	12.2
58	-	11/19/07-6/9/15	10	0	0%	221	220	200 - 240	14.5
73		8/28/03-6/23/10	8	0	0%	224	220	200 - 280	24.4
96	928 - 1158	4/2/09	1	0	0%	250	250	-	-
97	853 - 1253	4/15/07	1	0	0%	210	210	-	-
140	-	4/16/02-3/11/13	6	0	0%	230	215	210 - 290	31.6
141	-	8/28/03-6/9/15	10	0	0%	226	225	190 - 270	23.8
Facility Group Summary			**51**	**0**	**0%**	**224**	**220**	**190 - 290**	**19.7**
Downgradient Group									
118		11/5/03-2/21/06	3	0	0%	380	370	370 - 400	17.3
120		4/8/02-6/3/14	10	0	0%	247	248	210 - 270	17.6
121	605 - 1025	6/6/02-7/9/09	7	0	0%	235	235	220 - 250	9.6
Downgradient Group Summary			**20**	**0**	**0%**	**263**	**244**	**210 - 400**	**52.9**

The above summary table suggests that the average TDS concentration in facility wells is greater than in upgradient wells, and that there is an increase in TDS concentrations downgradient from the facility. The average concentrations for all three well groups are lower than the average TDS concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (321 mg/L), 1978 to 1997 (370 mg/L) and 1990 to 2009 (350 mg/L) (WEI 2000, 2011, 2014). These average TDS concentrations are the lowest of all management zones included in this study.

5.1.2 Boxplots

Boxplots using data from wells representing upgradient, downgradient, and facility groundwater quality are shown in Figures 25 and 26 for nitrate and TDS concentrations, respectively.

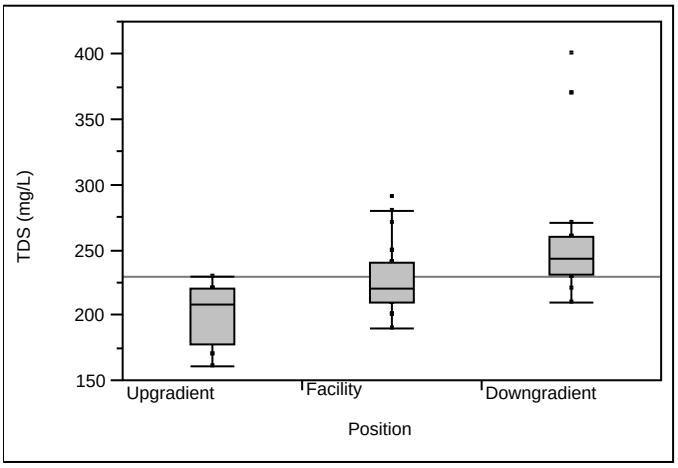


Average nitrate concentration San Jacinto Upper Pressure management zone

- 1993 to 2012 - 1.4 mg/L
- 1990 to 2009 - 1.5 mg/L
- 1978 to 1997 - 1.9 mg/L
- 1954 to 1973 - 1.4 mg/L

Figure 25. Boxplot of upgradient, facility, and downgradient nitrate concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies

The boxplots indicate that most nitrate results are at non-detected concentrations, and all distributions of nitrate concentrations are less than the historical averages for the San Jacinto Upper Pressure management zone.



Average TDS concentration San Jacinto Upper Pressure management zone

- 1993 to 2012 - 350 mg/L
- 1990 to 2009 - 350 mg/L
- 1978 to 1997 - 370 mg/L
- 1954 to 1973 - 321 mg/L

Figure 26. Boxplot of upgradient, facility, and downgradient TDS concentrations for Arie & Josh De Jong, CBJ, and Ed Vander Woude Dairies

The boxplots indicate that the median TDS concentration in facility wells is greater than upgradient wells. TDS levels in downgradient wells tend to be greater than those in either facility or upgradient. However, all results for all three well groups are below the average TDS concentrations for the San Jacinto Upper Pressure management zone.

5.1.3 Quantitative Statistical Analysis

Because the nitrate datasets for all well groups contain greater than 20 percent non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and ANOVA was used to test for significant differences among TDS concentrations from all three well groups (upgradient vs. facility vs. down gradient).

	Mean TDS (mg/L)			
Upgradient	Facility	Downgradient	F value	*P* value
200 a	224 b	263 c	18.1	< 0.001

In the table above, group means followed by the same letter(s) do not differ significantly ($P \leq 0.10$). The ANOVA results show that mean TDS concentrations in all three locations are significantly different from each other. Mean facility TDS level was significantly higher than mean upgradient TDS concentration, and mean TDS level downgradient significantly exceeded both facility or upgradient mean TDS concentrations.

5.1.4 Conclusions

Based on the available data, it appears that the combined dairy operations at Arie & Josh De Jong and CBJ dairies have increased TDS concentrations in facility and downgradient groundwater. The extent to which Ed Vander Woude Dairy might have contributed to the increases cannot be determined based on available information. The following specific observations were made which support the conclusion:

- There does not appear to be an increase in nitrate concentrations in facility or downgradient wells compared to upgradient wells and all well concentrations are lower than the historical averages for the San Jacinto Upper Pressure management zone.
- The average TDS concentration in downgradient wells is higher than that in upgradient or facility wells.
- TDS concentrations in all well groups are lower than the average historical TDS concentrations for the San Jacinto Upper Pressure management zone.
- The boxplot of TDS concentrations indicates an increase in downgradient wells compared to facility wells.
- The ANOVA results indicate that mean TDS concentrations are significantly higher in facility and downgradient wells compared to upgradient wells and that the mean TDS concentration in downgradient wells is significantly higher than that in facility wells.

Based on the available information, it is not feasible to determine the extent to which the Arie & Josh De Jong and CBJ dairy operations have impacted downgradient TDS concentrations. Numerous non-dairy sources of TDS, including irrigated fields and septic systems make it infeasible to determine the impact

of the dairy operations alone. The variable groundwater flow direction reported in the referenced reports makes it difficult to identify upgradient wells with a high degree of confidence; therefore, the comparisons to upgradient groundwater quality are questionable.

In this case, further study is needed to more accurately determine the dairy operation impacts including additional groundwater samples collected over a similar time period, further analysis of groundwater flow directions; and an inventory of sources of TDS to groundwater, such as leaky storage ponds, irrigation of cropland, and disposal of dairy manure and wastewater to land.

5.2 R & J Haringa Dairy

R & J Haringa Dairy is located northeast of the intersection of Ramona Expressway and Record Road, and approximately 0.5 mile northeast of John Oostdam Dairy (see Figure 27).

The R & J Haringa Dairy was reported to have started operations May 1983. Based on groundwater mapping (WRCAC 2014), published reports (WEI 2000, EMWD 2013), and field verification by EMWD during a site visit conducted in September, 2015, R & J Haringa Dairy is located over a groundwater mound, with flow entering from the mountains to the northeast and all surrounding areas to the west, south, and east being downgradient with respect to groundwater flow. Therefore, no upgradient wells exist; the wells located outside the footprint of the dairy are considered to be downgradient and are compared to the facility wells. Additionally, the facility well concentrations are compared to the historical averages. Potential non-dairy impacts on downgradient groundwater quality include a golf course, irrigated fields and septic systems. A fault zone is located to the northeast of the dairy.

The analysis for this dairy includes four facility wells with a total of 37 samples collected from 8/23/1995 to 9/1/2015 and seven wells located downgradient with a total of 68 nitrate and 69 TDS samples collected from 4/13/1995 to 9/1/2015.

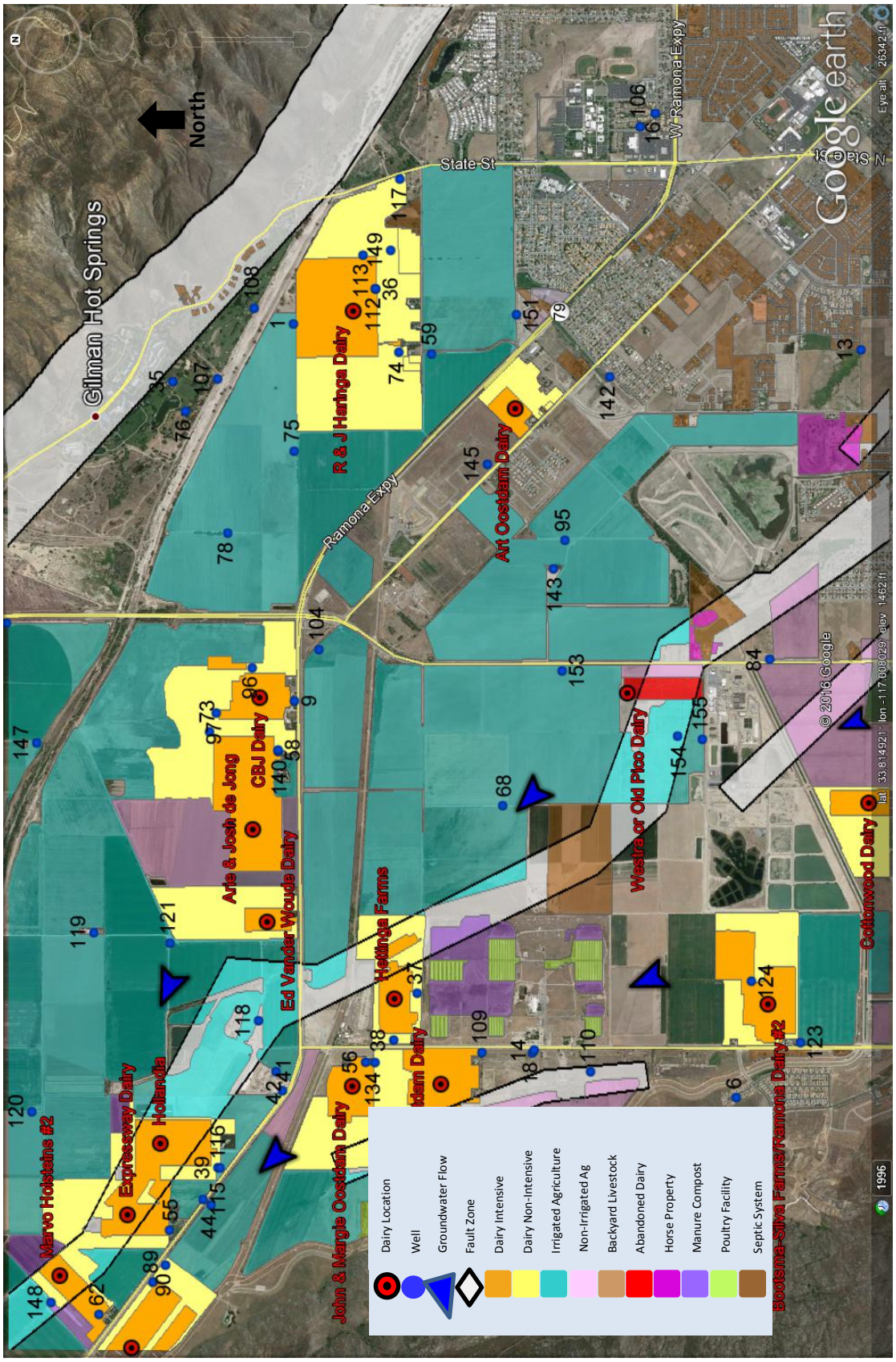


Figure 27. Location map of the vicinity of R & J Haringa Dairy and Art Oostdam Dairy

5.2.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this group of dairies for wells located within the dairy footprint (dairy intensive and non-intensive land use) and wells located downgradient of the dairy. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for each group of wells.

Table 20. Comparison of Nitrate Concentrations in Facility Wells vs. Downgradient Wells for R & J Haringa Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
No upgradient wells									
Facility Group									
36	-	8/1/07-9/1/15	10	9	90%	<0.1	<0.1	<0.1 – 0.2	0.05
74	985 - 1225	6/30/99-6/9/15	11	10	91%	<0.1	<0.1	<0.1 – 0.1	0.02
112	-	3/1/99-6/2/06	8	8	100%	<0.1	<0.1	<0.1 – 0.1	0.02
113	-	8/23/95-8/3/98	8	0	0%	0.1	0.1	0.05 – 0.4	0.11
Facility Group Summary			**37**	**27**	**73%**	**<0.1**	**<0.1**	**<0.1 – 0.4**	**0.06**
Downgradient Group									
35	-	12/2/05-6/20/13	9	9	100%	<0.1	<0.1	<0.1 – 0.1	0.02
59	848 - 1388	7/6/95-10/27/14	12	6	50%	0.2	0.1	<0.1 - 0.7	0.25
75	680 – 1270	4/13/95-7/17/14	12	9	75%	0.5	<0.1	<0.1 – 5.6	1.61
76	-	8/25/03-6/20/13	8	7	88%	<0.1	<0.1	<0.1 – 0.1	0.02
78	-	12/29/99-6/17/14	10	10	100%	<0.1	<0.1	<0.1 – 0.1	0.02
107	-	9/21/99-6/30/10	8	8	100%	<0.1	<0.1	<0.1 – 0.1	0.02
108	-	9/6/00-9/1/15	9	7	78%	<0.1	<0.1	<0.1 – 8.0	2.64
Downgradient Group Summary			**68**	**56**	**82%**	**<0.1**	**<0.1**	**<0.1 – 8.0**	**1.17**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that there is no difference in nitrate concentrations in the facility wells compared to downgradient wells. Both group averages are considerably lower than the average nitrate concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (1.4 mg/L), 1978 to 1997 (1.9 mg/L), 1990 to 2009 (1.5 mg/L) and 1993 to 2012 (1.5 mg/L) (WEI 2000, 2011, 2014).

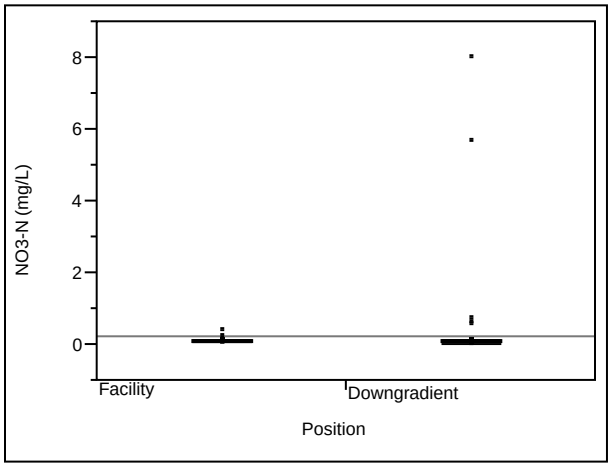
Table 21. Comparison of TDS Concentrations in Facility Wells vs. Downgradient Wells for R & J Haringa Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
No upgradient wells									
Facility Group									
36	-	8/1/07-9/1/15	10	0	0%	210	205	190 - 260	20.5
74	985 - 1225	6/30/99-6/9/15	11	0	0%	250	260	200 - 280	26.7
112	-	3/1/99-6/2/06	8	0	0%	210	210	190 - 230	12.0
113	-	8/23/95-8/3/98	8	0	0%	219	220	200 - 240	12.6
Facility Group Summary			**37**	**0**	**0%**	**224**	**220**	**190 - 280**	**25.8**
Downgradient Group									
35	-	12/2/05-6/20/13	9	0	0%	223	230	180 - 240	19.4
59	848 - 1388	7/6/95-10/27/14	12	0	0%	370	305	200 - 660	161.2
75	680 – 1270	4/13/95-7/17/14	12	0	0%	206	212	160 - 260	27.2
76	-	8/25/03-6/20/13	8	0	0%	244	235	200 - 330	40.0
78	-	12/29/99-6/17/14	10	0	0%	211	220	170 - 230	20.6
107	-	9/21/99-6/30/10	8	0	0%	209	225	120 - 240	38.7
108	-	9/6/00-9/1/15	9	0	0%	225	230	212 - 230	6.8
Downgradient Group Summary			**69**	**0**	0%	**244**	**220**	**120 - 660**	**90.7**

The above summary table suggests that facility well concentrations have lower average TDS concentrations when compared to wells located downgradient of the dairy. The average concentrations for both well groups are lower than the average TDS concentrations for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (321 mg/L), 1978 to 1997 (370 mg/L), 1990 to 2009 (350 mg/L) and 1993 to 2012 (350 mg/L) (WEI 2000, 2011, 2014). Additionally, the facility and outside of facility footprint group averages are less than the WQO for the San Jacinto Upper Pressure management zone of 320 mg/L.

5.2.2 Boxplots

Boxplots using combined data from wells located within the dairy footprint (dairy intensive and non-intensive land use) and wells located downgradient of the dairy footprint are shown in the figures below for nitrate and TDS concentrations, respectively.

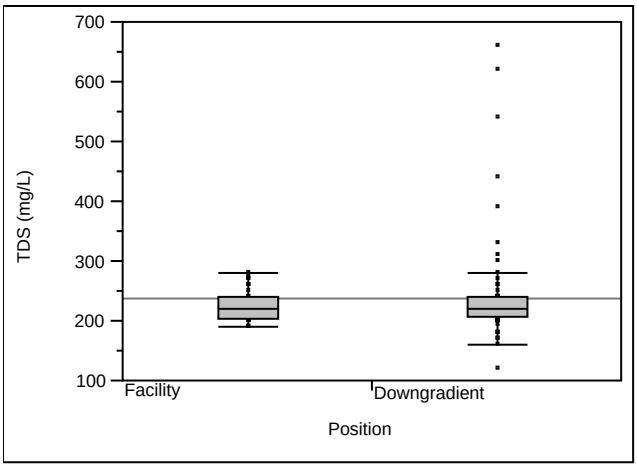


Average nitrate concentration San Jacinto Upper Pressure management zone

- 1993 to 2012 - 1.4 mg/L
- 1990 to 2009 - 1.5 mg/L
- 1978 to 1997 - 1.9 mg/L
- 1954 to 1973 - 1.4 mg/L

Figure 28. Boxplot of nitrate concentrations for facility wells vs. downgradient wells for R & J Haringa Dairy

The boxplots indicate that most nitrate results are at non-detected concentration, and other than two outliers in the downgradient well results, all distributions of nitrate concentrations are less than the historical averages for the San Jacinto Upper Pressure management zone.



Average TDS concentration San Jacinto Upper Pressure management zone

- 1993 to 2012 - 350 mg/L
- 1990 to 2009 - 350 mg/L
- 1978 to 1997 - 370 mg/L
- 1954 to 1973 - 321 mg/L

Figure 29. Boxplot of TDS concentrations for facility wells vs. downgradient wells for R & J Haringa Dairy

The boxplots indicate that the median TDS concentration in facility wells is essentially the same as downgradient wells. Other than a few outliers, all results for both well groups are less than the average TDS concentrations for the San Jacinto Upper Pressure management zone.

5.2.3 Quantitative Statistical Analysis

Because the nitrate datasets for both well groups contain greater than 20 percent non-detects a quantitative statistical analysis is not appropriate. However, all of the TDS data represent detected concentrations, and a t-Test was used to test for significant differences in TDS concentrations between the two well groups.

Mean TDS (mg/L)			
Outside Facility	Facility	t value	*P* value
224 a	244 a	1.35	0.179

The *P* value indicates that the mean TDS concentrations in wells located outside the facility do not differ significantly from mean TDS concentrations in facility wells.

5.2.4 Conclusions

Based on the available data, it appears that the dairy operations at R & J Haringa Dairy have not increased nitrate or TDS concentrations in groundwater downgradient of the facility. The following specific observations were made which support the conclusion:

- The nitrate concentrations in the wells located downgradient of the dairy appear to be higher than wells located within the facility boundaries. However, the highest concentration in the

downgradient well group are found in the Golden Era Golf Course well; these could be due to fertilizers applied to the golf course or septic systems used at the golf course.

- Except for two outliers in the downgradient well results, both distributions of nitrate concentrations are less than the historical averages and the WQO for the San Jacinto Upper Pressure management zone.
- The average TDS concentration in facility wells is not significantly greater than that in wells located downgradient of the facility.
- The average TDS concentration both well groups are lower than the average historical TDS concentrations and the WQO for the San Jacinto Upper Pressure management zone.

5.3 Art Oostdam Dairy

Art Oostdam Dairy (previously John Oostdam Dairy) is located northwest of North Lyon Avenue between North Ramona Blvd and West Ramona Expressway, approximately 0.6 miles southwest of R & J Haringa Dairy, in the San Jacinto Lower Pressure management zone (see Figure 27). The dairy was reported as vacant in the 2014 Salt Report (then John Oostdam Dairy), but was reopened as Art Oostdam Dairy late in 2015. The John Oostdam Dairy was reported to have started operations June 1990. Based on groundwater mapping (WRCAC 2014) and published reports (WEI 2000, EMWD 2013) the groundwater flow direction in the vicinity of Art Oostdam Dairy is variable. The Fall 1997 groundwater flow map in the Wildermuth report (WEI 2000) indicates that flow in the immediate vicinity of the dairy as east to west. The Spring 2012 groundwater elevation contours from the EMWD report shows a groundwater divide to the north of the dairy and groundwater flow in the vicinity of the dairy from northwest to southeast. The variability in groundwater flow direction, including possible areas of groundwater flow reversal during different periods of time, make it difficult to determine upgradient and downgradient well locations. Additionally, Art Oostdam Dairy has no facility wells. For this dairy, the analysis consists of a comparison of the nitrate and TDS concentrations in surrounding wells to the average concentrations for the San Jacinto Upper Pressure management zone. Because no change in the understanding of the groundwater flow direction has occurred since the last analysis, there is no reason to eliminate any of the samples from the dataset.

Potential non-dairy impacts to groundwater quality in the vicinity include a golf course, irrigated fields and septic systems. A fault zone is located to the northeast of the dairy.

The analysis for this dairy includes six wells located outside of the dairy area with a total of 30 samples collected from 8/4/1987 to 12/27/2014.

5.3.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this dairy for wells located outside of the dairy only. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for the group of wells located outside the footprint of the dairy.

Table 22. Nitrate Concentrations for Art Oostdam Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Outside of Facility Footprint Group									
59	848 – 1388	7/26/95-12/27/14	12	6	50%	0.2	0.1	<0.1 – 0.7	0.25
95	-	8/28/03-6/17/05	3	2	67%	0.1	0.1	<0.1 – 0.2	0.08
142	703 – 1231	5/9/96-9/23/03	7	5	71%	<0.1	0.1	<0.1 – 0.1	0.02
143	1071 – 1317	7/18/00-5/20/04	5	5	100%	<0.1	<0.1	<0.1 – 0.1	0.01
145	-	9/22/03-5/17/04	2	2	100%	<0.1	<0.1	<0.1 – 0.1	0.04
151	-	8/4/87	1	1	100%	<0.1	<0.1	-	-
Outside of Facility Footprint Group Summary			**30**	**20**	**67%**	**0.1**	**0.1**	**<0.1 – 0.7**	**0.1**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that the average nitrate concentrations in wells surrounding the facility are lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (1.4 mg/L), 1978 to 1997 (1.9 mg/L), 1990 to 2009 (1.5 mg/L) and 1993 to 2012 (1.4 mg/L) (WEI 2000, 2011, 2014). Additionally, the outside of facility footprint group average is less than the WQO for the San Jacinto Upper Pressure management zone of 1.4 mg/L.

Table 23. TDS Concentrations for Art Oostdam Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Outside of Facility Footprint Group									
59	848 – 1388	7/26/95-12/27/14	12	0	0%	360	305	200 - 660	161.2
95	-	8/28/03-6/17/05	3	0	0%	227	230	210 - 240	15.3
142	703 – 1231	5/9/96-9/23/03	7	0	0%	190	180	180 - 220	15.3
143	1071 – 1317	7/18/00-5/20/04	5	0	0%	250	240	230 - 280	20.0
145	-	9/22/03-5/17/04	2	0	0%	210	210	210	0
151	-	8/4/87	1	0	0%	195	195	-	-
Outside of Facility Footprint Group Summary			**30**	**0**	**0%**	**277**	**230**	**180 - 660**	**127.6**

The above summary table indicates that the average TDS concentrations in wells surrounding the facility are lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (321 mg/L), 1978 to 1997 (370 mg/L), 1990 to 2009 (350 mg/L) and 1993 to 2012 (350 mg/L) (WEI 2000, 2011, 2014). Additionally, the outside of facility footprint group averages are less than the WQO for the San Jacinto Upper Pressure management zone of 320 mg/L.

5.3.2 Boxplots

Boxplots are not applicable for this analysis.

5.3.3 Quantitative Statistical Analysis

A quantitative statistical analysis is not possible with one dataset.

5.3.4 Conclusions

Based on groundwater monitoring samples collected in six wells located in the vicinity of Art Oostdam Dairy, it does not appear that the dairy has impacted offsite groundwater quality in excess of average concentrations reported for the San Jacinto Upper Pressure management zone; however, the degree of confidence in this conclusion is low because it is based solely on wells located outside the dairy footprint. The following specific observations were made which support the conclusion:

- Average nitrate concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.
- Average TDS concentrations in wells surrounding the dairy are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.

To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary, including facility groundwater quality data and further study to determine groundwater flow direction in the vicinity of the dairy.

5.4 Scott Brothers Dairy

Scott Brothers Dairy is located southwest of Gilman Springs Road, approximately one mile northwest of the intersection of Gilman Springs Road and North Sanderson Avenue (see Figure 30).

The Scott Brothers Dairy was reported to have started operations June 1978. Based on groundwater mapping, published reports (WEI 2000, EMWD 2013), and field verification by the operator and EMWD during a site visit conducted in September, 2015, the groundwater flow in the vicinity of the dairy's animal confinement areas is generally to the southwest, toward the fault that bisects the operation and is a barrier to groundwater flow. There are no upgradient or facility wells north of the fault and downgradient wells are not possible for this portion of the dairy due to the location of the fault and the direction of groundwater flow. South of the fault, groundwater flow direction is generally from the east to the west. For this dairy, the upgradient and downgradient wells are located relative to the facility wastewater ponds and do not evaluate potential impacts of the portion of the facility north of the fault. The data available for the analysis of this dairy includes upgradient well samples collected from 2001 to 2015 and downgradient well samples collected from 2001 to 2008.

For this dairy, the analysis consists of a comparison of the nitrate and TDS concentrations in downgradient wells to the average concentrations for the San Jacinto Upper Pressure management zone. Potential non-dairy impacts to groundwater quality in the vicinity include irrigated fields. A southeast-northwest-oriented fault zone runs directly across the southern half of the cow confinement area and second fault zone is located under the easternmost impoundment.

The analysis for this dairy includes two wells located upgradient of the dairy impoundments with a total of 18 samples collected from 9/28/2001 to 9/1/2015, and one well located downgradient of the dairy impoundments with a total of 7 samples collected from 6/11/2001 to 4/14/2008.

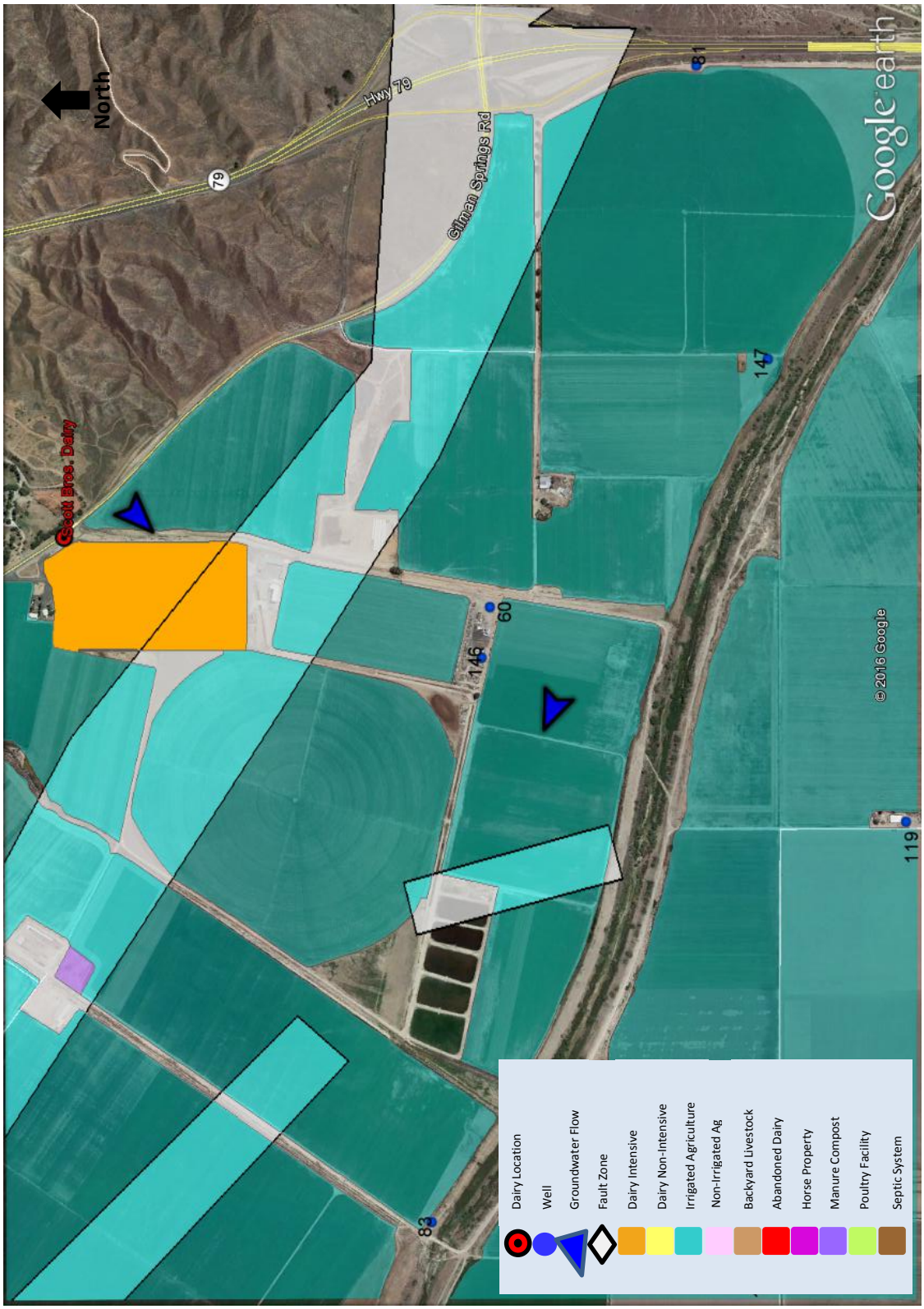


Figure 30. Location map of the vicinity of Scott Brothers Dairy

5.4.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this dairy for wells located downgradient of the dairy only. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects; and the mean, median, range, and standard deviation for each individual well, as well as the summary data for the group of wells located downgradient of the dairy.

Table 24. Downgradient Nitrate Concentrations for Scott Brothers Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
60	613 – 1033	7/2/03-6/9/15	8	6	75%	<0.1	<0.1	<0.1 – 0.2	0.06
146	440 - 1200	9/28/01-9/1/15	10	8	80%	<0.1	<0.1	<0.1 – 0.7	0.26
Upgradient Group Summary			**18**	**14**	**78%**	**0.2**	**<0.1**	**<0.1 – 0.7**	**0.20**
Facility Group									
No Facility wells									
Downgradient Group									
83	704 - 1024	6/11/01-4/14/08	7	6	86%	0.2	<0.1	<0.1 – 0.8	0.28
Downgradient Group Summary			**7**	**6**	**86%**	**0.2**	**<0.1**	**<0.1 – 0.8**	**0.28**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

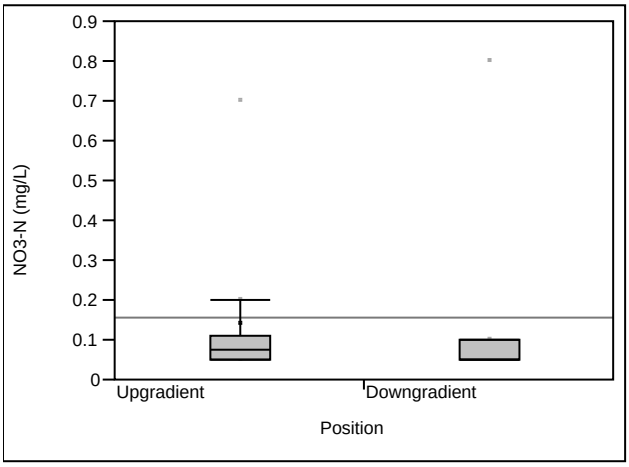
The above summary table indicates that the average nitrate concentration in the well downgradient of the facility impoundments is similar to the upgradient concentrations, and both are considerably lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (1.4 mg/L), 1978 to 1997 (1.9 mg/L), 1990 to 2009 (1.5 mg/L) and 1993 to 2012 (1.4 mg/L) (WEI 2000, 2011, 2014). Both upgradient and downgradient sample group averages are also less than the WQO for the San Jacinto Upper Pressure management zone of 1.4 mg/L.

Table 25. Downgradient TDS Concentrations for Scott Brothers Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
60	613 – 1033	7/2/03-6/9/15	8	0	0%	278	275	260 - 300	16.2
146	440 - 1200	9/28/01-9/1/15	10	0	0%	329	335	260 - 370	32.8
Upgradient Group Summary			**18**	**0**	**0%**	**306**	**300**	**260 - 370**	**36.7**
Facility Group									
No Facility wells									
Downgradient Group									
83	704 - 1024	6/11/01-4/14/08	7	0	0%	277	280	260 - 290	11.1
Downgradient Group Summary			**7**	**0**	**0%**	**277**	**280**	**260 - 290**	**11.1**

The above summary table indicates that the average TDS concentration in the downgradient well is lower than the upgradient averages, and both are lower than the historical averages for the San Jacinto Upper Pressure management zone for the periods 1954 to 1973 (321 mg/L), 1978 to 1997 (370 mg/L), 1990 to 2009 (350 mg/L) and 1993 to 2012 (350 mg/L) (WEI 2000, 2011, 2014). Both upgradient and downgradient sample group averages are also less than the WQO for the San Jacinto Upper Pressure management zone of 320 mg/L.

5.4.2 Boxplots

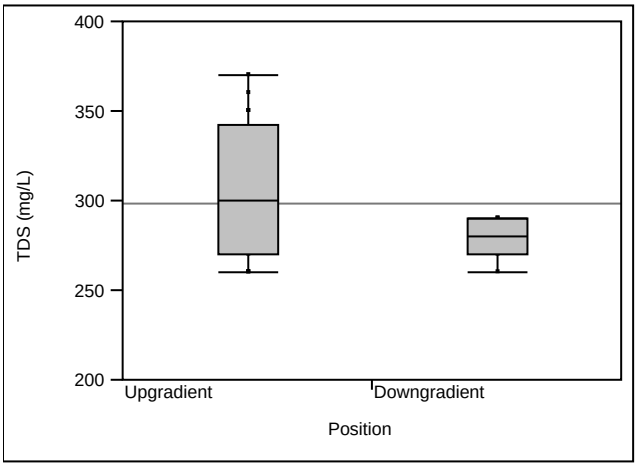


Average nitrate concentration San Jacinto Upper Pressure management zone

- 1993 to 2012 - 1.4 mg/L
- 1990 to 2009 - 1.5 mg/L
- 1978 to 1997 - 1.9 mg/L
- 1954 to 1973 - 1.4 mg/L

Figure 31. Boxplot of nitrate concentrations for upgradient and downgradient wells for Scott Brothers Dairy

The boxplots indicate that nitrate concentrations upgradient and downgradient of the facility impoundments were in the same very low range. Note that the prevalence of nitrate values below the detection limit makes drawing any conclusions difficult.



Average TDS concentration San Jacinto Upper Pressure management zone

- 1993 to 2012 - 350 mg/L
- 1990 to 2009 - 350 mg/L
- 1978 to 1997 - 370 mg/L
- 1954 to 1973 - 321 mg/L

Figure 32. Boxplot of TDS concentrations for upgradient and downgradient wells for Scott Brothers Dairy

The boxplots indicate that downgradient concentrations were at the low end of the range observed in the upgradient wells, indicating no significant influence of the dairy.

5.4.3 Quantitative Statistical Analysis

Because the downgradient nitrate dataset contains fewer than 10 samples, qualitative statistical analysis is not possible.

Mean TDS concentrations for wells upgradient and downgradient of the facility impoundments were compared using a t-Test.

Mean TDS (mg/L)			
Upgradient	Downgradient	t value	*P* value
307 **a**	277 **b**	-2.06	0.051

The *P* value indicates that the mean TDS concentration in downgradient wells is significantly lower than that in wells that are upgradient of the facility impoundments.

5.4.4 Conclusions

Based on groundwater samples collected upgradient and downgradient of the Scott Brothers Dairy impoundments, it does not appear that the dairy impoundments have impacted groundwater quality. However, the degree of confidence in this conclusion is low because it is based on a limited dataset (downgradient data from a single well). Observations regarding the animal confinement areas and other dairy activities north of the fault are not possible. The following specific observations were made which support the conclusion:

- Nitrate concentrations are similar in both upgradient and downgradient wells.
- Downgradient TDS concentrations are lower than upgradient concentrations.
- Average nitrate concentrations in wells upgradient and downgradient of the dairy impoundments are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.
- Average TDS concentrations in wells upgradient and downgradient of the dairy impoundments are lower than historical concentrations and the WQO for the San Jacinto Upper Pressure management zone.

To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary to accurately characterize the facility groundwater quality.

5.5 John & Margie Oostdam Heifer Ranch

John & Margie Oostdam Heifer Ranch is located west of Alessandro Avenue, approximately 0.25 miles south of the intersection of West Ramona Expressway and Alessandro Avenue (see Figure 33).

Based on groundwater mapping (WRCAC 2014) and published reports (WEI 2000, EMWD 2013), the groundwater flow in the vicinity of the heifer ranch is generally to the southwest, as indicated by the

generalized groundwater flow arrow in Figure 33. John & Margie Oostdam Heifer Ranch has no wells within the area identified as dairy intensive, and the nearest downgradient wells are located at least 1.5 miles downgradient where significant residential development exists, including dense areas of septic use. Potential non-dairy impacts to groundwater quality in the vicinity of the dairy include a plant nursery, septic systems, and irrigated fields. A southeast-northwest-oriented fault zone is located along the base of the mountains approximately one mile to the northeast.

The lack of available information for this dairy (i.e., facility and downgradient wells) makes it infeasible to determine the potential impact on groundwater quality. In this case, further study is needed to more accurately determine the dairy operation impacts, including facility and downgradient groundwater quality information.

As of the date of this report the facility was vacant. No further analysis has been conducted. However, if in the future dairy operations commence at this location, the dairy operator will be responsible for compliance with the applicable groundwater data monitoring or analysis requirements in place at that time.

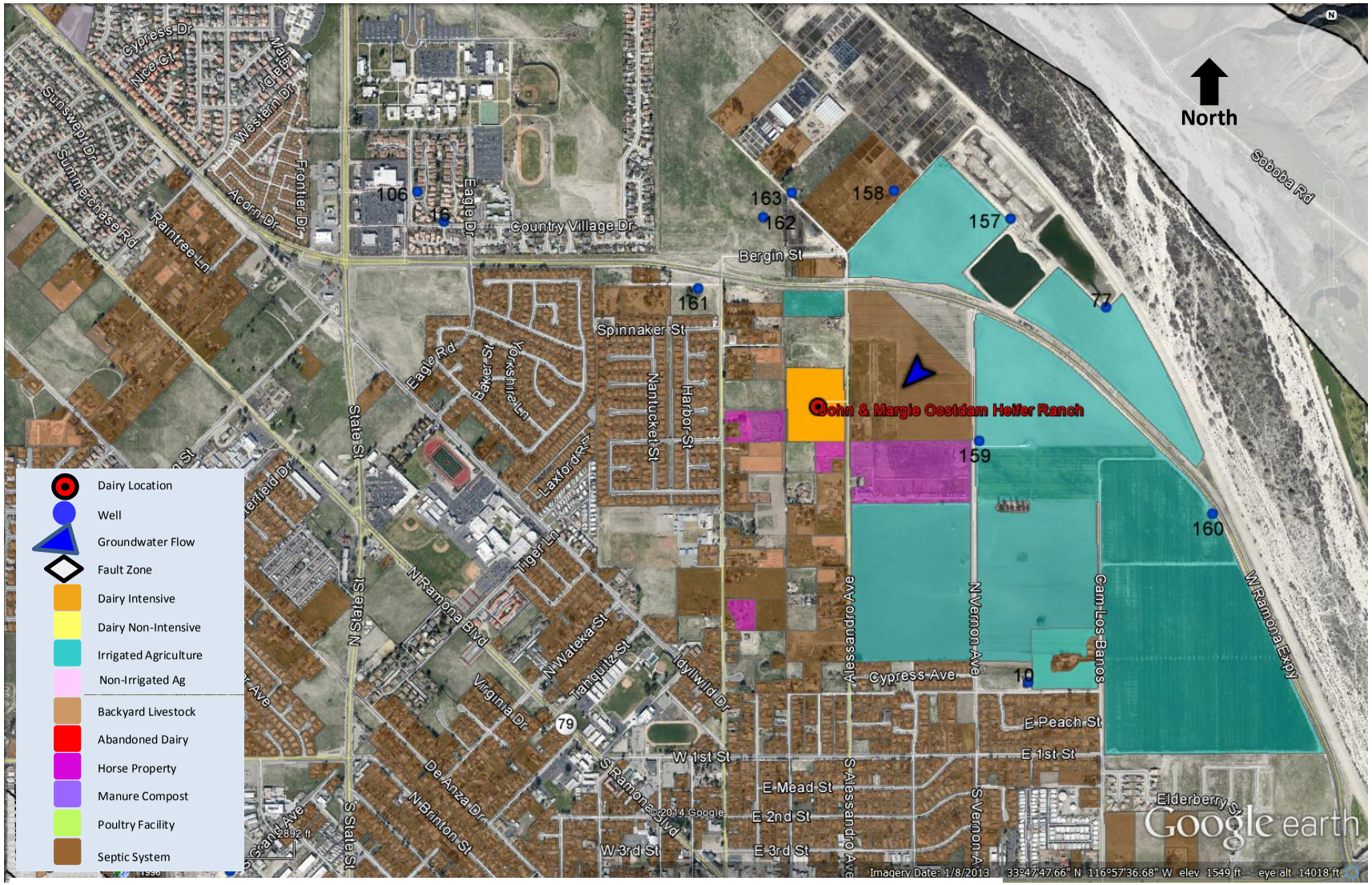


Figure 33. Location map of the vicinity of John & Margie Oostdam Heifer Ranch

6.0 Impacts Analysis – Elsinore Groundwater Management Zone

6.1 Herman De Jong Dairy

Herman De Jong Dairy is located south of the intersection of Corydon Road and Garden Street near Sedco Hills. The dairy is located in the Elsinore management zone in the Elsinore/Temescal Valley groundwater basin (see Figure 34).

No precise groundwater flow information was available for this facility, although groundwater would generally be expected to flow toward Lake Elsinore, located approximately 2 miles northeast of the facility. In November, 2015, Elsinore Valley Municipal Water District staff confirmed that all wells used in the analysis for this dairy are downgradient with respect to the direction of groundwater flow. Herman De Jong has no facility wells. For this dairy, the analysis consists of a comparison of the nitrate and TDS concentrations in the downgradient wells to the average concentrations for the Elsinore groundwater management zone. Potential non-dairy impacts to downgradient groundwater quality include residential development, and an airport. A southeast-northwest trending fault zone is located to the southwest of the dairy.

The analysis for this dairy includes six wells located downgradient of the dairy with a total of 29 samples collected from 8/4/1987 to 9/26/2012. No new data were available for this dairy; therefore the analysis is identical to the previous report.

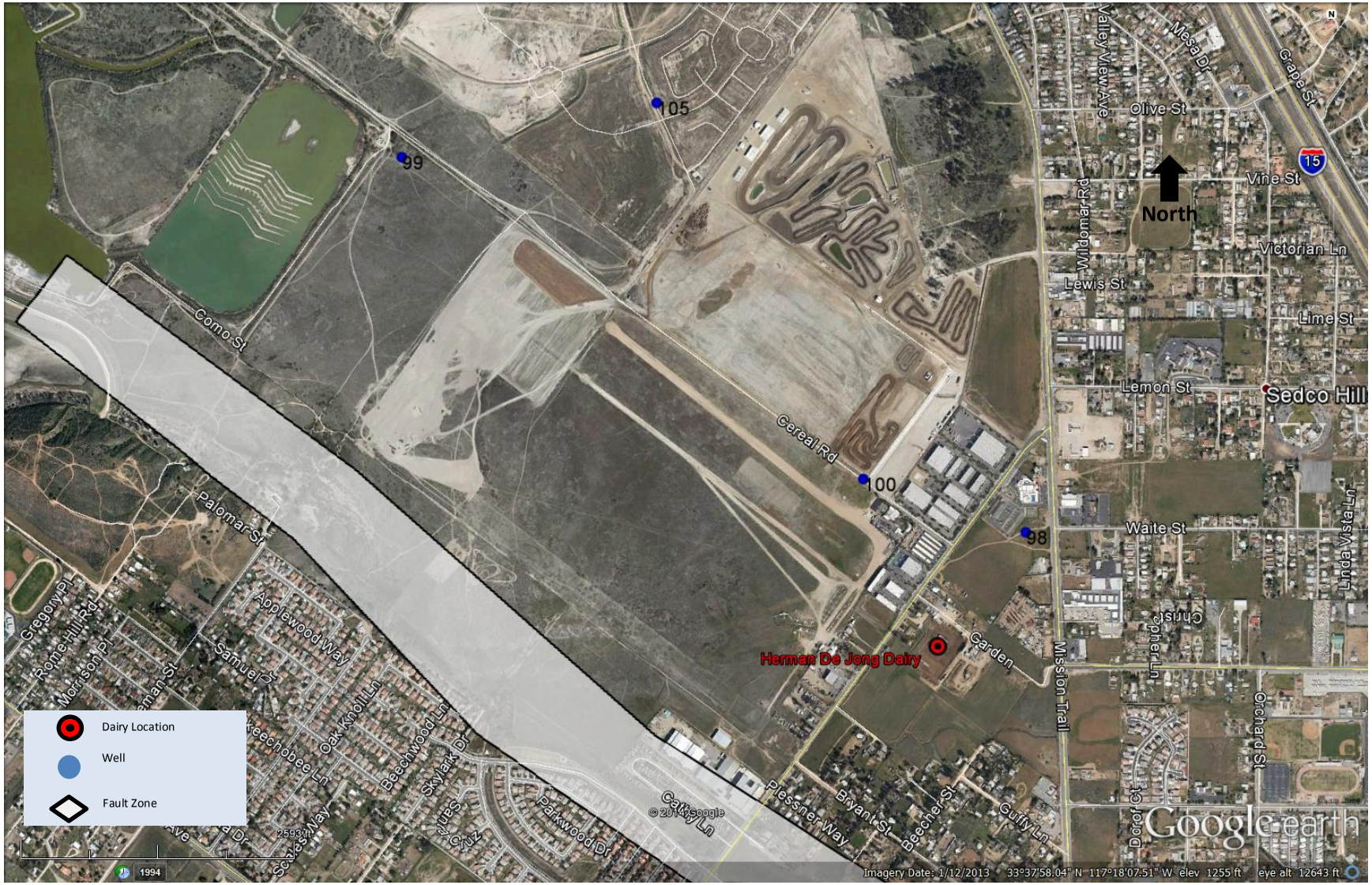


Figure 34. Location map of the vicinity of Herman De Jong Dairy

6.1.1 Summary Data

The tables below summarize the available nitrate and TDS data used in the analysis of this dairy for wells located outside of the dairy only. The summarized data include the perforated interval of the well (if available) and the sample dates of the available data. The table includes the number of samples, number of non-detects, percentage of non-detects, and the mean, median, range, and standard deviation for each individual well, as well as the summary data for the group of wells located downgradient of the dairy.

Table 26. Nitrate Concentrations for Herman De Jong Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean NO_3-N (mg/L)	Median NO_3-N (mg/L)	Range NO_3-N (mg/L)	Std. Dev.
Upgradient Group									
No Upgradient wells									
Facility Group									
No Facility wells									
Downgradient Group									
98	-	1997 - 2008	12	4	33%	2.3	1.2	<0.1 – 10.0	3.65
99	-	1997 - 2012	16	1	6%	0.3	0.05	<0.1 – 1.4	0.51
100	-	1997 – 2008	12	0	0%	1.1	1.3	<0.1 – 1.8	0.54
105	-	2009 - 2012	5	0	0%	1.0	1.0	0.8 – 1.2	0.17
Downgradient Group Summary			**45**	**5**	**11%**	**1.1**	**1.0**	**<0.1 – 10.0**	**2.02**

Mean, median and standard deviation are calculated using one-half the detection limit for all non-detects.
ND = Non-Detect

The above summary table indicates that the average nitrate concentrations in wells downgradient of the facility are greater than historical averages for the Elsinore management zone for the periods 1954 to 1973 (1.0 mg/L), and less than the historical averages for the periods 1978 to 1997 (2.6 mg/L), 1990 to 2009 (2.2 mg/L) and 1993 to 2012 (2.1 mg/L) (WEI 2000, 2011, 2014).

Table 27. TDS Concentrations for Herman De Jong Dairy

Well	Perforated Interval (elev. Feet)	Sample Date(s)	n	# ND	% ND	Mean TDS (mg/L)	Median TDS (mg/L)	Range TDS (mg/L)	Std. Dev.
Upgradient Group									
No Upgradient wells									
Facility Group									
No Facility wells									
Downgradient Group									
98		1997 - 2008	10	0	0%	454	490	278 - 580	96.2
99		1997 - 2012	16	0	0%	371	355	260 - 514	76.9
100		1997 – 2008	12	0	0%	326	303	290 - 440	52.6
105		2009 - 2012	5	0	0%	506	508	458 - 558	35.9
Downgradient Group Summary			**43**	**0**	**0%**	**393**	**376**	**260 - 580**	**93.9**

The above summary table indicates that the average TDS concentrations in wells downgradient of the facility are lower than the historical averages for the Elsinore management zone for periods 1954 to 1973 (476 mg/L), 1978 to 1997 (480 mg/L), 1990 to 2009 (470 mg/L) and 1993 to 2012 (490 mg/L) (WEI 2000, 2011, 2014). The downgradient group average is also less than the WQO for the Elsinore management zone of 480 mg/L.

6.1.2 Boxplots

Boxplots are not applicable for this analysis.

6.1.3 Quantitative Statistical Analysis

A quantitative statistical analysis is not possible with one dataset.

6.1.4 Conclusions

Based on groundwater monitoring samples collected in six wells downgradient of Herman De Jong Dairy, it does not appear that the dairy has impacted offsite groundwater quality in excess of the most recent average concentrations reported for the Elsinore management zone. The following specific observations were made which support the conclusion:

- Average nitrate concentrations in wells downgradient of the dairy are slightly greater than the Elsinore management zone historical concentrations for 1954 to 1973 (1.0 mg/L), and less than the historical averages for the periods 1978 to 1997 (2.6 mg/L), 1990 to 2009 (2.2 mg/L) and 1993 to 2012 (2.1 mg/L).
- Average TDS concentrations in wells downgradient of the dairy are lower than historical concentrations and the WQO for the Elsinore management zone.

The degree of confidence in this conclusion is low, based on availability of well sample data to compare upgradient and facility groundwater quality with that observed in downgradient wells. To evaluate the potential impacts of this facility with a higher degree of confidence additional information is necessary to accurately characterize the facility groundwater quality.

7.0 Conclusions and Recommendations

The dairy-level statistical analysis conducted in 2014 (WRCAC 2014) concluded that for most dairies or groups of dairies, there was no statistically significant elevation of groundwater nitrate concentrations in facility or downgradient wells. A significant TDS impact was suggested for a few locations. This revised report is based on updated information regarding non-dairy sources of nitrate and TDS, refinements in understanding of groundwater flow characteristics, and more recent groundwater quality data.

As identified in the 2014 report and for this updated analysis as well, numerous uncertainties in the data and analyses reduce the level of confidence in conclusions of either no impact or significant impact. These uncertainties include:

- Lack of systematic well sampling results in variable overlap in the time periods covered by samples from upgradient, facility, and downgradient wells (although limiting comparisons of upgradient and downgradient well data to dates concurrent with sampling of facility wells has addressed this issue somewhat);
- Unknown depths of groundwater sampled and large variations in the perforated intervals in the wells;
- Close proximity of some dairies;
- Lack of adequate data from upgradient or downgradient groundwater;

- High incidence of censored data for nitrate;
- Lack of site-specific knowledge of groundwater flow direction and velocity; and
- Incomplete information on dairy management and land use information to document the magnitude of nitrate and/or TDS generation.

The permit requires submittal within 18 months of adoption of the permit that the dischargers in the San Jacinto watershed shall collect and analyze groundwater monitoring data from wells within a 5 mile radius[5] of the CAFO facilities to confirm that the CAFO facilities have not impacted the quality of groundwaters in the area. The 2014 Salt Report met this permit requirement.

The permit also states that 6 months after acceptance of the groundwater data by the RWQCB, individual dairies with impacts will identify an action plan and submit for approval to the RWQCB, followed by implementation within 6 months of plan approval. Pursuant to this requirement and the RWQCB's response to the 2014 Salt Report, WRCAC developed work plans for further action by dairies with conclusions of "no impact," "potential impact," and "inconclusive." WRCAC submitted the work plans to the Regional Board for review on January 29, 2016. The work plans will be finalized upon RWQCB review and acceptance of this revised report

Table 28 shows that, of the 23 facilities in operation as of March 2016, 18 dairies have no impact for nitrates and 5 dairies have data that is inconclusive for various reasons. TDS results indicate that 10 dairies have no impact, 1 has no impact for part of the operation and is inconclusive for another part of the operation, 4 dairies have inconclusive data, and 8 have potential impact, although additional determinations are necessary due to commingling or proximity to other possible sources. The 2014 Salt Report concluded that there was no evidence that any of the dairies are directly responsible for impacting groundwater quality at this time. This updated analysis also concludes that there is no evidence that any of the dairies have been directly responsible for impacting groundwater quality.

[5] A pre-analysis review of the distribution of available wells in the vicinity of each dairy revealed that selection of upgradient wells within a radius of 1.5 miles of each facility would result in the greatest number of wells that are representative of upgradient and downgradient conditions while minimizing interference from other possible sources, and would most often result in a dataset that meets the data quality goal of having at least 10 samples and less than 20 percent non-detects; the minimum dataset necessary to complete a quantitative statistical analysis (see section 1.3). This approach was discussed and agreed upon in a conference call with RWQCB staff on January 13, 2014 (SARWQCB 2014).

Table 28. Summary of Conclusions of Dairy Impacts on Groundwater Quality

Report Section	Dairy	Nitrate (source(s) of uncertainty) [a]	TDS (source(s) of uncertainty) [a]
2.1	Hettinga Dairy	No impact (1-4)	No impact (1-4)
2.1	John & Margie Oostdam Dairy	No impact (1-4)	No impact (1-4)
2.1	Oostdam Dairy	No impact (1-4)	No impact (1-4)
2.2a	Boersma Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2a	Gerben Hettinga Expressway Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2a	Hollandia Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2a	Marvo Holsteins Dairy #2	No impact (1-4)	Potential impact (1-4,6)
2.2b	Boersma Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2b	Gerben Hettinga Expressway Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2b	Hollandia Dairy	No impact (1-4)	Potential impact (1-4,6)
2.2b	Marvo Holsteins Dairy #2	No impact (1-4)	Potential impact (1-4,6)
2.3	Dick Van Dam Dairy	No impact (1-4)	Potential impact (1-4,6) [c]
2.3	Cottonwood Dairy	No impact (1-4)	Potential Impact (1-4,6) [c]
2.3	Bootsma-Silva Farms/Ramona Dairy #2	No impact (1-4)	Potential Impact (1-4,6) [c]
2.4	Goyenetche Dairy #2	Inconclusive (1-4,7-9)	Inconclusive (1-4,7-9)
2.5	Albert Goyenetche Dairy #2	No impact (1-5)	No impact (1-5)
2.5	John Bootsma Dairy	No impact (1-5)	No impact (1-5)
2.5	Offinga Dairy	No impact (1-5)	No impact (1-5)
2.6	Pastime Lakes Dairy	No impact (1-4)	No impact (1-4)
3.1	Van Ryn Dairy [b]	Facility closed	Facility closed
3.2	Jim Bootsma Jr. Dairy	No impact (1-5)	No impact (1-5,9)
3.2	Marvo Holsteins Dairy	No impact (1-5)	No impact (1-5,9)
4.1	Abacherli Dairy [b]	Facility closed	Facility closed
4.1	Boere Dairy [b]	Facility closed	Facility closed
4.2	E.L. Farms [b]	Inconclusive (1-4,7-9) (Facility closed)	Inconclusive (1-4,7-9) (Facility closed)
5.1	Arie & Josh De Jong Dairy	No impact (1-6)	Potential impact (1-6)
5.1	CBJ Dairy [b]	No impact (1-6) (Facility closed)	Potential impact (1-6) (Facility closed)
5.1	Ed Vander Woude Dairy	Inconclusive (1-6,8)	Inconclusive (1-6,8)
5.2	R&J Haringa Dairy	Inconclusive (1-5,7-9)	Inconclusive (1-5,7-9)
5.3	Art Oostdam Dairy	No impact (1-5)	No impact (1-5)
5.4	Scott Brothers Dairy – north of fault	Inconclusive (1-4,7-9)	Inconclusive (1-4,7-9)
5.4	Scott Brothers Dairy – south of fault	Inconclusive (1-4,8)	No impact (1-4,8)
5.5	John & Margie Oostdam Heifer Ranch [b]	Inconclusive (1-5,8,9) (Facility closed)	Inconclusive (1-5,8,9) (Facility closed)
6.1	Herman De Jong Dairy	Inconclusive (1-5,8)	Inconclusive (1-5,8)

a. Sources of uncertainty:
1) Unknown impact of non-dairy sources of nitrate and/or TDS.
2) Lack of groundwater samples collected over a similar time period.
3) Comparison of samples from wells with different perforated intervals.
4) Uncertainty of rate of groundwater movement.
5) Uncertainty in groundwater flow direction and/or impact of groundwater withdrawal on short-term flow patterns.
6) Close proximity of groups of dairies leads to uncertainty in impact of individual dairy.
7) No upgradient groundwater quality information.
8) No facility groundwater quality information.
9) No downgradient groundwater quality information.

b. Facility vacant as of March, 2016.

c. Low degree of confidence; no statistically significant increase, but raw values indicate potential impact.

The analyses conducted for this report were based on readily available data and are subject to the limitations noted above. As such, this should be considered a screening analysis for possible dairy impacts on groundwater quality in the San Jacinto area. These results should be confirmed before recommending any dairy-specific mitigation or remedial action.

The following future studies are suggested to refine and improve understanding of groundwater flow and quality in the entire San Jacinto area:

- Collect data on the direction and rate of groundwater movement to support an assessment of likely time frames in which to expect to see influences of dairies on groundwater quality (or the effects of remediation efforts). The data collection should be focused on areas that would support generalizations about the direction and rate of groundwater flow in the vicinity of the dairies.
- Develop an inventory of potential nitrate or TDS sources such as potentially leaky storage ponds, irrigation of cropland, and dairy wastewater disposal on pastures to provide data that will support development of improved basin-wide monitoring activities that will, in turn, support improved understanding of the sources and movement of nitrate and TDS across the basin.
- Work with EMWD to ensure continued sampling of existing wells occurs on a contemporary and concurrent schedule to support direct comparison of results, perhaps focusing on a limited number of wells if knowledge of the groundwater system can eliminate some wells as redundant.

In specific cases where the screening analysis has suggested a potential impact from a particular facility or group of facilities, further investigation should be conducted to gather site specific data and information to address the sources of uncertainty in the screening analysis. Any such additional investigations would be the responsibility of individual dairy operators and would not be conducted by WRCAC. Such investigations could include:

- Periodic site investigations to identify potential sources of elevated nitrate or TDS as well as other potential, non-dairy TDS and nitrate sources, as the basis of a more detailed analysis of site specific impacts (i.e., periodic updates to the site visits conducted in September, 2015). This should include expertise from EMWD to verify local groundwater flow direction and provide advice regarding acceptable well condition and potential for new well installation or monitoring. Investigations could be conducted as part of a basin-wide inventory of potential nitrate and TDS sources as described above. Investigations should be conducted for each facility for which the screening analysis continues to suggest a potential impact on groundwater nitrate or TDS. Review of site investigation data might suggest additional shallow water table wells, either for broad characterization of the facility/group area or around a specific potential source (e.g., up and downgradient from a crop field being irrigated with dairy wastewater or a suspected leaky wastewater pond).

- Verification of current facility conditions by conducting a complete inspection to ensure that the facility and operations are in full compliance with permit conditions.
- More frequent sampling of existing wells.
- Soil profile sampling to document soil nitrate/TDS concentrations and variation with depth and/or to evaluate soil types and infiltration potential.
- A detailed geophysical investigation to document depth to groundwater table(s), permeability of the aquifer(s) and the overlying unsaturated zone, specific local groundwater flow patterns and velocities, and the influence of pumping wells on local groundwater. The investigations could include additional observation wells (discussed below), soil borings, well pump tests, and other procedures to generate new data for the purposes of confirming or rejecting the screening-level conclusion. In high-priority cases, analysis for parameters of groundwater quality other than nitrate or TDS (e.g., isotopes, trace metals) that could be more sensitive tracers of dairy influence. Investigations could be conducted for each facility for which the screening analysis suggests a potential impact on groundwater nitrate or TDS but might be more feasible if conducted as part of a regional effort that targets specific areas of uncertainty.
- Additional investigations could include a targeted intensive groundwater sampling program to identify possible plumes of nitrate or TDS moving from specific sources, movement during wet vs. dry periods, annual rates of change in concentration, etc. Existing wells that were not included in the data provided by EMWD or identified as part of the current effort might be available for data collection to achieve the objectives below; those wells should be identified as part of the detailed site investigations recommended above.
- As additional observation wells are added on a regional basis, locations should be considered which would provide additional data for certain facilities found to have a potential impact, or where the screening analyses was inconclusive because of a lack of upgradient, downgradient, or facility observation wells, as summarized in Table 29.

Table 29. Recommended Locations for Additional Data Collection based on Screening Level Analysis.

Dairy	Screening Level Conclusion	Data Location Needs
Boersma	Potential impact from group, individual dairy contribution is inconclusive	Upgradient, downgradient and facility
Gerben Hettinga Expressway		Upgradient, downgradient and facility
Hollandia		Upgradient, downgradient and facility
Marvo Holsteins #2		Upgradient, downgradient and facility
Dick Van Dam	Potential impact from group, individual dairy contribution is inconclusive	Upgradient, downgradient and facility
Cottonwood		Upgradient, downgradient and facility
Bootsma-Silva Farms/Ramona Dairy #2 (old Vermeer Dairy)		Upgradient, downgradient and facility
Arie & Josh De Jong	Potential impact from group, individual dairy contribution is inconclusive	Upgradient, downgradient and facility
CBJ		Upgradient, downgradient and facility
Ed Vander Woude		Upgradient, downgradient and facility
Goyenetche Dairy #2	Inconclusive impact	Upgradient, downgradient and facility
Jim Bootsma Jr.		Downgradient
Marvo Holsteins		Downgradient
E.L. Farms		Upgradient, downgradient and facility
Ed Vander Woude		Facility
R & J Haringa		North of fault: Upgradient, downgradient and facility South of fault: Downgradient and facility
Scott Brothers		Upgradient and facility
John & Margie Oostdam Heifer Ranch		Downgradient and facility
Herman De Jong		Upgradient and facility

7.1 Action Plan

This revised report and the final work plans and this analysis, as summarized in Table 28, represent the extent of WRCAC's planned activities toward meeting the dairy permit requirements with regard to collecting and analyzing monitoring data to evaluate dairy impacts on nitrate and TDS on groundwater. Activities are limited to:

Activity	Schedule
1. Submit this revised groundwater analysis/dairy impacts report to RWQCB	April 1, 2016
2. Notify dairies of results of report findings	Within 1 week of RWQCB's approval of the revised report
3. Compile and submit to RWQCB new data collected for wells used to evaluate "no impact" facilities	Annually, within 60 days of the data being published by EMWD

All other compliance activities, including identification of additional data sources for "potential impact" facilities and proposal of corrective actions for "potential impact" facilities, are the responsibility of individual dairy operators in cooperation with the RWQCB.

8.0 References

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