San Luis & Delta-Mendota Water Authority

Grassland Drainage Area Coalition

Order R5-2015-0095

Annual Monitoring Report

2018

Groundwater Tend Monitoring: January 1 to December 31 2018
Nitrogen Plan Summary Data: March 1 2017 to February 28 2018
Farm Evaluation Summary Data: March 1 2017 to February 28 2018

May 31, 2019

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TABLE OF CONTENTS

SECTION 1: EXECUTIVE SUMMARY....1
SECTION 2: DESCRIPTION OF THE GRASSLAND DRAINAGE AREA COALITION....1
SECTION 3: MONITORING OBJECTIVES AND DESIGN....3
SECTION 4: DISCUSSION OF DATA, EXCEEDANCES, SPATIAL/TEMPORIAL TREND ANALYSIS, AND ACTIONS TO ADDRESS EXCEEDANCES....3
SECTION 5: MITIGATION MONITORING....5
SECTION 6: SUMMARY OF EDUCATION AND OUTREACH ACTIVITIES....5
SECTION 7: CONCLUSIONS AND RECOMMENDATIONS....6
SECTION 8: ATTACHMENTS....6

TABLES

TABLE 1 TESTED CONSTITUENTS

TABLE 2 SUMMARY OF GROUNDWATER QUALITY RESULTS

FIGURES

FIGURE 1 GRASSLAND BYPASS PROJECT LOCATION MAP

ATTACHMENTS

ATTACHMENT 1 2018 ANNUAL GROUNDWATER MONITORING RESULTS

ATTACHMENT 2 NITROGEN MANAGEMENT PLAN SUMMARY REPORT ANALYSIS

ATTACHMENT 3 SUMMARY OF MANAGEMENT PRACTIC INFORMATION COLLECTED FROM FARM EVALUATIONS AND MANAGED WETLAND EVALUATIONS FOR THE 2017 GROWING SEASON

R5-2015-0095 MONITORING REPORT REQUIRED COMPONENTS

Component No.	Description	Report Section
1	Signed Transmittal Letter	Attached
2	Title Page	Cover
3	Table of Contents	Table of Contents
4	Executive Summary	Section 1
5	Description of the GDA geographical area	Section 2
6	Monitoring objectives and design	Section 2 & Attachment 1
7	Sampling site/monitoring well descriptions and rainfall records for the time period covered under the AMR	Attachment 1: Section 3.1
8	Location map(s) of sampling sites/monitoring wells, crops and land uses	Attachment 1: Figure 1
9	Tabulated results of all analyses arranged in tabular form so that the required information is readily discernible	Attachment 1: Table 3
10	Discussion of data relative to water quality objectives/trigger limits, water quality management plan milestones/Basin Plan Amendment Workplan (BPAW), where applicable	Attachment 1: Section 3.4
11	Electronic data submittal	Submitted Electronically
12	Sampling and analytical methods used	Attachment 1: Section 3.2
13	Associated laboratory and field quality control samples results	Attachment 1: Section 3.5
14	Summary of Quality Assurance Evaluation results and an assessment of precision, accuracy, and completeness	Attachment 1: Section 3.5
15	Summary of exceedances of water quality objectives/trigger limits occurring during the reporting period	Attachment 1: Table 3
16	Actions taken to address water quality exceedances that have occurred, including but not limited to, revised or additional management practices implemented	Section 4
17	Evaluation of monitoring data to identify temporal and spatial trends and patterns	Section 4

Component No.	Description	Report Section
18	NMP Summary Report Evaluation	Attachment 2
19	Summary of management practice information collected as part of Farm Evaluations	Attachment 3
20	Summary comparison of township Groundwater Protection Targets and actual value achieved for each township	NA: Due July, 2020
21	Summary of mitigation monitoring	Section 5 and Attachment 1: Section 4.3
22	Summary of education and outreach activities	Section 6
23	Conclusions and recommendations	Section 7

SECTION 1: EXECUTIVE SUMMARY

This report includes groundwater trend monitoring results for the 2018 calendar year, nitrogen management plan summary data for the 2017 crop year, and farm evaluation summary data for the 2017 crop year within the Grassland Drainage Area (GDA).

2018 was classified as a below-normal hydrologic year type for the westside of the San Joaquin Valley with Federal Water Contractors receiving 50% of their federal water contract allocation. A total of 7.0"[1] of rain fell during the report period, with significant rain events in January, February, March, and April.

2018 was the first year of groundwater trend monitoring and well network sampling occurred in the Fall of 2018. Eight wells were identified for inclusion within the well network, however, two of those well were later determined to be inaccessible and were not sampled. The six wells sampled all had total dissolved solids (TDS) in excess of the maximum contaminant level (MCL) of 1000 mg/L. Two network wells had nitrate concentrations in excess of the MCL (10 mg/L). Sulfate and boron concentrations were also high in the majority of the wells sampled. Groundwater within the GDA is naturally mineralized and the elevated levels of TDS, boron and other constituents are not unusual. **Attachment 1** includes a detailed discussion and presentation of the groundwater trend monitoring results.

Additional network wells have been identified for inclusion in the 2019 monitoring program to replace the two wells that are inaccessible and to expand the network.

Attachment 2 includes a summary of the nitrogen management plans submitted to the Grassland Drainage Area Coalition (GDAC). All coalition members submitted nitrogen management plan summaries and the report provides a detailed summary of the submitted data.

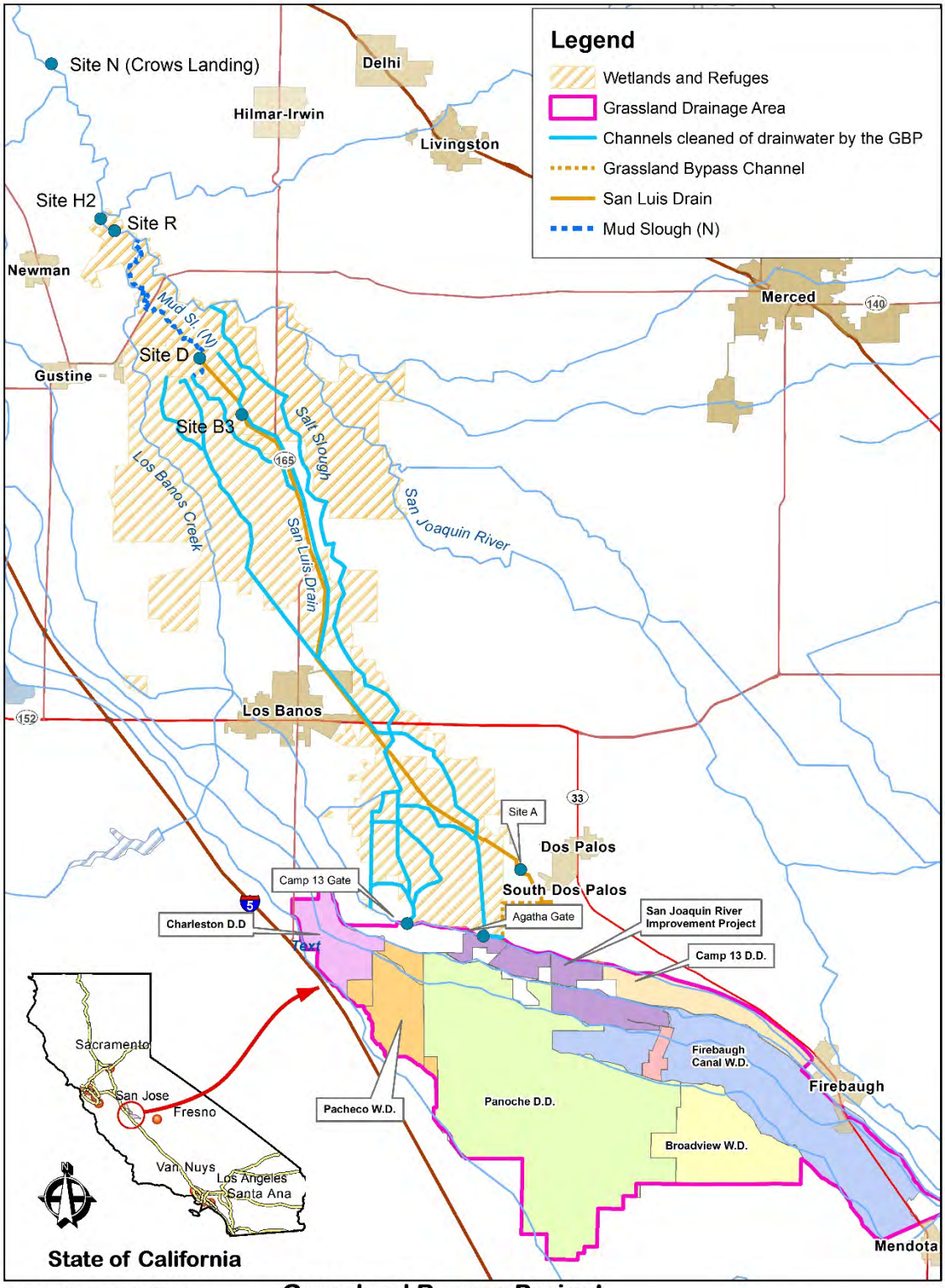
Attachment 3 is a summary of the farm evaluation data submitted by growers within the GDAC for the 2017 crop year. All coalition members submitted farm evaluation data.

SECTION 2: DESCRIPTION OF THE GRASSLAND DRAINAGE AREA COALITION

The GDAC is located within the San Joaquin Valley Groundwater Basin, generally south of Los Banos, between the San Joaquin River and Interstate 5. The Coalition boundary encompasses approximately 104,000 acres, including about 70,000 acres of highly productive irrigated agricultural land. The GDAC includes all or part of six districts – Broadview Water District, Charleston Drainage District (a portion of San Luis Water District), Camp 13 Drainage District (a portion of CCID), Firebaugh Canal Water District, Pacheco Water District, and Panoche Drainage District, along with some unincorporated farmland. Broadview Water District is no longer irrigated and is not a member of the GDAC. **Figure 1** shows the location of the GDAC as well as the member districts.

The predominant crops within the GDAC are almonds, pistachios, cotton, tomatoes, grapes, and a variety of field crops. A detailed discussion of the soils as well as maps showing the cropping pattern within the GDAC is included in **Attachment 1**.

[1] Average of precipitation totals from CIMIS Station 7 and Station 124.



Coordinate System: NAD 83, US Foot
Hydrology: Named_Rivers_STreams.shp
Roads/Cities: ESRI, Tele Atlas North America
Districts: wdfed24.shp

Grassland Bypass Project Location Map

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SECTION 3: MONITORING OBJECTIVES AND DESIGN

Groundwater trend monitoring implemented by the GDAC are designed to meet the requirements of Order R5-2015-0095 (Order). These objectives can be summarized as (1) to determine current water quality conditions of groundwater and (2) to develop long-term groundwater quality information that can be used to evaluate regional effects. A more detailed summary of the groundwater trend monitoring objectives and design is included in **Attachment 1**. Monitoring well locations, well details, monitoring schedule, analytes, and methods are also discussed in **Attachment 1**.

SECTION 4: DISCUSSION OF DATA, EXCEEDANCES, SPATIAL/TEMPORIAL TREND ANALYSIS, AND ACTIONS TO ADDRESS EXCEEDANCES.

2018 was the first year of the Groundwater Trend Monitoring Program, with groundwater samples collected in November and December of 2018. **Table 1** lists the constituents tested at each sampled wells.

Table 1: Tested Constituents

Constituent	MCL[a]	Constituent	MCL[a]
Nitrate (as nitrogen)	10 mg/L	Carbonate	NA
Total Dissolved Solids (TDS)	1000 mg/L	Hydroxide	NA
Boron	1000 µg/L	Total Alkalinity	NA
Calcium	NA	pH	6.5/8.5
Magnesium	NA	Specific Conductivity	NA
Potassium	NA	Temperature	NA
Sodium	NA	Dissolved Oxygen	NA
Chloride	500 mg/L	ORP	NA
Sulfate	500 mg/L	Turbidity	NA
Nitrite (as nitrogen)	NA	Depth to Water	NA
Bicarbonate	NA		

[a] Maximum Contaminant Level for drinking water. Some MCLs are secondary standards and some are State Notification Level values. See Attachment 1.

Eight wells were identified for inclusion into the well network, however two wells were inaccessible and were not sampled. A tabulation of all water quality results as well as exceedances is shown in **Table 2** and discussed in more detail in **Attachment 1**.

Table 2: Summary of Groundwater Quality Results.

Site ID	Date Sampled		Nitrate (as nitrogen)	Total Dissolved Solids (TDS)	Boron	Calcium	Magnesium	Potassium	Sodium	Chloride	Sulfate	Nitrite (as nitrogen)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	pH	Specific Conductance (EC)	Temperature	Dissolved Oxygen (DO)	Oxidation-Reduction Potential (ORP)	Turbidity	Depth to Water
		UNITS:	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH Units	uS/cm	°C	mg/L	mV	NTU	ft, bgs
		MDL:	0.5	10	500	1	0.1	1	1	13	13	NA	10	10	10	10	NA						
		MCL:	10 [1]	500/ 1,000 [2]	1,000 [4]					250/ 500[2]	250/ 500[2]	1					6.5/ 8.5 [3]						
GDA001	11/26/18		**12**	**2,600**	**3,100**	280	82	2.1	420	**360**	**1,200**	ND	344.3	ND	ND	180	7.54	3,390	22	1.16	72.8	1.24	14.3
GDA001 (duplicate)	11/26/18		**12**	**2,600**	**3,000**	280	81	2.1	410	**370**	**1,200**	ND	344.3	ND	ND	180	7.54	3,390	22	1.16	72.8	1.24	14.3
GDA002	11/29/18		ND	**2,600**	**4,000**	380	88	4.9	250	180	**1,500**	ND	147.5	ND	ND	74	7.83	2,880	20.5	2.04	83.5	0.4	37.0
GDA003	12/11/18		6.4	**3,400**	**4,400**	630	98	3.3	340	**360**	**1,900**	ND	103.3	ND	ND	52	7.73	3,711	19.2	3.17	-25.1	0.02	49.5
GDA004	11/26/18		0.65	**1,200**	740	260	31	1.3	62	65	**700**	ND	160.7	ND	ND	81	7.84	1,468	18.4	4.39	64.1	0.02	N/A
GDA005	11/26/18		**35**	**3,900**	**8,100**	490	190	4.8	550	**800**	**1,800**	ND	180.3	ND	ND	89	7.52	5,092	18.8	3	103.4	0.02	N/A
GDA006			Well not available/accessible for sampling.																				
GDA007			Well not available/accessible for sampling.																				
GDA011	12/10/18		ND	**2,300**	**2,300**	150	36	9	570	**440**	**910**	ND	426.2	2.7	ND	210	7.88	3,216	17.4	3.05	-49.5	0.16	>150

[1] Primary Maximum Contaminant Level (MCL) for drinking water

[2] Secondary MCL (recommended/upper range) for drinking water

[3] Suggested lower/upper acceptable range for drinking water

[4] State Notification (Action) level - A health-based notification level established by the State of California for some constituents lacking MCLs; if a public water system detects a constituent at concentrations above the action level, local governing bodies must be notified.

ND = Not detected above laboratory minimum detection level or reporting limit (MDL) shown; N/A = no access to water level reading.

Bold values indicate results above an MCL or action level

Samples collected during the 2018 monitoring period exceeded MCLs for TDS (all six wells), boron, (five wells), chloride (four wells), nitrate (two wells), and sulfate (six wells). The naturally-occurring high concentrations of many dissolved chemical constituents in groundwater, particularly shallow groundwater, within the western San Joaquin Valle are well documented and these exceedances are not unexpected. Because this is the first year of Groundwater Quality Trend Monitoring with only a single sample event, a spatial/temporal analysis of the data is not yet practical. Under the Groundwater Quality Trend Monitoring program, evaluation of trends and patterns in groundwater quality will be conducted and reported at five year intervals once sufficient data are available. However, certain qualitative observations can be made:

- Overall salinity is high in all wells. As would be expected, this salinity is composed of many naturally-occurring anions and cations, including high levels of chloride, sodium, calcium, as well as other elements like boron and sulfate.
- Nitrate levels in most wells are not excessively high and nitrite is not present. Nitrate exceedances occurred in conjunction with elevated concentrations of other constituents including TDS, boron, chloride, and sulfate.
- Geologic data demonstrates that soils from the coastal mountain range and western San Joaquin Valley are naturally high in a variety of minerals (including nitrate in some sediments) and the elevated concentrations of many constituents could be naturally occurring.

The available data is insufficient to determine if the measured exceedances are caused by agricultural activities or are simply background water quality conditions. Regardless of the cause, the GDAC is committed to the actions listed in the Comprehensive Groundwater Quality Management Plan (CGMP):

- Education of members.
- Implementation of Management Practices.
- Identification and Tracking of Management Practices through FE surveys and Nitrogen Management Plan summaries.
- Provide outreach materials to members reporting nitrogen applied levels compared to other comparable members and identified outliers.

Additionally, the GDAC will continue the groundwater trend monitoring in accordance with the Order.

SECTION 5: MITIGATION MONITORING.

To date, no ground-disturbing activities have been undertaken for the implementation of the Order and no corresponding mitigation actions have been required.

SECTION 6: SUMMARY OF EDUCATION AND OUTREACH ACTIVITIES.

The GDA Coalition has conducted education and outreach activities specifically for the GQTM program during 2018 utilizing a variety of methods. These include the following:

- Discussion of the program objectives and need for well volunteers for the GQTM network with Coalition district entities including during monthly meetings of the Grassland Basin Drainers Steering Committee and through direct contacts with district representatives

- Direct communication with well owners or Coalition grower members through phone calls, emails, and during well site visits to discuss the GQTM program and objectives and need for well owner participation
- Annual meeting, held February 9 2018 (Firebaugh VFW hall) where the farm evaluation reports, nitrogen planning requirements, trend monitoring program and future domestic well monitoring are presented to farmers.

As part of the Trend Monitoring Program wells were monitored in November 2018 and July 2019. In September 2019, the request Central Valley Regional Water Quality Control Board requested that notification be provided to members/well owners of wells used for human consumption if the results were above 10 mg/L. The Coalition provided notices to the member/owners of 3 wells with exceedances of nitrogen. This notification included a form to be provided to well users indicating that water from the affected well is unsafe to drink

Additional outreach activities to GQTM network well owners are planned for 2019 to communicate results from the Fall 2018 GQTM sampling event and to refer well owners to the Coalition's Groundwater Quality Management Plan where management practices intended to protect groundwater quality are identified.

SECTION 7: CONCLUSIONS AND RECOMMENDATIONS.

This report is the first Annual Monitoring Report compiled and submitted by the GDAC, covering one year of groundwater trend monitoring data (2018) and one year of nitrogen plan and farm evaluation plan summaries (both 2017). While this data provides an initial baseline conditions for the coalition area, it would be premature to come to significant conclusions. However, some observations are presented below:

- Additional network wells need to be added. Initially, the Coalition identified eight network wells, however two of the wells (25% of the network) were found to be permanently inaccessible. Five additional wells have been identified for inclusion in the 2019 monitoring. See **Attachment 1** for a more detailed discussion.
- 100% of the nitrogen plan summaries were submitted for the 2017 crop year, providing a detailed baseline on nitrogen management practices implemented by growers. See **Attachment 2** for a more detailed discussion.
- 100% of the Farm Evaluation Plans were submitted for the 2017 crop year. This provided the best available data on grower-implemented management practices and baseline conditions. See **Attachment 3** for a more detailed discussion.

SECTION 8: ATTACHMENTS.

Three attachments included in the report provide a detailed review and discussion of the monitoring data. These attachments, and the key report elements included in them, are as follows:

- **Attachment 1 – 2018 Annual Groundwater Monitoring Results.** This attachment covers the monitoring activities of the 2018 groundwater trend monitoring year, including water quality results and quality assurance. Report components included in this attachment are:
    - Component 6: Monitoring Objectives & Design.
    - Component 7: Sampling site/monitoring well descriptions and rainfall records.
    - Component 8: Locations of sampling sites/monitoring wells, crops, and land uses.

- Component 9: Tabulations of results of all analyses.
- Component 10: Discussion of water quality results.
- Component 12: Sampling and analytical methods used.
- Component 13: Associated Laboratory and Field Quality Control Results.
- Component 14: Summary of laboratory and field quality control results.
- Component 15: Summary of exceedances of water quality objectives/trigger limits.

Additionally, laboratory reports and electronic data files for the water quality data were provided to Regional Board staff. Due to their size and nature, these files were submitted directly to Regional Board Staff and are not included in this report.

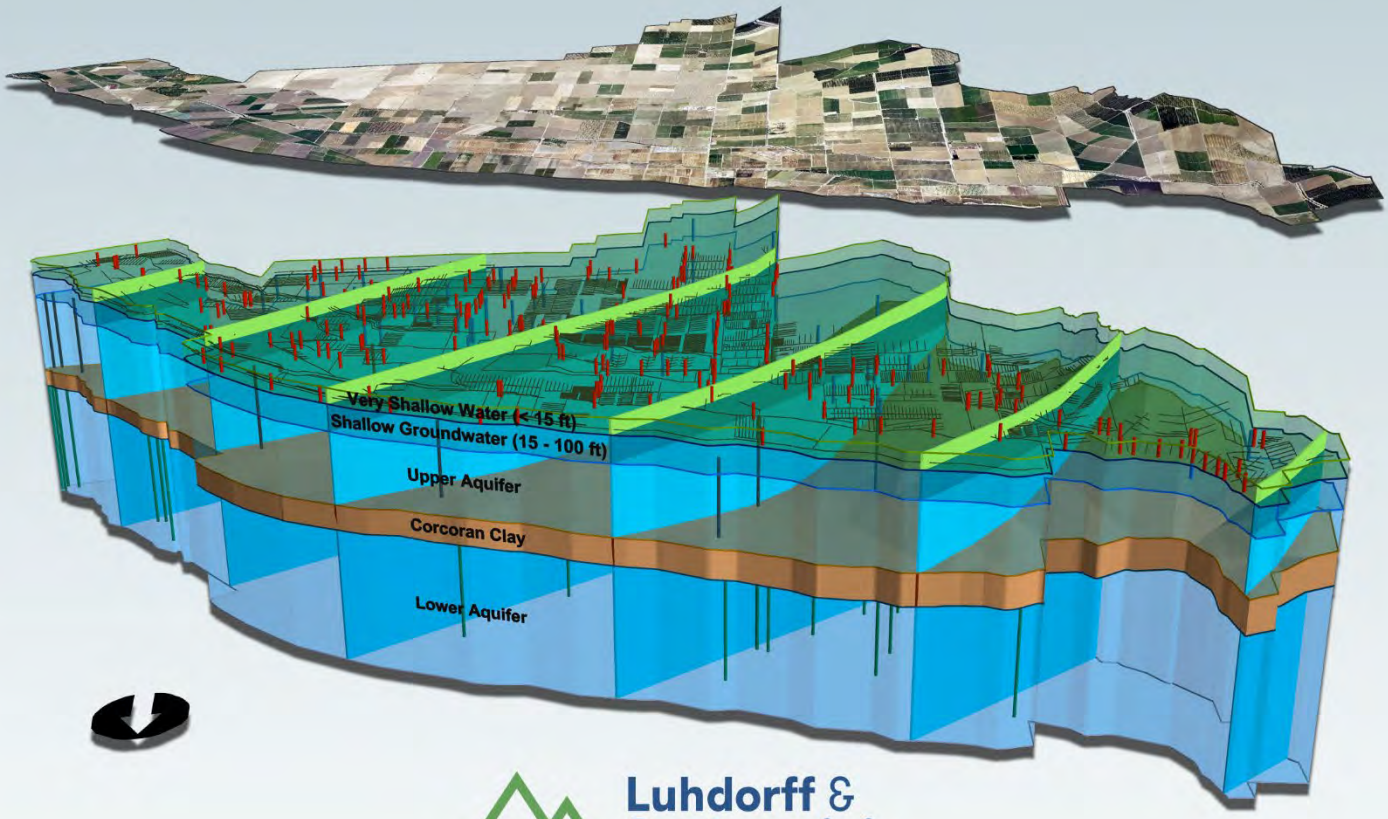
- **Attachment 2 – Nitrogen Management Plan Summary Report Analysis.** This attachment provides a summary of the nitrogen management plan data submitted for the 2017 crop year. Report components included in this attachment are:
  - Component 18: NMP Summary Report Evaluation.

- **Attachment 3 – Summary of Management Practice Information Collected from Farm Evaluations and Managed Wetland Evaluations for the 2017 Growing Season.** This attachment provide a summary of the collected Farm Evaluation Plan data submitted for the 2017 crop year. Report Components included in this attachment are:
  - Component 19: Summary of management practice information collected as part of Farm Evaluations.

ATTACHMENT 1
2018 ANNUAL GROUNDWATER MONITORING RESULTS

Grassland Drainage Area

2018 Annual Groundwater Monitoring Results



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May 2019
(Revised October 2019)

Grassland Drainage Area

2018
Annual Groundwater Monitoring Results

May 2019
(Revised October 2019)

Prepared For

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Table of Contents

1 EXECUTIVE SUMMARY 1
2 BACKGROUND AND GQTM OBJECTIVES 1
3 GROUNDWATER QUALITY TREND MONITORING 3
3.1 Groundwater Quality Sampling Sites 3
3.2 Fall 2018 Groundwater Quality Sampling Activities 6
3.3 Groundwater Quality Sampling Results 6
3.4 Evaluation of Groundwater Quality Trends and Patterns 9
3.5 Summary of Quality Assurance Evaluation for Fall 2018 Sampling Event 9
3.5.1 Purging, sample handling, and custody 9
3.5.2 Field and analytical completeness 9
3.5.3 Analytical precision and accuracy 10
3.5.4 Quality Assurance Evaluation Conclusions 10
3.6 Ongoing GQTM Network Development 18
3.6.1 2019 GQTM Network Updates 19
3.6.2 GQTM Network Discussion 22
3.6.3 Coordinated Monitoring 23
3.6.4 Future and Ongoing GQTM Network Evaluation and Refinement 23
3.6.5 GQTM Sampling Timing 24
4 ADDITIONAL ANNUAL REPORTING REQUIREMENTS 27
4.1 Summary of Nitrogen Management Plan Information 27
4.2 Summary of Management Practice Information from Farm Evaluations 27
4.3 Summary of Mitigation Monitoring 27
4.4 Summary of Education and Outreach Activities 27
4.5 Electronic Data Submittal and Data Uploaded to Geotracker 28
5 CONCLUSIONS AND RECOMMENDATIONS 28
6 REFERENCES 29

List of Tables

Table 1 2018 GQTM Network Wells
Table 2 2018 CIMIS Monthly Rainfall Measurements
Table 3 Fall 2018 GQTM Sampling Results
Table 4 Completeness of Field and Analytical Testing
Table 5 Completeness of Field QC
Table 6 Evaluation of Sample Hold Times
Table 7 Evaluation of Field Duplicates and Blanks
Table 8 Evaluation of Lab Controls and Spikes
Table 9 2019 GDA Coalition GQTM Network Update Wells
Table 10 Assessment of GQTM Network Sufficiency

List of Figures

Figure 1 Fall 2018 GQTM Network Wells with Major Land Use Types
Figure 2 2016 Land Use Types within One Mile of 2018 GQTM Network Wells
Figure 3 2018 CIMIS Monthly Rainfall Measurements
Figure 4 Fall 2018 GQTM TDS Concentrations with Major Land Use Types
Figure 5 Fall 2018 GQTM Nitrate Concentrations with Major Land Use Types
Figure 6 2019 GQTM Well Network Update
Figure 7 2019 GQTM Well Network Update with Major Land Use Types
Figure 8 2016 Land Use Types within One Mile of 2019 GQTM Network Wells

Appendices

Appendix A Well Completion Reports for GQTM Network Wells
Appendix B Electronic Data Submittal (provided as accompanying digital file package)

1 EXECUTIVE SUMMARY

As part of compliance with the Central Valley Regional Water Quality Control Board's (Regional Board or CVRWQCB) *Order No. R5-2015-0095 Waste Discharge Requirements General Order for Growers in the Grassland Drainage Area*, hereafter referred to as the WDRs (CVRWQCB, 2015), the Grassland Basin Drainage Steering Committee (herein referred to as GDA Coalition or Coalition) must develop and implement a Groundwater Quality Trend Monitoring (GQTM) Program. The initial GDA Coalition GQTM well network sampling event occurred in Fall 2018 during late November and early December and included sampling of six wells for nitrate and major cations and anions. Two wells originally included in the GQTM network for Fall 2018 could not be sampled because of lack of availability of the wells for sampling. Actions taken to address GQTM well network coverage within the GDA are discussed in this report.

The groundwater quality results from the Fall 2018 sampling included nitrate concentrations above the primary drinking water maximum contaminant level (MCL) of 10 milligrams per liter (mg/L) in two network wells. Additionally, all six sampled wells had concentrations of total dissolved solids (TDS) considerably above the recommended and upper secondary drinking water MCLs of 500 mg/L and 1,000 mg/L, respectively, with TDS concentrations in five of six wells over 2,000 mg/L, more than twice the upper MCL. Groundwater in the GDA region is naturally high in salinity and dissolved solids and such high TDS concentrations are not unusual for the area. Sulfate concentrations in groundwater sampled from all wells were also above the recommended and upper MCLs and most of the wells sampled also exhibited high concentrations of chloride exceeding the recommended MCL. All but one of the six sampled wells had boron concentrations above the State public health goal (PHG), with boron concentrations generally about three or four times the PHG level. In accordance with the GDA GQTM Workplan and the Workplan for the Central Valley Groundwater Monitoring Collaborative (CVGMC)(LSCE et al., 2018), of which the GDA Coalition is a participant, evaluation of patterns and trends in groundwater quality and any relationships with agricultural practices will be conducted at five year intervals commencing after sufficient GQTM data have been developed for evaluating temporal trends in groundwater quality.

Additional GQTM network wells have been identified for inclusion in the 2019 sampling event with the addition of five new network wells for 2019, and the removal of two original network wells that have been determined to not be accessible for future sampling. The proposed GQTM network for 2019 includes a total of eleven wells distributed across the Coalition region. Future sampling of the GQTM network wells is planned to occur during the July time period each year.

2 BACKGROUND AND GQTM OBJECTIVES

The Central Valley Regional Water Quality Control Board's (Regional Board or CVRWQCB) *Order No. R5-2015-0095 Waste Discharge Requirements General Order for Growers in the Grassland Drainage Area*, hereafter referred to as the WDRs (CVRWQCB, 2015), requires the Grassland Basin Drainage Steering Committee (herein referred to as GDA Coalition or Coalition) to develop and implement a Groundwater Quality Trend Monitoring (GQTM) Program. The GDA WDRs Attachment B, Section IV.C. (p. 1-2) states:

"*1. Objectives.* The objectives of Groundwater Quality Trend Monitoring are (1) to determine current water quality conditions of groundwater relevant to irrigated agriculture, and (2) to develop long-term groundwater quality information that can be used to evaluate the regional effects (i.e., not site-specific effects) of irrigated agriculture and its practices.

2. Implementation. To reach the stated objectives for the Groundwater Quality Trend Monitoring program, the third-party shall develop a groundwater quality monitoring network that will (1) be implemented over both high and low vulnerability areas in the third-party area; and will (2) employ shallow wells, but not necessarily wells completed in the uppermost zone of first encountered groundwater. The use of existing wells is less costly than installing wells specifically designed for groundwater quality monitoring, while still yielding data which can be compared with historical and future data to evaluate long-term groundwater quality trends. The third party may also consider using existing monitoring networks such as those used by AB 3030 and SB 1938 plans.

3. Reporting. The results of trend monitoring are to be included in the third-party's Monitoring Report and shall include a map of the sampled wells, tabulation of the analytical data, and time concentration charts. Groundwater quality monitoring data are to be submitted electronically to the State Water Board's GeoTracker Database and to the Central Valley Water Board.

Following collection of sufficient data (sufficiency to be determined by the method of analysis proposed by the third-party or Trend Monitoring Group) from each well, the third-party is to evaluate the data for trends. The methods to be used to evaluate trends shall be proposed by the third-party or Trend Monitoring Group in the Groundwater Quality Trend Monitoring Workplan described in section IV.E below."

On May 16, 2018, the GDA Coalition submitted the *Grassland Drainage Area Groundwater Quality Trend Monitoring Workplan* (LSCE, 2018a) to address the requirements for the GQTM Program as outlined in the WDRs Attachment B, Sections III.C and III.E. A subsequent Addendum to the Workplan was submitted in August 2018 (LSCE, 2018b) to address comments on the Workplan provided by the Regional Board. The Addendum to the Workplan presented an initial proposed GQTM well network considered the beginning of an evolving network, not a static end result. The Regional Board issued a Conditional Approval letter on September 4, 2018 (CVRWQCB, 2018) indicating the GQTM sampling should commence in Fall 2018 and also highlighting several elements that are required to be addressed within the Annual Monitoring Report to be submitted by April 30, 2019.

The Coalition is located within the San Joaquin Valley Groundwater Basin, generally south of Los Banos between the San Joaquin River and Interstate 5, and encompasses approximately 104,000 acres, including about 70,000 acres of highly productive irrigated agricultural land. The GDA Coalition area covers four San Luis Unit Districts - Broadview Water District, Charleston Drainage District (a portion of San Luis Water District), Pacheco Water District, and Panoche Drainage District; and two San Joaquin River Exchange Contractor Districts – Firebaugh Canal Water District, and Camp 13 Drainage District (a portion of the Central California Irrigation District), along with some areas that are not incorporated into any district. Broadview Water District is not irrigated and does not have any surface water supply as its Central Valley Project (CVP) supply was acquired by Westlands Water District. Because Broadview Water District is not irrigated, lands within the district are not members of the GDA Coalition.

The GDA Coalition region is overlain by sediments of marine origin characterized by high salinity with a high fraction of heavy clays that contain a variety of minerals including boron and selenium. These soil conditions have contributed to a healthy and productive agricultural environment, but groundwater in the area is naturally high in salinity and very shallow water occurs throughout much of the area due to

the limited capability for deep percolation of applied irrigation water through heavy clay materials. The occurrence of shallow water is managed with subsurface (tile) drain systems and deep earthen channels. The Groundwater Quality Assessment Report (LSCE, 2016) prepared for the Coalition region provides a detailed description of hydrogeologic and groundwater quality conditions in the GDA Coalition region.

3 GROUNDWATER QUALITY TREND MONITORING

The first sampling event of the GDA GQTM Program occurred in Fall 2018 and the results from this sampling event are presented in this report. The initial Fall 2018 GQTM sampling was conducted utilizing network wells selected to accomplish the GQTM Program objectives of monitoring regional and long-term trends in groundwater quality in relation to agricultural practices as outlined in the GQTM Workplan and subsequent Addendum with the expectation that the network would evolve and expand in future years. The GQTM network for the Fall 2018 sampling event consisted of eight network wells identified in the July 2018 Addendum to the GQTM Workplan.

3.1 Groundwater Quality Sampling Sites

Information related to the eight Fall 2018 GQTM network wells are summarized in **Table 1** and their locations are displayed on **Figure 1**. Land uses mapped in 2016 based on USDA Cropscape[1] data are shown in **Figure 1** in relation to the GQTM network wells. The fraction of land use types within one mile of GQTM network wells is illustrated in **Figure 2**.

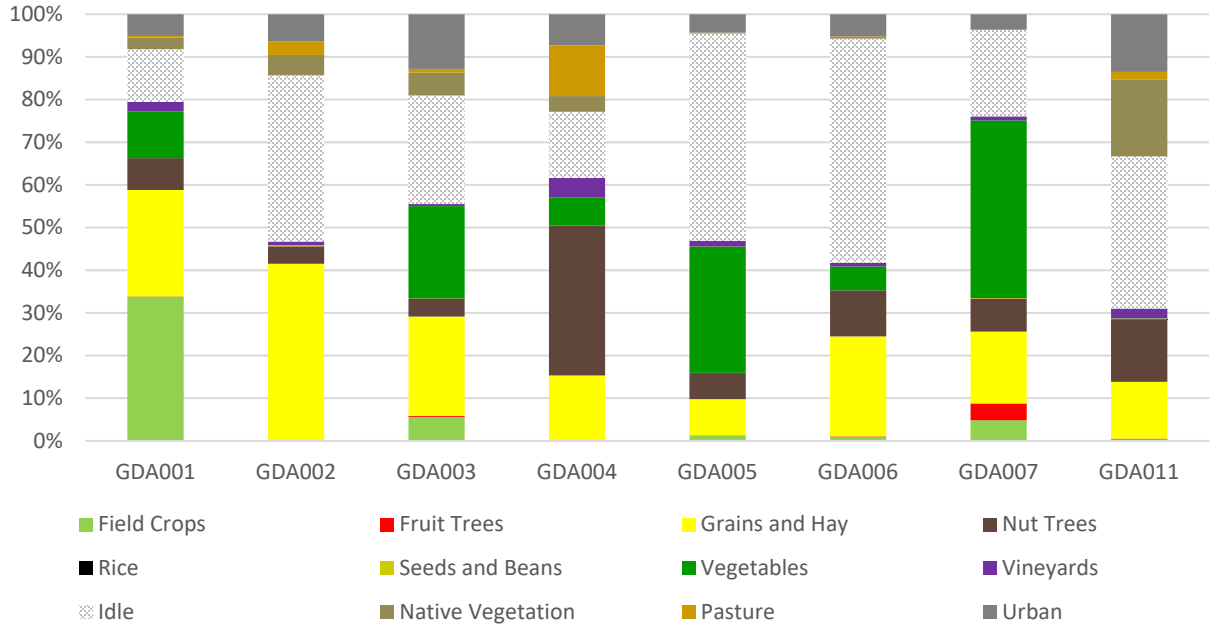

Figure 2: 2016 Land Use Types within One Mile of 2018 GQTM Network Wells

[1] https://nassgeodata.gmu.edu/CropScape/

Table 1: 2018 GQTM Network Wells

GQTM Well ID	Well Use	Well Construction Information					Latitude (NAD83)	Longitude (NAD83)	Depth Bottom of Upper Zone (feet)[1]	Percent Screened in Upper Zone	Explanation of Monitored Depth
		Seal Depth (feet)	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)	Year Drilled					
GDA001	Domestic	55	160	76	116	1993	36.95390	-120.81010	234	100%	Screens entirely in Upper Zone
GDA002	Domestic	180	227	200	220	2013	36.91044	-120.65553	319	100%	Screens entirely in Upper Zone
GDA003	Irrigation	50	380	310	370	2010	36.89217	-120.64936	345	58%	Mostly in Upper Zone; screens are above average domestic well depth in area (450 feet)
GDA004	Irrigation	20	205	50	140	2013	36.89408	-120.79298	107	43%	Partially in Upper Zone; defined Upper Zone is very shallow although well screens are considerably shallower than only nearby domestic well depth (460 feet)
GDA005	Domestic	110	200	130	190	2008	36.84886	-120.67171	378	100%	Screens entirely in Upper Zone
GDA006	Monitoring	80	153	84	104	2000	36.85010	-120.59850	258	100%	Screens entirely in Upper Zone
GDA007	Monitoring	98	150	102	122	2000	36.85040	-120.52620	229	100%	Screens entirely in Upper Zone
GDA011	Public Supply	150	308	168	288	1990	36.77631	-120.37361	204	30%	Screens are entirely within the Upper Aquifer above the Corcoran Clay (400 feet), although nearby very shallow older domestic wells skew Upper Zone depth from CV-SALTS; well screen depths are similar to domestic wells in area.

[1] The Upper Zone is defined by CV-SALTS (LSCE and LWA, 2016) based on typical domestic well depths and other hydrogeologic characteristics such as depth to the Corcoran Clay, where present. The depth of bottom of Upper Zone from CV-SALTS ranges from about 100 feet to about 400 feet in the Coalition region.

Monthly rainfall records for the GDA during the period January 2018 to December 2018 are presented in **Table 2** and **Figure 3** based on data for two nearby CIMIS[2] stations representative of the Coalition region. The total precipitation over the 12-month period during 2018 was approximately 7 inches with 6.63 inches recorded at the Panoche CIMIS station and 7.35 inches at the Firebaugh CIMIS station.

Table 2: 2018 CIMIS Monthly Rainfall Measurements

Month	Firebaugh	Panoche
January	1.52	1.59
February	0.24	0.15
March	2.54	1.85
April	0.64	0.55
May	0*	0
June	0*	0
July	0*	0
August	0*	0
September	0*	0
October	0.03	0
November	1.37	1.67
December	1.01	0.82
Total:	**7.35**	**6.63**

* Data adjusted for errant readings.

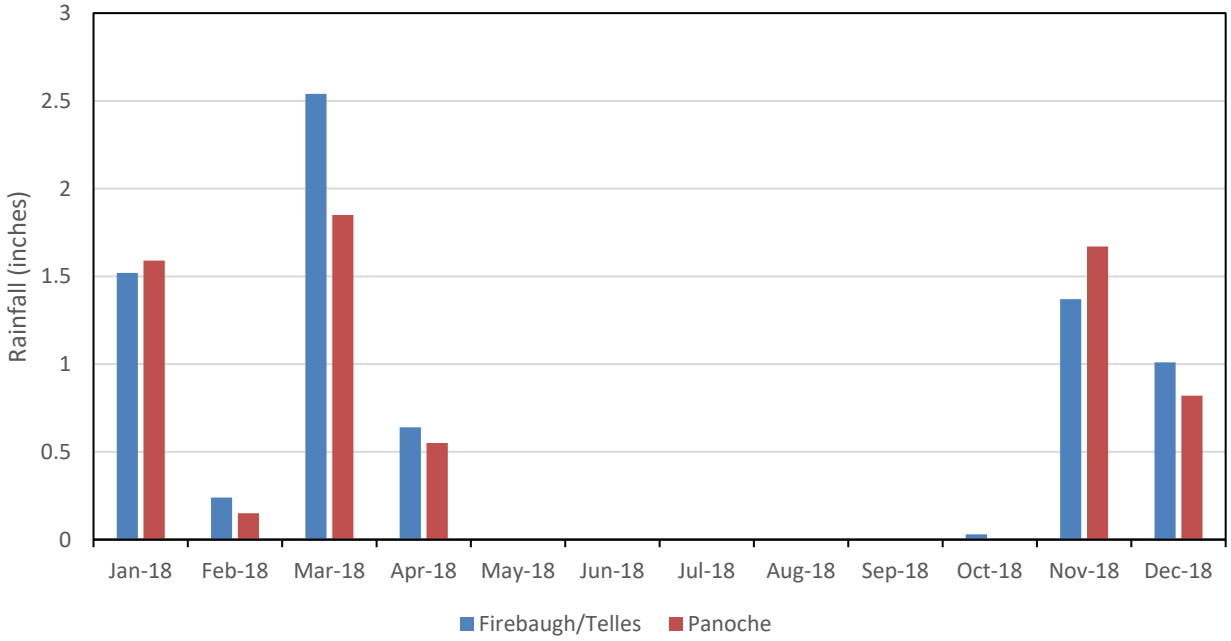

Figure 3: 2018 CIMIS Monthly Rainfall Measurements

[2] California Irrigation Management Information System, http://wwwcimis.water.ca.gov/cimis/welcome.jsp
CIMIS Site Designations: Firebaugh/Telles – 007, Panoche - 124

3.2 Fall 2018 Groundwater Quality Sampling Activities

Fall 2018 groundwater quality sampling for the GDA GQTM Program took place from November 26 to December 11, 2018. The sampling of several network wells was delayed due to inaccessibility resulting from weather-related conditions caused by precipitation and site access safety associated with travel along canal access roads. Most wells were sampled during the first several days of the sampling event in late November 2018 whereas wells GDA003 and GDA011 were sampled on December 10 and 11 once site access conditions were safe. Of the eight wells proposed for the GDA GQTM in the Workplan Addendum, only six of the wells could be sampled in Fall 2018. Two wells, GDA006 and GDA007, were not able to be sampled because the wells were no longer accessible or in existence as originally anticipated in the Workplan Addendum.

During vetting of suitable GQTM network wells for the the Workplan Addendum, two wells (GDA006 and GDA007) with DWR Well Completion Reports (WCRs) were identified and discussed with local district entities familiar with the area to assess their suitability for the network. Site visits to confirm the details of these wells could not be completed prior to submittal of the Workplan Addendum and they were added to the network based on their locations, information contained on the WCRs, and confirmation from local district entities regarding the accessibility of the wells for sampling. At the time of the Fall 2018 sampling event, it was observed that there had been a miscommunication between the local district entities and the Coalition regarding GDA006 and GDA007 resulting from unique well identifiers on the WCRs that were the same as those used by the local district entities for two different wells. Neither GDA006 or GDA007 could be located and are presumed to be abandoned. Both wells were constructed in 2000 concurrent with adjacent very shallow wells at each site; the very shallow wells have been located, but the somewhat deeper wells suitable for the GQTM network have not been located. Updates to the GQTM well network , including modifications made in response to these change, are discussed below as part of the proposed 2019 GQTM network update.

Aside from the delays and access challenges noted above, the Fall 2018 well sampling was conducted at each well without notable issues. Wells were measured for depth to water (if access to water level measurements was available) upon arrival at each site and prior to conducting any well purging. All wells were purged and sampled in accordance with the standard operation procedures (SOP) for sampling activities (MLJ et al., 2019) using existing pumping equipment or installed sampling pumping equipment. All sampled wells were monitored for field parameters, including pH, temperature, electrical conductivity (EC), dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity during the well purging and sampling event. In all wells sampled, the pumped water had achieved stabilization of field parameters prior to sample collection and no remarkable occurrences during the sampling process were noted. All water samples were stored on ice after collection and delivered to Eurofins Laboratory for analysis of nitrate and major cations and anions, in accordance with the GQTM requirements. Field forms from the sampling activities are provided as part of the electronic data submittal package submitted together with this document.

3.3 Groundwater Quality Sampling Results

The results from the Fall 2018 GQTM sampling event are presented in **Table 3**. Water quality results exceeding applicable drinking water standards are highlighted in bold in **Table 3**. For the purpose of

comparing results with water quality objectives, the results are discussed below relative to drinking water standards, although the naturally occurring high salinity in groundwater in the GDA makes groundwater unusable for drinking water purposes throughout most of the GDA region. No workplan for a Basin Plan Amendment specific to the GDA has been submitted to date.

In the Fall 2018 sampling, analytical water quality results for two of the sampled wells, GDA001 and GDA005, exceeded the primary drinking water MCL of 10 milligrams per liter (mg/L) for nitrate (as nitrogen); a duplicate sample analyzed from well GDA001 also exceeded the MCL for nitrate and is included in **Table 3**. All six of the sampled wells exceeded the secondary recommended and upper drinking water MCLs of 500 and 1,000 mg/L, respectively, for total dissolved solids (TDS) concentrations. TDS concentrations in the sampled wells ranged from 1,200 mg/L to 3,900 mg/L with concentrations above 2,000 mg/L for all but one of the wells sampled. This is reflective of the naturally high salinity of groundwater in the region. Sulfate concentrations in all six sampled wells were also above the secondary upper drinking water MCL of 500 mg/L; many of these wells had sulfate concentrations greater than 1,000 mg/L. Additionally, chloride concentrations in four wells were above the secondary recommended drinking water MCL of 250 mg/L. Relatively high boron concentrations occurred in all sampled wells with five of the six wells exhibiting boron levels above the State public health goal (PHG) of 1,000 micrograms per liter (µg/L) and many having concentrations more than three or four times the PHG. Again, the high levels of boron in the groundwater in the GDA are a result of the naturally occurring boron in sediments in the region.

Letters summarizing the Fall 2018 sampling results for individual wells and noting any identified water quality exceedances were transmitted to all GQTM network well owners. Additional communication with owners of network wells exhibiting nitrate exceedances is also in process to make well owners aware of management practices contained in the Coalition's Groundwater Quality Management Plan or other management practices intended to protect groundwater quality. These practices may include actions related to wellhead protection as well as agricultural management practices.

A spreadsheet with tabulated results for the Fall 2018 sampling is included with the accompanying electronic data submittal package. All laboratory analytical report files and chain of custody forms associated the sampling and analytical testing are also provided in the electronic data submittal package.

Table 3: Fall 2018 GQTM Sampling Results

Site ID	Date Sampled		Nitrate (as nitrogen)	Total Dissolved Solids (TDS)	Boron	Calcium	Magnesium	Potassium	Sodium	Chloride	Sulfate	Nitrite (as nitrogen)	Bicarbonate Alkalinity (as HCO3)	Carbonate (as CO3)	Total Alkalinity (as CaCO3)	pH	Specific Conductance (EC)	Temperature	Dissolved Oxygen (DO)	Oxidation-Reduction Potential (ORP)	Turbidity	Depth to Water
		UNITS:	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH Units	uS/cm	°C	mg/L	mV	NTU	ft, bgs
		MDL:	0.5	10	500	1	0.1	1	1	13	13	NA	10	10	10	NA						
		MCL:	10 [1]	500/ 1,000 [2]	1,000 [4]					250/ 500[2]	250/ 500[2]	1				6.5/ 8.5 [3]						
GDA001	11/26/18		**12**	**2,600**	**3,100**	280	82	2.1	420	**360**	**1,200**	ND	344.3	ND	180	7.54	3,390	22	1.16	72.8	1.24	14.3
GDA001 (duplicate)	11/26/18		**12**	**2,600**	**3,000**	280	81	2.1	410	**370**	**1,200**	ND	344.3	ND	180	7.54	3,390	22	1.16	72.8	1.24	14.3
GDA002	11/29/18		ND	**2,600**	**4,000**	380	88	4.9	250	180	**1,500**	ND	147.5	ND	74	7.83	2,880	20.5	2.04	83.5	0.4	37.0
GDA003	12/11/18		6.4	**3,400**	**4,400**	630	98	3.3	340	**360**	**1,900**	ND	103.3	ND	52	7.73	3,711	19.2	3.17	-25.1	0.02	49.5
GDA004	11/26/18		0.65	**1,200**	740	260	31	1.3	62	65	**700**	ND	160.7	ND	81	7.84	1,468	18.4	4.39	64.1	0.02	N/A
GDA005	11/26/18		**35**	**3,900**	**8,100**	490	190	4.8	550	**800**	**1,800**	ND	180.3	ND	89	7.52	5,092	18.8	3	103.4	0.02	N/A
GDA006			Well not available/accessible for sampling.																			
GDA007			Well not available/accessible for sampling.																			
GDA011	12/10/18		ND	**2,300**	**2,300**	150	36	9	570	**440**	**910**	ND	426.2	2.7	210	7.88	3,216	17.4	3.05	-49.5	0.16	>150

[1] Primary Maximum Contaminant Level (MCL) for drinking water

[2] Secondary MCL (recommended/upper range) for drinking water

[3] Suggested lower/upper acceptable range for drinking water

[4] State Notification (Action) level - A health-based notification level established by the State of California for some constituents lacking MCLs; if a public water system detects a constituent at concentrations above the action level, local governing bodies must be notified.

ND = Not detected above laboratory minimum detection level or reporting limit (MDL) shown; N/A = no access to water level reading.

3.4 Evaluation of Groundwater Quality Trends and Patterns

Maps of TDS and nitrate concentrations from the Fall 2018 GQTM sampling event are presented as **Figures 4 and 5**. As discussed above and illustrated in **Figure 4**, Fall 2018 TDS concentrations in all sampled wells were high reflecting the naturally highly saline groundwater conditions existing in the Coalition region. The two GQTM wells with the highest TDS concentrations were located in the central part of the GDA Coalition region. **Figure 5** presents the locations and concentrations of nitrate concentrations in GQTM network wells; the two nitrate exceedance wells, GDA001 and GDA005, are symbolized in red with concentrations above 10 mg/L whereas the other four wells sampled in Fall 2018 had nitrate concentrations below 10 mg/L, including three wells with very low or undetectable concentrations.

The primary objective of the GQTM Program is to evaluate regional temporal trends in groundwater quality as they relate to agricultural practices. As discussed in the GDA GQTM Workplan and in accordance with the CVGMC Workplan(LSCE et al., 2018), of which the GDA Coalition is a participant, more extensive evaluation of groundwater quality data and identification of any trends and associated relationships with agricultural practices, will be conducted and summarized at five-year intervals and once a sufficient period of record of groundwater quality data has been developed for assessing such trends.

The groundwater quality results from the Fall 2018 sampling event represent the first groundwater quality datapoint for all of the GDA GQTM network wells; therefore, no charts of time-series data for groundwater quality in network wells are presented in this report. In future groundwater monitoring results reporting, charts of time-series data for TDS and nitrate concentrations will be developed and maintained to inform the analysis and evaluation of groundwater quality trends in GQTM network wells as implementation of the Program continues.

3.5 Summary of Quality Assurance Evaluation for Fall 2018 Sampling Event

Consistent with the QAPP, field measurements of electrical conductivity (EC) at 25°C, pH, dissolved oxygen (DO), and temperature (T) were obtained during the sample retrieval and the laboratory performed analysis for nitrate-N, boron (B), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), chloride (Cl), sulfate (SO4), carbonate and bicarbonate alkalinity, and total dissolved solids (TDS).

3.5.1 Purging, sample handling, and custody

Wells were purged according to the SOP. Samples were retrieved upon stabilization of indicator parameters (i.e., EC and pH) and after the turbidity of the discharging water dropped below 10 NTUs. Purging and sampling activities were documented on field sheets provided in the QAPP, although some field forms were not thoroughly completed. Samples were collected in laboratory-supplied bottles and transported under prescribed chain of custody to the laboratory according to the QAPP.

3.5.2 Field and analytical completeness

A total of eight wells were planned for sampling and the QAPP prescribes the collection of one duplicate sample and one blank sample for every 20 samples retrieved. Only six of the eight planned wells could

be sampled in Fall 2018 resulting in 75 percent completeness for well sampling and field parameters (**Table 4**). As discussed above in **Section 3.2**, the two wells not sampled had previously been proposed for the GQTM program, but at the time of sampling were discovered to no longer be accessible. All well samples collected were analyzed at the laboratory resulting in 100 percent analytical completeness (**Table 4**). For the purpose of field quality control (QC), the QAPP prescribes the collection of one duplicate sample and one blank sample for every 20 samples retrieved (each must be at least 5 percent of total samples). In accordance with the QAPP, one duplicate sample was retrieved representing 14 percent of the samples. A field blank sample was inadvertently not submitted to the laboratory resulting. **Table 5** summarized the field duplicate and field blank samples from the Fall 2018 sampling event. A summary of the hold times specified in the QAPP for the laboratory analyses is presented in **Table 6**. All but one analysis was conducted within the allowed hold time; a single sample was analyzed outside the 48-hour hold time for nitrate and nitrite as nitrogen using analytical method EPA 300.0. This sample was analyzed about 10 hours over the specified hold time. If conducting the analysis for nitrate outside of the hold time were to affect concentration results, it is likely it would have caused higher than actual nitrate concentrations due to the tendency for nitrogen in water to convert to nitrate. Because the nitrate concentration for the sample that was run outside of the hold time was below the detection level for nitrate, the results for this sample are accepted as a reflection of actual nitrate concentrations below the detection level.

3.5.3 Analytical precision and accuracy

The laboratory performed all QA/QC for laboratory precision and accuracy in accordance with the QAPP including lab blanks, lab duplicates, matrix spikes, and lab control spikes. Results of the assessment of precision and accuracy are summarized in **Tables 7 and 8** and include evaluation of chemistry QC with field and laboratory blank samples; laboratory control and matrix spikes to evaluate accuracy; and field, laboratory, and matrix spike duplicates to evaluate precision. Analytical precision and accuracy met all acceptability requirements for all analytes tested; the matrix spikes for alkalinity as CaCO3 only had 38 percent within the 75-125 percent recovery range, although the QAPP does not prescribe matrix spikes for alkalinity as CaCO3.

3.5.4 Quality Assurance Evaluation Conclusions

All groundwater quality data are considered acceptable based on the review of QA/QC procedures and results in accordance with the requirements in the QAPP. The omission of the field blank from analytical testing does not pose a significant concern to the usability of the water quality data. Field blanks assess the total ambient conditions during sampling and transit, and laboratory sources of contamination. Therefore, they provide information for a specific date, time, and location where the field blank was obtained. Field blanks are of particular interest in the context of volatile organic compounds, pathogens, and ultra-low trace metals, where very small contaminant amounts have the potential to significantly alter the analytical results and affect decision making. This is not the case in the context of this data collection effort and associated general mineral analyses.

Items identified in the quality assurance evaluation that can be improved or corrected during future GQTM sampling events to better comply with protocols and procedures outlined in the QAPP, include greater thoroughness in completing field forms and performance of field blank analytical testing.

Additionally, the low recovery percentages recorded for some matrix spikes for alkalinity as CaCO3 will be addressed with the laboratory. In future sampling events, a narrative of the laboratory quality control will be provided on the analytical reports. However, none of these issues have been determined to significantly affect the reliability or usability of the data obtained as part of the Fall 2018 sampling event; therefore, all data were accepted and are considered useable. Resolution of the identified issues for future GQTM sampling events will be discussed with field sampling and laboratory personnel prior to and in preparation for the next sampling event.

Table 4: Completeness of Field and Analytical Testing

Constituent	Test Type	Analytical Method	Matrix	Wells Planned for Sampling	Wells Sampled	Field and Transport Completeness	Total Samples Analyzed	Analytical Completeness
Dissolved Oxygen (DO)	Field parameter	SM4500-O G-2001	Groundwater	8	6	75%	NA	NA
Electrical Conductivity (EC) at 25 °C	Field parameter	SM2510-B 1997	Groundwater	8	6	75%	NA	NA
pH	Field parameter	SM4500-H+ B-2000	Groundwater	8	6	75%	NA	NA
Temperature	Field parameter	SM2550-B 2000	Groundwater	8	6	75%	NA	NA
*Oxidation-reduction potential (ORP)	Field parameter	-	Groundwater	8	6	75%	NA	NA
*Turbidity	Field parameter	EPA180.1	Groundwater	8	6	75%	NA	NA
Nitrate + Nitrite as N	Laboratory	EPA 300.0	Groundwater	8	6	75%	6	100%
Alkalinity as CaCO3	Laboratory	SM 2320B	Groundwater	8	6	75%	6	100%
Carbonate	Laboratory	SM 2330B	Groundwater	8	6	75%	6	100%
Chloride	Laboratory	EPA 300.0	Groundwater	8	6	75%	6	100%
Bicarbonate	Laboratory	SM 2330B	Groundwater	8	6	75%	6	100%
Sulfate (SO4)	Laboratory	EPA 300.0	Groundwater	8	6	75%	6	100%
Boron	Laboratory	EPA 200.7	Groundwater	8	6	75%	6	100%
Calcium	Laboratory	EPA 200.7	Groundwater	8	6	75%	6	100%
Magnesium	Laboratory	EPA 200.7	Groundwater	8	6	75%	6	100%
Potassium	Laboratory	EPA 200.7	Groundwater	8	6	75%	6	100%
Sodium	Laboratory	EPA 200.7	Groundwater	8	6	75%	6	100%
Total Dissolved Solids (TDS)	Laboratory	SM2540C	Groundwater	8	6	75%	6	100%
			Total	144	108	75%	72	109%

* ORP and turbidity are optional field parameters.

Table 5: Completeness of Field QC

Constituent	Analytical Method	Matrix	Total Well Samples Analyzed	Field Duplicate Samples Analyzed	Field Blank Samples Analyzed	Total Samples Analyzed (well and duplicates)	Field Duplicate Completeness	Field Blank Completeness
Nitrate + Nitrite as N	EPA 300.0	Groundwater	6	1	0	7	14.3%	**0%**
Alkalinity as CaCO3	SM 2320B	Groundwater	6	1	0	7	14.3%	**0%**
Carbonate	SM 2330B	Groundwater	6	1	0	7	14.3%	**0%**
Chloride	EPA 300.0	Groundwater	6	1	0	7	14.3%	**0%**
Bicarbonate	SM 2330B	Groundwater	6	1	0	7	14.3%	**0%**
Sulfate (SO4)	EPA 300.0	Groundwater	6	1	0	7	14.3%	**0%**
Boron	EPA 200.7	Groundwater	6	1	0	7	14.3%	**0%**
Calcium	EPA 200.7	Groundwater	6	1	0	7	14.3%	**0%**
Magnesium	EPA 200.7	Groundwater	6	1	0	7	14.3%	**0%**
Potassium	EPA 200.7	Groundwater	6	1	0	7	14.3%	**0%**
Sodium	EPA 200.7	Groundwater	6	1	0	7	14.3%	**0%**
Total Dissolved Solids (TDS)	SM2540C	Groundwater	6	1	0	7	14.3%	**0%**
		Total	72	12	0	84	14.3%	0%

Completeness values below the acceptability requirement of 5 percent are presented in bold.

Table 6: Evaluation of Sample Hold Times

Constituent	Analytical Method	Matrix	Hold Time	Total Samples Analyzed (well and duplicates)	Samples Analyzed within Hold Time	Acceptability
Nitrate + Nitrite as N	EPA 300.0	Groundwater	48 hours	7	6	**86%**
Alkalinity as CaCO3	SM 2320B	Groundwater	14 days	7	7	100%
Carbonate	SM 2330B	Groundwater	14 days	7	7	100%
Chloride	EPA 300.0	Groundwater	28 days	7	7	100%
Bicarbonate	SM 2330B	Groundwater	14 days	7	7	100%
Sulfate (SO4)	EPA 300.0	Groundwater	28 days	7	7	100%
Boron	EPA 200.7	Groundwater	6 months	7	7	100%
Calcium	EPA 200.7	Groundwater	6 months	7	7	100%
Magnesium	EPA 200.7	Groundwater	6 months	7	7	100%
Potassium	EPA 200.7	Groundwater	6 months	7	7	100%
Sodium	EPA 200.7	Groundwater	6 months	7	7	100%
Total Dissolved Solids (TDS)	SM2540C	Groundwater	7 days	7	7	100%
			Total	84	83	99%

Acceptability values below 90 percent are presented in bold.

Table 7: Evaluation of Field Duplicates and Blanks

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability
Nitrate + Nitrite as N	EPA 300.0	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Alkalinity as CaCO3	SM 2320B	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Carbonate	SM 2330B	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Chloride	EPA 300.0	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Bicarbonate	SM 2330B	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Sulfate (SO4)	EPA 300.0	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Boron	EPA 200.7	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Calcium	EPA 200.7	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Magnesium	EPA 200.7	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Potassium	EPA 200.7	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Sodium	EPA 200.7	Groundwater	Field duplicate	RPD≤25%	1	1	100%
Total Dissolved Solids (TDS)	SM2540C	Groundwater	Field duplicate	RPD≤25%	1	1	100%
				Field Duplicate Total	12	12	100%

Acceptability values below 90 percent are presented in bold.

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability
Nitrate + Nitrite as N	EPA 300.0	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Alkalinity as CaCO3	SM 2320B	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Carbonate	SM 2330B	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Chloride	EPA 300.0	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Bicarbonate	SM 2330B	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Sulfate (SO4)	EPA 300.0	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Boron	EPA 200.7	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Calcium	EPA 200.7	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Magnesium	EPA 200.7	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Potassium	EPA 200.7	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Sodium	EPA 200.7	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
Total Dissolved Solids (TDS)	SM2540C	Groundwater	Field blank	<RL or < sample/5	0*	0*	-*
				Field Blank Total	0*	0*	-*

Acceptability values below 90 percent are presented in bold.

*Field blanks were inadvertently not analyzed and therefore acceptability percent could not be calculated. Field blanks are most important when analyzing for constituents where very small contaminant amounts can potentially significantly alter analytical results such as when testing for volatile organic compounds, pathogens, and ultra-low trace metals. This is not the case for this GQTM data collection effort, which involves nitrate and general minerals.

Table 8: Evaluation of Lab Controls and Spikes

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability
Lab Blanks							
Nitrate + Nitrite as N	EPA 300.0	Groundwater	Lab blank	<RL	3	3	100%
Alkalinity as CaCO3	SM 2320B	Groundwater	Lab blank	<RL	4	4	100%
Chloride	EPA 300.0	Groundwater	Lab blank	<RL	6	6	100%
Sulfate (SO4)	EPA 300.0	Groundwater	Lab blank	<RL	6	6	100%
Boron	EPA 200.7	Groundwater	Lab blank	<RL	4	4	100%
Calcium	EPA 200.7	Groundwater	Lab blank	<RL	4	4	100%
Magnesium	EPA 200.7	Groundwater	Lab blank	<RL	4	4	100%
Potassium	EPA 200.7	Groundwater	Lab blank	<RL	4	4	100%
Sodium	EPA 200.7	Groundwater	Lab blank	<RL	4	4	100%
Total Dissolved Solids (TDS)	SM2540C	Groundwater	Lab blank	<RL	3	3	100%
				Lab Blank Total	42	42	100%
Lab Control Spikes							
Nitrate + Nitrite as N	EPA 300.0	Groundwater	LCS	PR 90-110	6	6	100%
Alkalinity as CaCO3	SM 2320B	Groundwater	LCS	PR 75-125	8	8	100%
Chloride	EPA 300.0	Groundwater	LCS	PR 75-125	12	12	100%
Sulfate (SO4)	EPA 300.0	Groundwater	LCS	PR 75-125	12	12	100%
Boron	EPA 200.7	Groundwater	LCS	PR 75-125	8	8	100%
Calcium	EPA 200.7	Groundwater	LCS	PR 75-125	8	8	100%
Magnesium	EPA 200.7	Groundwater	LCS	PR 75-125	8	8	100%
Potassium	EPA 200.7	Groundwater	LCS	PR 75-125	8	8	100%
Sodium	EPA 200.7	Groundwater	LCS	PR 75-125	8	8	100%
Total Dissolved Solids (TDS)	SM2540C	Groundwater	LCS	PR 80-120	6	6	100%
				Lab Control Total	84	84	100%
Matrix Spikes							
Nitrate + Nitrite as N	EPA 300.0	Groundwater	MS	PR 80-120	6	6	100%
Alkalinity as CaCO3	SM 2320B	Groundwater	MS	PR 75-125	8	3	**38%**
Chloride	EPA 300.0	Groundwater	MS	PR 75-125	11	11	100%
Sulfate (SO4)	EPA 300.0	Groundwater	MS	PR 75-125	11	11	100%
Boron	EPA 200.7	Groundwater	MS	PR 75-125	8	8	100%
Calcium	EPA 200.7	Groundwater	MS	PR 75-125	8	8	100%
Magnesium	EPA 200.7	Groundwater	MS	PR 75-125	8	8	100%
Potassium	EPA 200.7	Groundwater	MS	PR 75-125	8	8	100%
Sodium	EPA 200.7	Groundwater	MS	PR 75-125	8	8	100%
				Matrix Spike Total	76	71	93%

Constituent	Analytical Method	Matrix	Sample Type	Acceptability Requirement	Total Samples	Samples within Acceptability	Acceptability
Analytical Duplicates							
Nitrate + Nitrite as N	EPA 300.0	Groundwater	MSD	RPD≤25	6	6	100%
Alkalinity as CaCO3	SM 2320B	Groundwater	MSD	RPD≤25	8	8	100%
Chloride	EPA 300.0	Groundwater	MSD	RPD≤25	11	11	100%
Sulfate (SO4)	EPA 300.0	Groundwater	MSD	RPD≤25	11	11	100%
Boron	EPA 200.7	Groundwater	MSD	RPD≤25	8	8	100%
Calcium	EPA 200.7	Groundwater	MSD	RPD≤25	8	8	100%
Magnesium	EPA 200.7	Groundwater	MSD	RPD≤25	8	8	100%
Potassium	EPA 200.7	Groundwater	MSD	RPD≤25	8	8	100%
Sodium	EPA 200.7	Groundwater	MSD	RPD≤25	8	8	100%
Total Dissolved Solids (TDS)	SM2540C	Groundwater	MSD	RPD≤25	6	6	100%
Analytical Duplicate Total					82	82	100%

Acceptability values below 90 percent are presented in bold.
LCS=lab control spike; MS=matrix spike; MSD=matrix spike duplicate

3.6 Ongoing GQTM Network Development

An initial network of wells was selected for the GQTM and presented in the Workplan (LSCE, 2018a) and Addendum (LSCE, 2018b) based on evaluation of candidate wells and their individual well characteristics in combination with locational considerations identified in the Workplan and Addendum. The Workplan presented the prioritization of areas for monitoring derived through a quantitative evaluation using factors based on required GQTM considerations indicated in the WDRs, including historical water quality, high vulnerability areas delineated in the GAR, proximity and flow direction relative to any communities, and land use and agricultural areas. Identified Monitoring Areas delineate general areas of higher monitoring priority. Unlike a random design approach, this focuses monitoring efforts in areas where impacts from agricultural activities are more likely to manifest in the groundwater. As described in the Workplan, the target depth zone for the GQTM network is the Upper Zone as delineated by CV-SALTS (LSCE and LWA, 2016). The depth of the Upper Zone in the GDA Coalition region is typically defined by the depth of the Corcoran Clay geologic unit.

Ongoing vetting of candidate wells has continued as part of identifying additional network wells. Well vetting efforts conducted by the Coalition involves many steps, including, but not limited to the following:

1. Confirming the existence of the individual well and location through correspondence with well owners or site visits,
2. Evaluating well construction information through review of a WCR or other comparable documentation of the well construction,
3. Determining well accessibility and means of collecting groundwater quality samples and water level measurements,
4. Reviewing well location and site in relation to land use activities that may affect the ability to detect trends in groundwater quality characteristics related to agricultural practices, and
5. Acquiring well owner permission for inclusion of the well in the GQTM network.

Well vetting is a significant Coalition effort necessitating outreach to well owners and agencies, review and inspection of well information and condition, and includes the development of well access agreements and participation arrangements.

Specific efforts conducted to identify wells for network expansion include evaluation of numerous candidate wells for consideration in the network involving review of existing well data records, review of WCRs, well owner contacts, well site reconnaissance and inspections, and acquiring agreements for well owner participation in the program, when appropriate and possible. The Coalition has been conducting outreach to members and candidate well owners through phone calls, emails, and site visits to confirm all necessary details with respect to the GQTM well network. Some of the highlights of these well vetting efforts include:

- Review of numerous redacted WCRs
- Mapping of potential candidate well WCRs
- Matching WCRs to member parcel locations, as possible

- Reviewing aerial photography near high priority monitoring areas (LSCE, 2018a) to identify potential domestic well owners
- Discussing and reviewing potential monitoring sites with local water districts or other local entities operating in the Coalition region
- Contacting potential well owners based on aerial photographic interpretation of potential domestic well sites and WCR locations
- Contacting Coalition members based on parcel locations
- Conducting site visits to evaluate candidate wells

Resulting from these efforts, many candidate wells were determined to be unsuitable for the network due to a variety of factors. Because of the high natural salinity of groundwater in the Coalition region, the use of groundwater for drinking water supply is extremely limited and the use of groundwater for irrigation or other beneficial uses is also relatively limited. Consequently, access to wells for monitoring groundwater, especially relatively shallow groundwater, is limited. Of identified candidate wells, some examples of reasons candidate wells were not selected for the network include the well construction information is not available or could not be ascertained through field inspection, the well is determined to be too deep, the well no longer exists, the well is not at the location where originally thought, contact could not be made with the well owner, or the well owner did not agree to participate in the program.

Through these ongoing well search efforts, the Coalition identified several wells to add to the GQTM network for 2019, and the Coalition is continuing coordination with land owners to determine if other wells are suitable for future addition to the network.

3.6.1 2019 GQTM Network Updates

An initial GQTM well network consisting of eight (8) wells spatially distributed throughout the Coalition region was presented in the Workplan Addendum (LSCE, 2018b). The initial network wells included a mix of observation, irrigation, domestic, and public supply wells and are listed in **Table 1**. An updated network of wells for future sampling has been identified with attention focused on adding wells in or near the search areas highlighted in the Workplan Addendum. There are very few existing wells in the GDA that meet the location and depth requirements and objectives for the trend monitoring program. Potentially suitable network wells include those located near high priority monitoring areas that are constructed in the Upper Zone above the Corcoran Clay, but which are not monitoring the first encountered groundwater. The water quality of the shallow groundwater is very poor within the GDA and not suitable for potable use. This is evident from the 2018 results of the trend monitoring shown in **Table 3**. As a result, the residences and domestic uses in the area typically do not use groundwater and are mostly provided water through surface water sources, either out of the California Aqueduct or from other surface water sources and treated through regional treatment systems or treated on site.

Five new wells were added to the GQTM network for 2019. Additionally, two wells originally proposed in the Workplan Addendum (GDA006 and GDA007) were removed from the network because the wells were determined to be unavailable for sampling as part of the GQTM program. The proposed GQTM network for 2019 consists of a total of eleven wells. All of the GQTM network wells presented have been vetted to the extent possible and the well owners have agreed to participate in the program. Some

additional wells with pending well information or pending owner agreements have also been identified, but these wells are not included in the proposed GQTM network at this time. If these wells are determined suitable for the program and owner agreement is obtained prior to the 2019 sampling event, they will be added to the network for sampling in 2019 and in future years. The details of any additional network wells will be provided in reporting on 2019 annual groundwater monitoring results.

Figure 6 presents a map of the current proposed network wells including those originally shown in the Workplan Addendum together with additional network wells added since the Addendum. Available well details for all of the proposed 2019 GQTM network wells are presented in **Table 9.** Major land uses within one mile of these wells are representative of the top commodities grown in the Coalition region. Network wells were selected to target locations around the highest priority monitoring areas and wells were selected to monitor changes in groundwater quality associated with a variety of top commodities, as shown in **Figures 2 and 3**. Currently available WCRs or other well construction documentation for the network wells are also included in **Appendix B**. Only one WCR is available for the five new network wells added for 2019, although the well depths of the other new wells have been confirmed through field verification conducted during site visits.

Table 9: 2019 GDA Coalition GQTM Network Update Wells

GQTM Well ID	State Well Number	WCR Number	Well Use	Well Construction Information					Latitude (NAD83)	Longitude (NAD83)	Depth Bottom of Upper Zone (feet)[1]	Percent Screens in Upper Zone	Explanation of Monitored Depth
				Seal Depth (feet)	Seal Mat.	Total Well Depth (feet)	Depth Top of Screen (feet)	Depth Bottom of Screen (feet)					
GDA001	11S/11E-30	426375	Dom	55	Bent	160	76	116	36.95390	-120.81010	234	100%	Screens entirely in Upper Zone
GDA002	12S/12E-04R	e0167974	Dom	180	Bent	227	200	220	36.91044	-120.65553	319	100%	Screens entirely in Upper Zone
GDA003	12S/12E-15C	e0108733	Irrig	50	Cem	380	310	370	36.89217	-120.64936	345	58%	Mostly in Upper Zone; screens are above average domestic well depth in area (450 feet)
GDA004	12S/11E-08P	e0173400	Irrig	20	Cem	205	50	140	36.89408	-120.79298	107	43%	Partially in Upper Zone; defined Upper Zone is very shallow although well screens are considerably shallower than only nearby domestic well depth (460 feet)
GDA005	12S/12E-33D	01095504	Dom	110	Bent	200	130	190	36.84886	-120.67171	378	100%	Screens entirely in Upper Zone
~~GDA006~~	~~12S/13E-31D~~	~~783270M~~	~~Mon~~	~~80~~	~~Cem/ Bent~~	~~153~~	~~84~~	~~104~~	~~36.85010~~	~~-120.59850~~	~~258~~	~~100%~~	~~Screens entirely in Upper Zone~~
~~GDA007~~	~~12S/13E-35D~~	~~783272M~~	~~Mon~~	~~98~~	~~Cem/ Bent~~	~~150~~	~~102~~	~~122~~	~~36.85040~~	~~-120.52620~~	~~229~~	~~100%~~	~~Screens entirely in Upper Zone~~
GDA008	12S/11E-36	410008	Dom	140	Bent	245	170	230	36.85003	-120.71802	201	52%	Screens mostly in Upper Zone; well is only domestic well in area
GDA011	13S/15E-30B	314244	PWS	150	Cem	308	168	288	36.77631	-120.37361	204	30%	Screens are entirely within the Upper Aquifer above the Corcoran Clay (400 feet), although nearby very shallow older domestic wells skew Upper Zone depth from CV-SALTS; screens in well are similar to domestic wells in area.
GDA012			Mon			80			36.85087	-120.49372	220	100%	Well depth within Upper Zone
GDA013			Mon			250			36.85157	-120.65373	392	100%	Well depth within Upper Zone
GDA014			Mon			80			36.82181	-120.65617	379	100%	Well depth within Upper Zone
GDA016			Irrig			228			36.88130	-120.60384	288	100%	Well depth within Upper Zone

[1] Depth of bottom of Upper Zone is from CV-SALTS. PWS = public water supply; Irrig = irrigation; Dom = domestic; Mon = monitoring; Bent = bentonite; Cem = cement

Original GQTM network wells in July 2018 Workplan Addendum; strikethrough indicates well removed from the network because of unavailability/inaccessibility for ongoing water quality sampling

New 2019 GQTM network well

3.6.2 GQTM Network Discussion

Table 10 summarizes the status of the GQTM network and network development efforts relative to the Monitoring Areas delineated on **Figure 6**, which represent general areas of highest priority within the Coalition region as described in the Workplan. An assessment of the sufficiency of the network for fulfilling the objectives of the GQTM Program and monitoring of regional trends in groundwater quality relative to agricultural practices, with specific attention paid to sufficiency of the network relative to the delineated Monitoring Areas, is presented in **Table 10**.

The locations of the proposed 2019 GQTM updated network wells in relation to major land use types are displayed on **Figure 7**. **Figures 8** presents land uses within one mile of each of the 2019 GQTM network wells. The eleven wells presented for the monitoring network in 2019 will provide representation of groundwater quality trends in areas where a variety of the top commodities are grown in the Coalition region. These include crops categories such as grains and hay, nut trees, vegetables, field crops, and also vineyards.

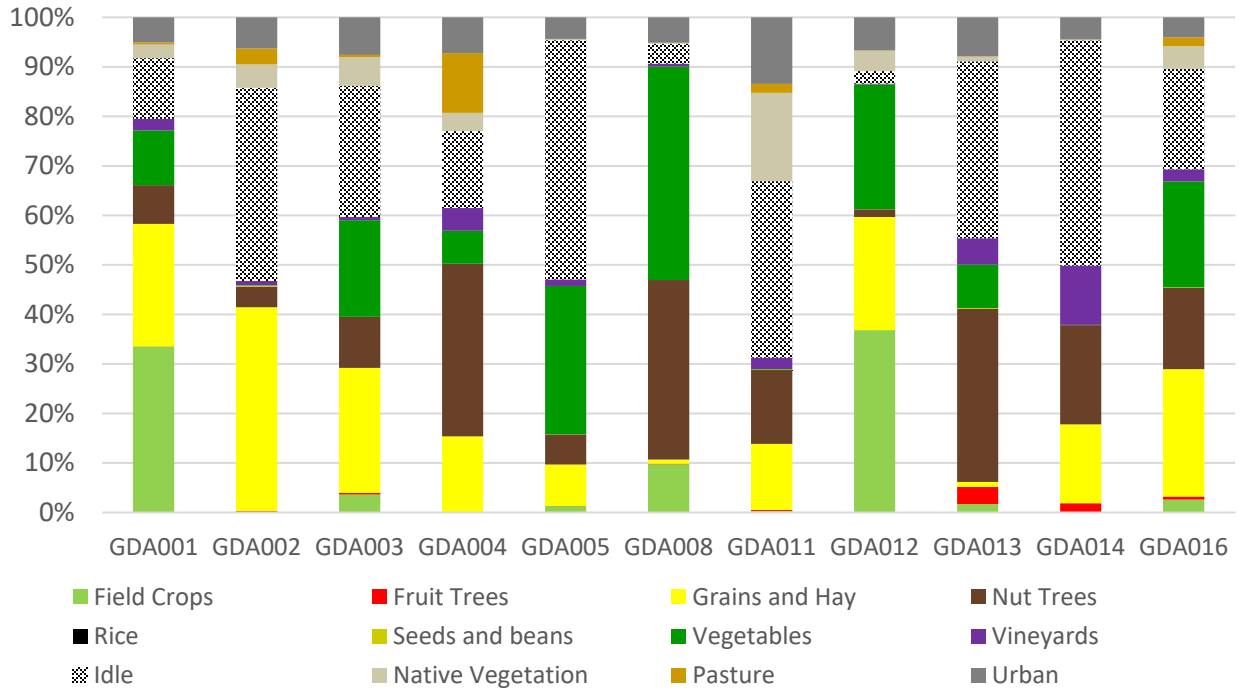

Figure 8: 2016 Land Use Types within One Mile of 2019 GQTM Network Wells

As noted above, the rationale for the distribution of the GQTM network wells includes recognition of a variety of factors to ensure the appropriate location for monitoring considered all of the factors identified in the WDR and additional considerations of interest identified by the Coalition. These factors were incorporated into a monitoring prioritization scheme that included numeric weighting of factors for targeting areas for monitoring, and the distribution of the network wells is based on this quantitative prioritization of areas and delineated Monitoring Areas.

The proposed GQTM network represents a network of wells with potential for additional wells to be added prior to 2019 sampling and ongoing network refinement as the program progresses. The ultimate

GQTM network will be sufficient to evaluate long-term regional groundwater quality trends related to irrigated agriculture effects and practices. The 2019 GQTM network, along with the planned evolution of the network, is sufficient to address the GQTM requirements because the network design is based on a monitoring prioritization that incorporates the key factors and considerations required by the WDRs (e.g., consideration of agricultural commodities, consideration of factors in vulnerability prioritization, consideration of recharge areas to communities). The GQTM sampling in 2019 will utilize the existing network of well while continued evaluation and refinement of the GQTM network during the implementation of the program will ensure that the network accomplishes the objectives of the program. The appropriate number and location of wells for the GQTM network will be informed by the ongoing evaluation of data from the program itself with potential constraints as described above. In conjunction with existing and ongoing groundwater quality data evaluated as part of the GAR (LSCE, 2016) (and updates to the GAR), the GQTM network and analyses conducted as part of the GQTM Program, will also complement the characterization of groundwater quality previously conducted and to be periodically updated as part of the five-year GQTM characterization and reporting and GAR updates.

3.6.3 Coordinated Monitoring

Although not directly part of the GQTM network for the GDA Coalition region, there are additional GQTM network wells proposed for adjacent coalition regions (i.e., Westside San Joaquin Water Quality Coalition and Westlands Water Quality Coalition) that are located close to the GDA Coalition boundary and which also serve the objectives of the GQTM Program in tracking of regional groundwater quality trends related to agricultural practices. Collectively, the GQTM efforts being conducted by the GDA Coalition, along with those of the adjacent Coalitions, many of which are participating in the CVGMC, will help inform regional groundwater quality trends in the area.

3.6.4 Future and Ongoing GQTM Network Evaluation and Refinement

The GQTM well network is expected to be dynamic and the 2019 GQTM network update presented herein is part of an ongoing process of network development and refinement. The spatial representation of the GQTM well network will be evaluated on an annual basis with respect to the objectives of the program. Specific attention will focus on the adequacy of monitoring in areas where the direction and magnitude of temporal trends in groundwater quality suggest a consistent pattern that may be attributable to influences from irrigated agriculture. Recommendations will be made regarding potential addition, elimination, or substitution of wells. During GQTM implementation, efforts will be made to verify well construction information for any complementary wells being monitored by other entities (LSCE, 2018a), and if appropriate and beneficial, establish agreements to formally incorporate these wells into the GQTM network.

Although the GQTM network wells presented in this document represent the wells proposed for 2019 monitoring as part of the GQTM program, additional evaluation of candidate wells in several network well search areas is still ongoing. As noted above, well search efforts continue with focus on identifying additional network wells in the southwestern part of the Coalition in Monitoring Area 3 as shown on **Figure 6** and also in the southeastern part of the Coalition within Monitoring Area 5. The target depths for network wells in these areas continue to be based on consideration of the Upper Zone depth in combination with the depth to groundwater and depth from which beneficial users extract

groundwater. Focused outreach efforts and evaluation of available well information to identify suitable wells for the GQTM network will continue in these areas. As additional GQTM network wells are identified in these areas, they will be incorporated into the GQTM Program, including sampling and reporting efforts, as appropriate.

3.6.5 GQTM Sampling Timing

Future sampling of the GQTM network wells is planned to occur annually during the July time period, a shift in timing that has been discussed with the Regional Board. As indicated in the Workplan, all GQTM network wells will be sampled and tested for nitrate (as nitrogen), electrical conductivity, pH, dissolved oxygen, and temperature annually. At least every five years, the network wells will also be tested for additional constituents including TDS, carbonate, bicarbonate, chloride, sulfate, boron, calcium, sodium, magnesium, and potassium.

Table 10: Assessment of GQTM Network Sufficiency

Monitoring Area	Network Wells		2019 Network Wells by Section Monitoring Priority		Assessment of Monitoring Area Network Sufficiency
	Sampled 2018	Proposed 2019	V. Low-Medium	High-V. High	
Monitoring Area 1	1	1		1	One original network well from 2018 is in a high priority part of the monitoring area. The monitoring area encompasses approximately two square miles in the northwestern corner of the Coalition and the one network well is interpreted to be sufficient for monitoring this area.
Monitoring Area 2	1	1		1	Monitoring Area 2 contains one network well within a high priority section. There are a total of eight high or very high priority sections within the monitoring area, although the depth to the regional groundwater system is often deep in this area. To date, no additional network wells have been identified in this area. Efforts will continue to identify an additional suitable well for the network to monitor the two higher priority sections in the eastern part of Monitoring Area 2. Domestic water in this area is provided from surface water out of the San Luis Canal and treated by Panoche Water District.
Monitoring Area 3					No network wells were included in Monitoring Area 3 in 2018 and no suitable wells have been identified for addition to the network in 2019. Monitoring Area 3 remains a focus for ongoing search efforts to identify network wells. Domestic water in this area is provided from surface water.
Monitoring Area 4		1	1		The one original network well from 2018 in this monitoring area (GDA007) is being removed from the network due to it no longer being available for sampling. One suitable network well (GDA012) has been identified for addition in 2019 to provide representation of groundwater quality trends within Monitoring Area 4. Extensive efforts have been conducted to identify a suitable network well closer to where GDA007 was and all identified existing potential wells for monitoring in this area have been explored and evaluated. Well GDA012 is believed to be sufficient for representation of groundwater quality trends in this part of the Coalition. Domestic water in this area is provided from surface water.
Monitoring Area 5					No network wells were sampled in this monitoring area in 2018 and no suitable wells have been identified for addition to the network in 2019. This is a small monitoring area contains one medium, one high, and one very high priority section. Efforts will continue to identify suitable wells for monitoring in this area as part of the GQTM program.
Monitoring Area 6	1	1		1	One network well (GDA011) exists and was sampled in this monitoring area in 2018; GDA011 is located in a very high priority section. One well is believed to be sufficient for representation of groundwater quality trends in this part of the Coalition region.

Monitoring Area	Network Wells		2019 Network Wells by Section Monitoring Priority		Assessment of Monitoring Area Network Sufficiency
	Sampled 2018	Proposed 2019	V. Low-Medium	High-V. High	
Monitoring Area 7	1	1		1	One network well (GDA005) included in 2018 is located in a medium priority section in Monitoring Area 7 and one additional network well (GDA008) is being proposed in a high priority section in Monitoring Area 7. Monitoring Area 7 consists of two medium and six high priority sections and the combination of GDA005 and GDA008 are believed to be sufficient to represent groundwater quality trends in this part of the Coalition region. Domestic water in this area is provided from surface water out of the San Luis Canal and treated by Panoche Water District.
Monitoring Area 8		2		2	No wells were identified in this monitoring area for the 2018 network. One new network well (GDA014) is proposed as an addition to the network for 2019. GDA014 is in the one very high priority section in Monitoring Area 8. The one new network well is believed to be sufficient for representation of groundwater quality trends in this Monitoring Area, which encompasses five sections equal to about five square miles.
Monitoring Area 9	1	2		2	One network well (GDA003) was sampled in 2018 and is located between medium and very high priority sections; one additional network well is being proposed for 2019 in a high priority section in Monitoring Area 9. The two wells are believed to be sufficient for monitoring groundwater quality trends in this part of the Coalition region.
Monitoring Area 10		1		1	One well originally proposed for the network in 2018 (GDA006) is being removed from the network due to lack of access to the well for sampling. One new network well (GDA013) is being proposed for addition to the network in 2019 in a high priority section in the western part of Monitoring Area 10. Efforts to identify a suitable replacement well closer to the location of the removed 2018 network well (GDA006) will continue, although most or all existing potential wells for monitoring in this area have already been explored and evaluated. One domestic well in this area is known to be completed below the Corcoran Clay.
Other Coalition Areas	1	1		1	One network well from 2018 (GDA002) is not located within a delineated monitoring area although it is located in a high priority monitoring section and adjacent to the San Joaquin River Water Quality Improvement Project area and provides associated groundwater quality trend monitoring representation in this area. Most of the other areas outside of the delineated monitoring areas are retired lands on which no irrigated agriculture occurs.
Totals:	**6**	**11**	**1**	**10**	

4 ADDITIONAL ANNUAL REPORTING REQUIREMENTS

Several additional elements identified in the MRP as being required as part of annual reporting on monitoring activities are noted and discussed below briefly, as they may relate specifically to groundwater monitoring activities, with cross-references provided to other documents where items are addressed.

4.1 Summary of Nitrogen Management Plan Information

A summary of Nitrogen Management Plan information submitted to the GDA Coalition is contained in a separate and accompanying document *Summary of Nitrogen Management Plan Information* prepared by MLJ Environmental.

4.2 Summary of Management Practice Information from Farm Evaluations

A summary of management practice information from Farm Evaluations is contained in a separate and accompanying document *Summary of Management Practice Information Collected from Farm Evaluations and Managed Wetland Evaluations for 2017 Growing Season* prepared by Summers Engineering.

4.3 Summary of Mitigation Monitoring

To date, no mitigation monitoring has been conducted as part of the GQTM program. See the Annual Monitoring Report for discussion of mitigation monitoring activities conducted by the Coalition.

4.4 Summary of Education and Outreach Activities

The GDA Coalition has conducted education and outreach activities specifically for the GQTM program during 2018 utilizing a variety of methods. These include the following:

- Discussion of the program objectives and need for well volunteers for the GQTM network with Coalition district entities including during monthly meetings of the Grassland Basin Drainers Steering Committee and through direct contacts with district representatives
- Direct communication with well owners or Coalition grower members through phone calls, emails, and during well site visits to discuss the GQTM program and objectives and need for well owner participation
- Annual meetings where the nitrogen planning requirements, trend monitoring program and future domestic well monitoring are presented to farmers.

Additional outreach activities specifically to GQTM network well owners were conducted in September 2019 to communicate results from the Fall 2018 GQTM sampling event and notify well owners of any MCL exceedances identified during the previous sampling event. Furthermore, future communication of sampling results to GQTM network well owners who are also Coalition members, will incorporate reference to the Coalition's Groundwater Quality Management Plan, where management practices intended to protect groundwater quality are identified, and also provide any other relevant guidance to comply with the ILRP requirements.

The Annual Monitoring Report includes discussion of all education and outreach activities conducted by the Coalition over the reporting period.

4.5 Electronic Data Submittal and Data Uploaded to Geotracker

In accordance with the requirements for reporting of annual groundwater monitoring results, an electronic data submittal is being provided to accompany this report. Included in the electronic data submittal are the following items:

- Excel worksheet containing export of data uploaded to Geotracker
- Excel worksheet containing:
    - Summary table of information on 2018 GQTM network wells, including latitude and longitude information
    - Summary table of results from Fall 2018 GQTM sampling event in tabular form
    - Summary sheet of laboratory analytical methods
    - Summary table of information on 2019 GQTM network wells, including latitude and longitude information
- GIS shapefile dataset with locations of 2018 GQTM network wells and locations of wells proposed for 2019 GQTM sampling
- Field forms for Fall 2018 GQTM sampling event
- Laboratory analytical report files including chain of custody forms and laboratory narrative of QC failures and identification of any analytical problems and anomalies

5 CONCLUSIONS AND RECOMMENDATIONS

The Fall 2018 GQTM sampling event was successfully completed with six of the eight GQTM wells being sampled. During the sampling event it was determined that two wells originally proposed as part of the GQTM network are no longer available for sampling and as a result are being removed from the network for future sampling events. Water quality results from the 2018 sampling indicate two wells with nitrate concentrations above the MCL and all wells with varying degrees of high concentrations of other dissolved constituents, especially TDS, sulfate, chloride, and boron, consistent with the natural high salinity groundwater conditions in the area. Insufficient data are available for evaluating trends and patterns in groundwater quality at this point in the GQTM program implementation. In accordance with the GDA GQTM Workplan and the CVGMC Workplan, such evaluations will be conducted at five-year intervals starting in reporting on the first five years of GQTM data. Letters summarizing the Fall 2018 sampling results for individual wells and noting any identified water quality exceedances were prepared and transmitted to all GQTM network well owners in September 2019. Additional communication by the Coalition with owners of network wells exhibiting nitrate exceedances will continue to make well owners aware of management practices contained in the Coalition's Groundwater Quality Management Plan or other management practices intended to protect groundwater quality.

Five additional network wells have been identified for inclusion in the network for 2019 making eleven wells in the proposed GQTM network for 2019. Due to the highly saline character of groundwater in the GDA there is limited reliance on groundwater in the Coalition region; therefore, a limited number of

available wells, especially wells of relatively shallow depth, are suitable for the GQTM program. This makes identifying additional GQTM network wells challenging. Nevertheless, several well search areas remain and the GDA Coalition should continue efforts to identify suitable network wells in these areas, particularly in the southwestern part of the Coalition region.

A number of items have been identified in the quality assurance evaluation that can be improved or corrected during future GQTM sampling events to better comply with protocols and procedures outlined in the QAPP, including improved consistency and thoroughness in completing field forms and sufficient field blank analytical testing in accordance with the QAPP. However, none of these issues have been determined to affect the reliability or usability of the data obtained as part of the Fall 2018 sampling event. The 2019 sampling is planned for June 2019 and the improvements identified as part of the quality assurance evaluation will be discussed with field sampling personnel prior to and in preparation for the next sampling event.

6 REFERENCES

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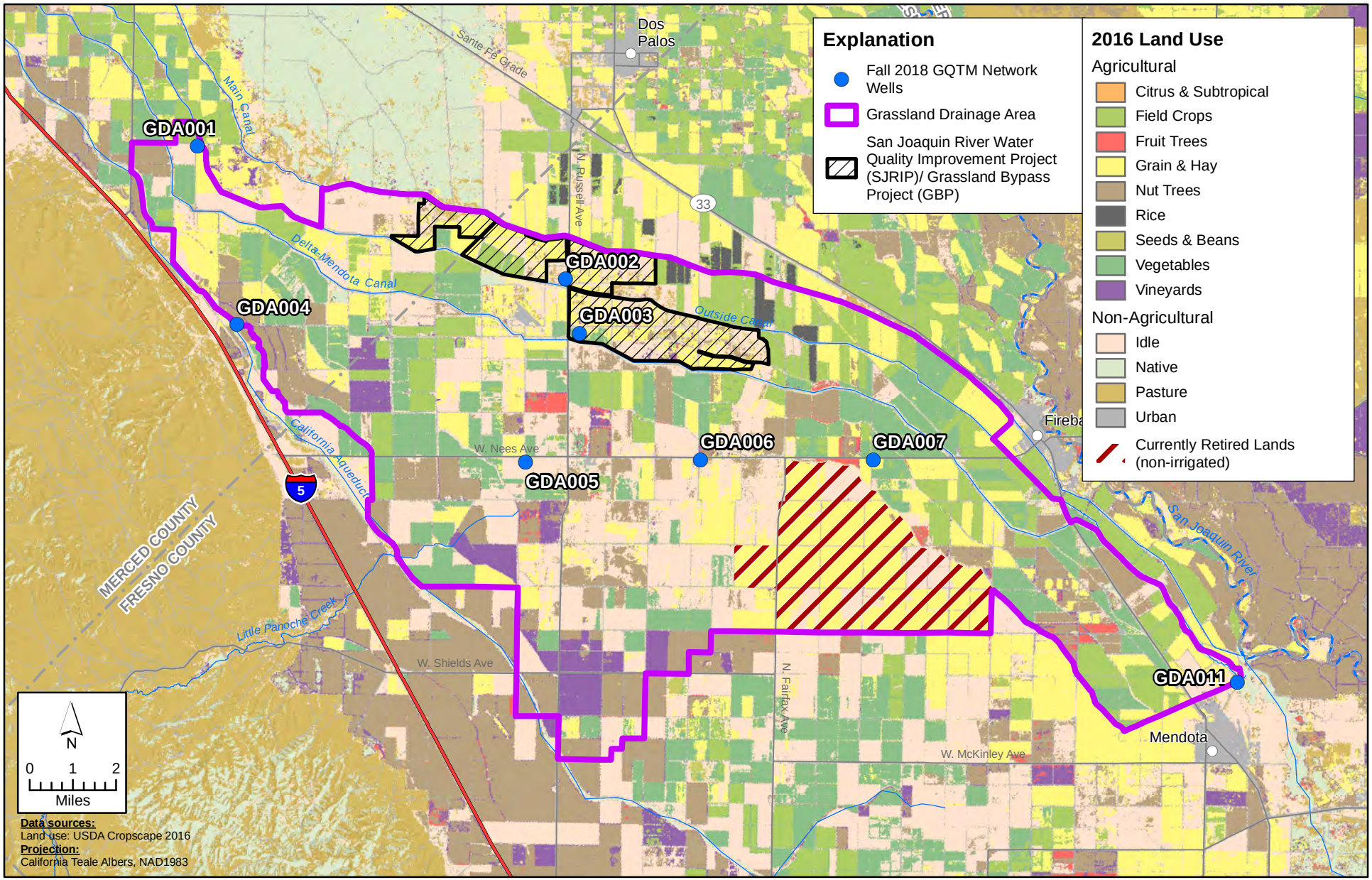
Map Figures



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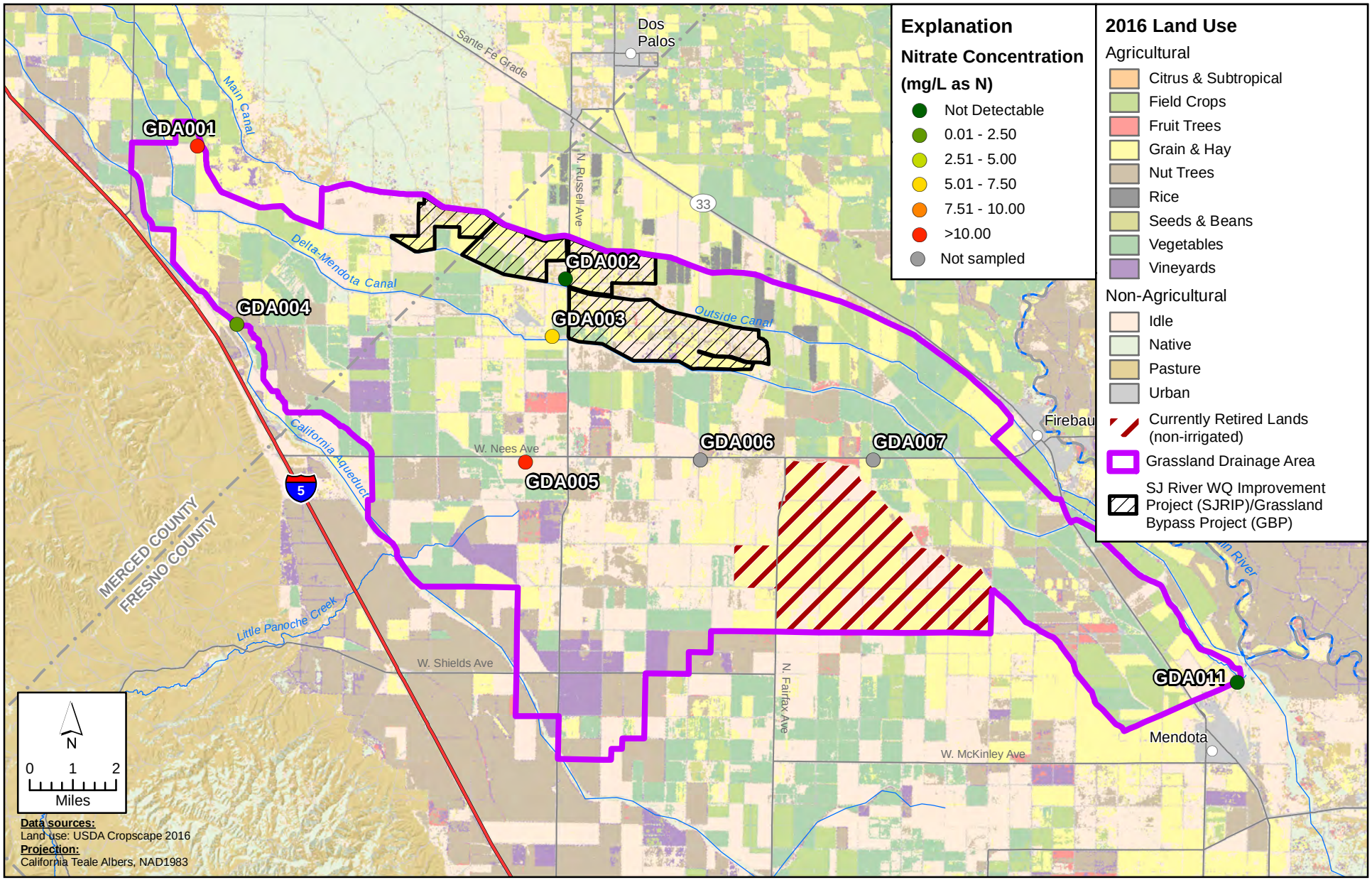
Luhdorff & Scalmanini
Consulting Engineers

FIGURE 1
Fall 2018 GQTM Network Wells with Major Land Use Types

Groundwater Quality Trend Monitoring
Grassland Drainage Area



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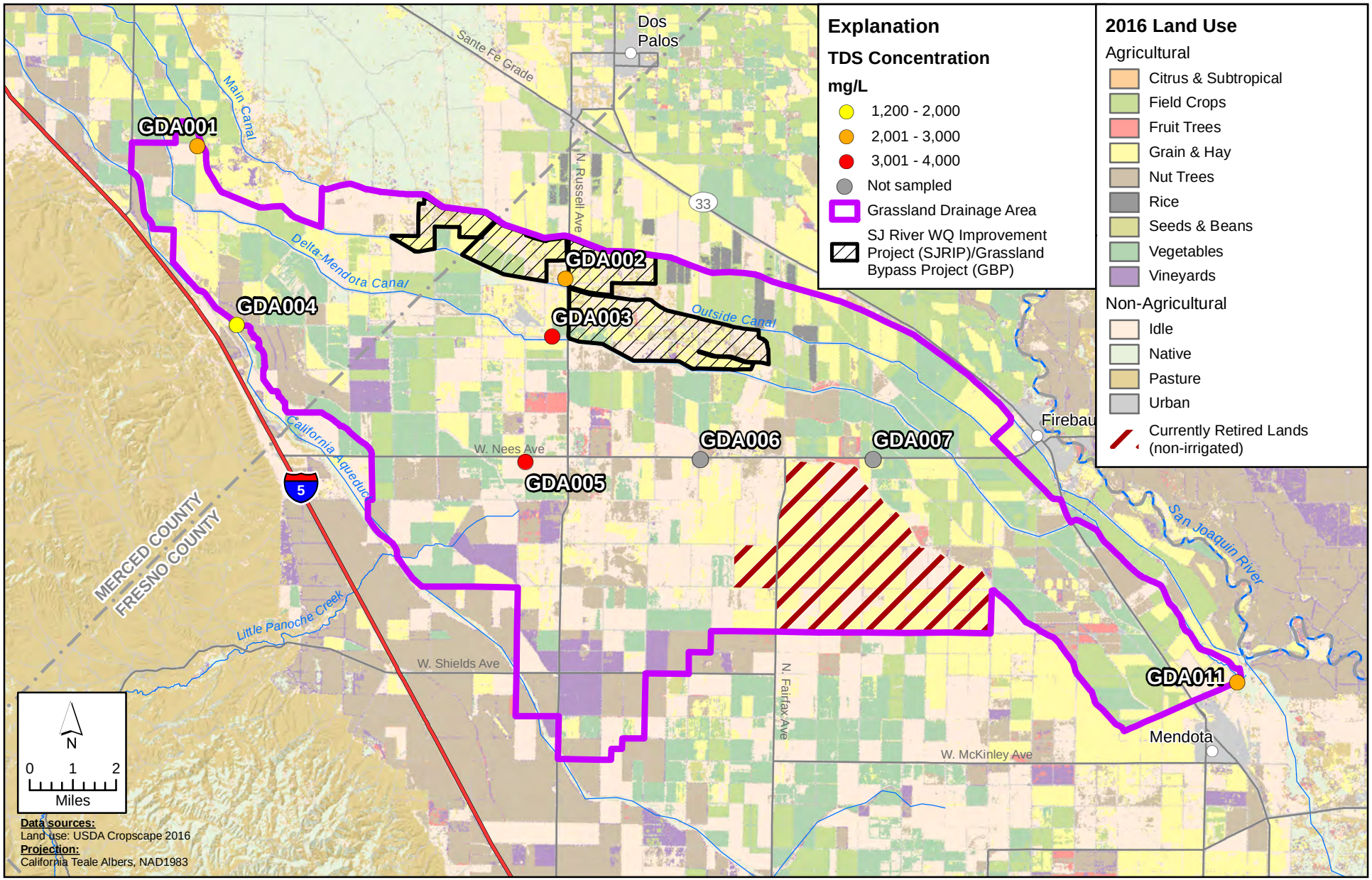
Luhdorff & Scalmanini
Consulting Engineers

FIGURE 4

Fall 2018 GQTM Nitrate Concentrations with Major Land Use Types

Groundwater Quality Trend Monitoring
Grassland Drainage Area



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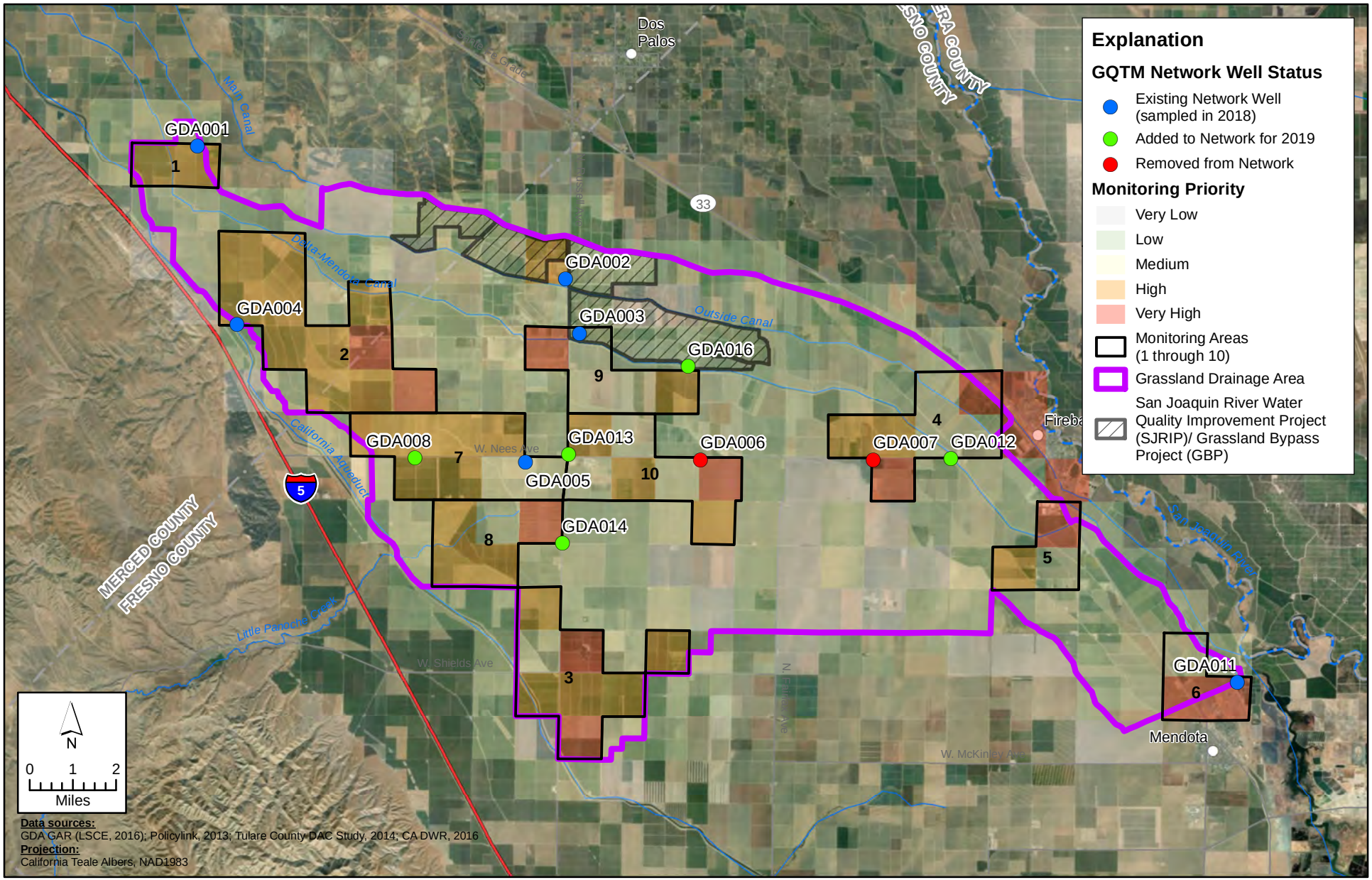
Consulting Engineers

FIGURE 5

Fall 2018 GQTM TDS Concentrations with Major Land Use Types

Groundwater Quality Trend Monitoring
Grassland Drainage Area



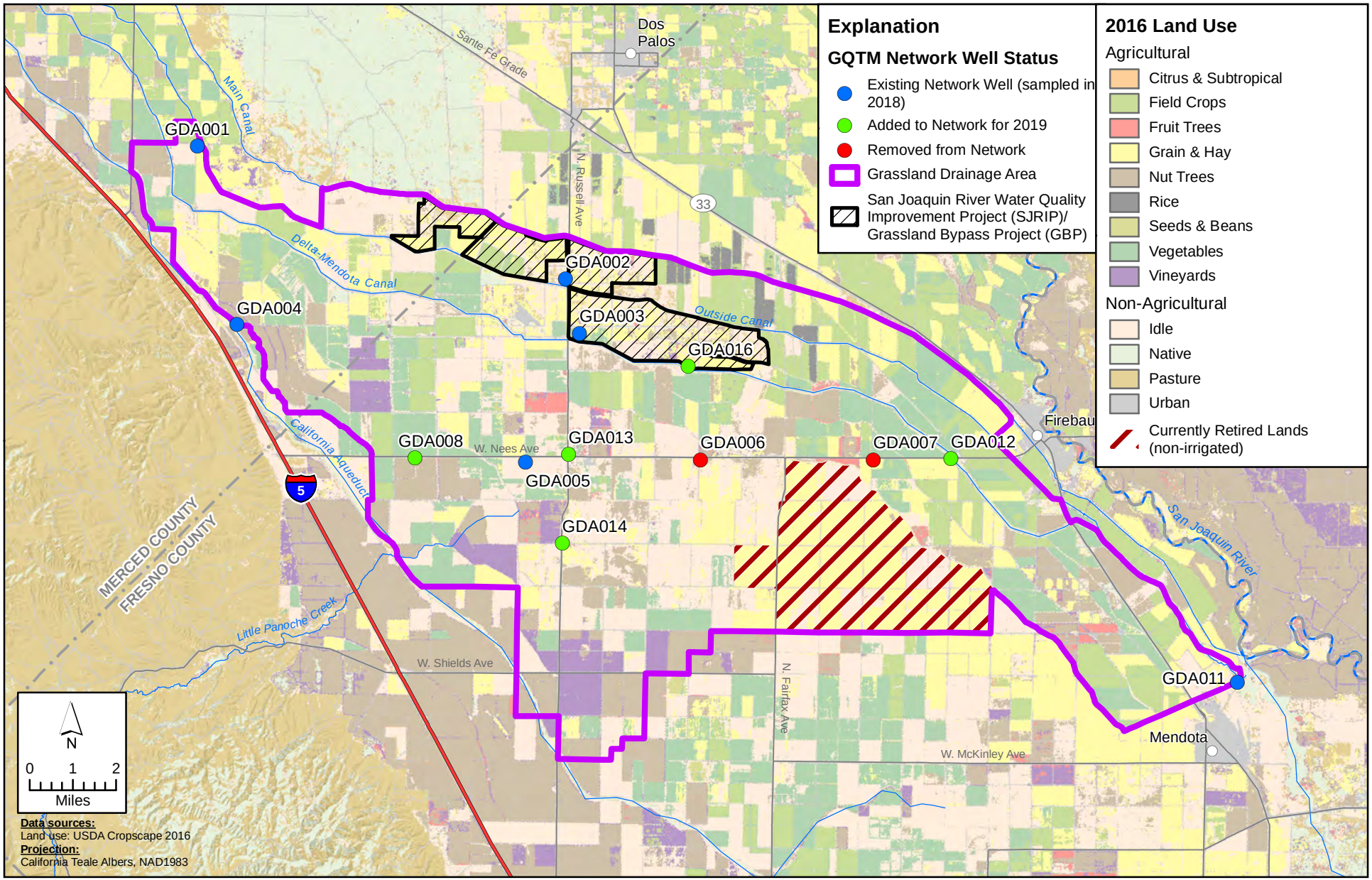
X:\2018\18-148 SLDMWA - GDA 2019 ILRP Technical Support\GIS\Figure 6 GDA Annual Report 2018_GQTM Network Update Wells 2019.mxd

Luhdorff & Scalmanini
Consulting Engineers

FIGURE 6

2019 GQTM Well Network Update

Groundwater Quality Trend Monitoring
Grassland Drainage Area



X:\2018\18-148 SLDMWA - GDA 2019 ILRP Technical Support\GIS\Figure 7 GDA Annual Report 2018_GQTM Network Update Wells 2019 Landuse 2016.mxd

Luhdorff & Scalmanini
Consulting Engineers

FIGURE 7
2019 GQTM Well Network Update with Major Land Use Types
Groundwater Quality Trend Monitoring
Grassland Drainage Area

Appendix A:
Well Completion Reports for GQTM Network Wells

This appendix presents supplemental information about the proposed GQTM network wells, including available Well Completion Reports or other well construction documentation for the network wells.

GDA001

ORIGINAL
File with DWR

11/11-30

Page ___ of ___

Owner's Well No. _____

Date Work Began June 16, 1993 Ended _____

Local Permit Agency Merced Co. Health Dept.

Permit No. 93-120 DO Permit Date _____

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 426375

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER 17 (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	1	Top Soil
1	86	Clay
86	89	Sand
89	113	Clay
113	114	Sand & Small Gravel
114	134	Clay
134	145	Clay & Shale
145	160	Clay

UNCONFINED

TOTAL DEPTH OF BORING 160 (Feet)

TOTAL DEPTH OF COMPLETED WELL 116 (Feet)

Address Woo & Cotton Gin Rds.

City Los Banos

County Merced

APN Book ___ Page ___ Parcel ___

or Township ___ Range ___ Section ___

or Latitude ___ ' ' NORTH (DEG. MIN. SEC.) Longitude ___ ' ' WEST (DEG. MIN. SEC.)

LOCATION SKETCH

NORTH

WEST

EAST

SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.
PLEASE BE ACCURATE & COMPLETE

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

X Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Mud Rotary FLUID Bentonite/Water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL _____ (Ft.) & DATE MEASURED _____

ESTIMATED YIELD* _____ (GPM) & TEST TYPE _____

TEST LENGTH _____ (Hrs.) TOTAL DRAWDOWN _____ (Ft.)

* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	76	12	X				PVC	6"	160sch	
76	116	12		X			PVC	6"	160sch	Screen

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	55		X		
55	116			X	Sand/Gravel

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other _____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME HENNINGS BROS. DRILLING CO., INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 3525 PELANDALE AVE. CITY MMODESTO STATE CA ZIP 95356

Signed Catharine Wengel
WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED July 19, 1993

C-57 LICENSE NUMBER 290813

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

GDA002

*The free Adobe Reader may be used to view and complete this form. However, software must be purchased to complete, save, and reuse a saved form.

File Original with DWR

Page 1 of 1

Owner's Well Number

Date Work Began 01/02/2013 Date Work Ended 1/3/2013

Local Permit Agency Fresno County Environmental Health Department

Permit Number WP0031650 Permit Date 12/20/12

State of California

Well Completion Report

Refer to Instruction Pamphlet

No. e0167974

DWR Use Only – Do Not Fill In

12S/12E-04 1/3

State Well Number/Site Number

N Latitude W Longitude

APN/TRS/Other

Geologic Log

Orientation ⦿ Vertical ○ Horizontal ○ Angle Specify

Drilling Method Direct Rotary Drilling Fluid Bentonite mud

Depth from Surface Feet	to Feet	Description Describe material, grain size, color, etc
0	3	Top Soil
3	5	Clay
5	15	Clay Sandy
15	16	Clay
16	29	Sand Clayey
29	31	Sand
31	37	Clay Sandy
37	39	Sand Clayey
39	40	Sand
40	43	Clay Sandy
43	134	Clay
134	136	Sand Clayey
136	139	Sand
139	141	Clay Sandy
141	183	Clay
183	191	Clay Sandy
191	194	Sand Clayey
194	196	Clay Sandy
196	198	Sand Clayey
198	204	Sand
204	210	Sand Clayey
210	212	Clay Sandy
212	220	Sand
220	223	Clay Sandy
223	227	Sand
		Yield: Strong
		TDS: 1400 mg/l

Total Depth of Boring 227 Feet

Total Depth of Completed Well 220 Feet

Well Owner

Na

Ma

Ci

Well Location

Address Same

City County Fresno

Latitude Deg. Min. Sec. N Longitude Deg. Min. Sec. W

Datum WGS84 Decimal Lat. 36.610401 Decimal Long. -120.6555

APN Book 004 Page 060 Parcel 30

Township 12S Range 12E Section 4

Location Sketch

(Sketch must be drawn by hand after form is printed.)

North

West East

South

Illustrate or describe distance of well from roads, buildings, fences, rivers, etc. and attach a map. Use additional paper if necessary. **Please be accurate and complete.**

Activity

⦿ New Well

○ Modification/Repair

○ Deepen

○ Other

○ Destroy

Describe procedures and materials under "GEOLOGIC LOG"

Planned Uses

⦿ Water Supply

☑ Domestic ☐ Public

☐ Irrigation ☐ Industrial

○ Cathodic Protection

○ Dewatering

○ Heat Exchange

○ Injection

○ Monitoring

○ Remediation

○ Sparging

○ Test Well

○ Vapor Extraction

○ Other

Water Level and Yield of Completed Well

Depth to first water (Feet below surface)

Depth to Static Water Level 61 (Feet) Date Measured 01/03/2013

Estimated Yield * (GPM) Test Type Air Lift

Test Length 1.0 (Hours) Total Drawdown (Feet)

*May not be representative of a well's long term yield.

Casings

Depth from Surface Feet	to Feet	Borehole Diameter (Inches)	Type	Material	Wall Thickness (Inches)	Outside Diameter (Inches)	Screen Type	Slot Size if Any (Inches)
0	80	9 7/8	Blank	PVC	SDR 26	5		
80	160	9 7/8	Blank	PVC	SDR 21	5		
160	200	9 7/8	Blank	PVC	SDR 17	5		
200	220	9 7/8	Screen	PVC	SDR 21	5	Milled Slots	0.032

Annular Material

Depth from Surface Feet	to Feet	Fill	Description
0	180	Bentonite	Grout
180	220	Filter Pack	#12X20

Attachments

☐ Geologic Log

☐ Well Construction Diagram

☐ Geophysical Log(s)

☐ Soil/Water Chemical Analyses

☑ Other Plot Plan

Attach additional information, if it exists.

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name Dos Palos Well Dr illing

Person, Firm or Corporation

2028 Blossom Street Dos Palos CA 93620

Address City State Zip

Signed Michael J. Merriman 01/11/2013 471586

C-57 Licensed Water Well Contractor Date Signed C-57 License Number

DWR 188 REV. 1/2006

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Property Lines
Septic System
148'
New Well 36.910401° -120.655566°
Failed Well
25'
122'
Septic System
Google earth
Imagery Date: 9/27/2012 1998
lat 36.910435° lon -120.655170° elev 148 ft
Eye alt 519 ft

125/126-04
2/3

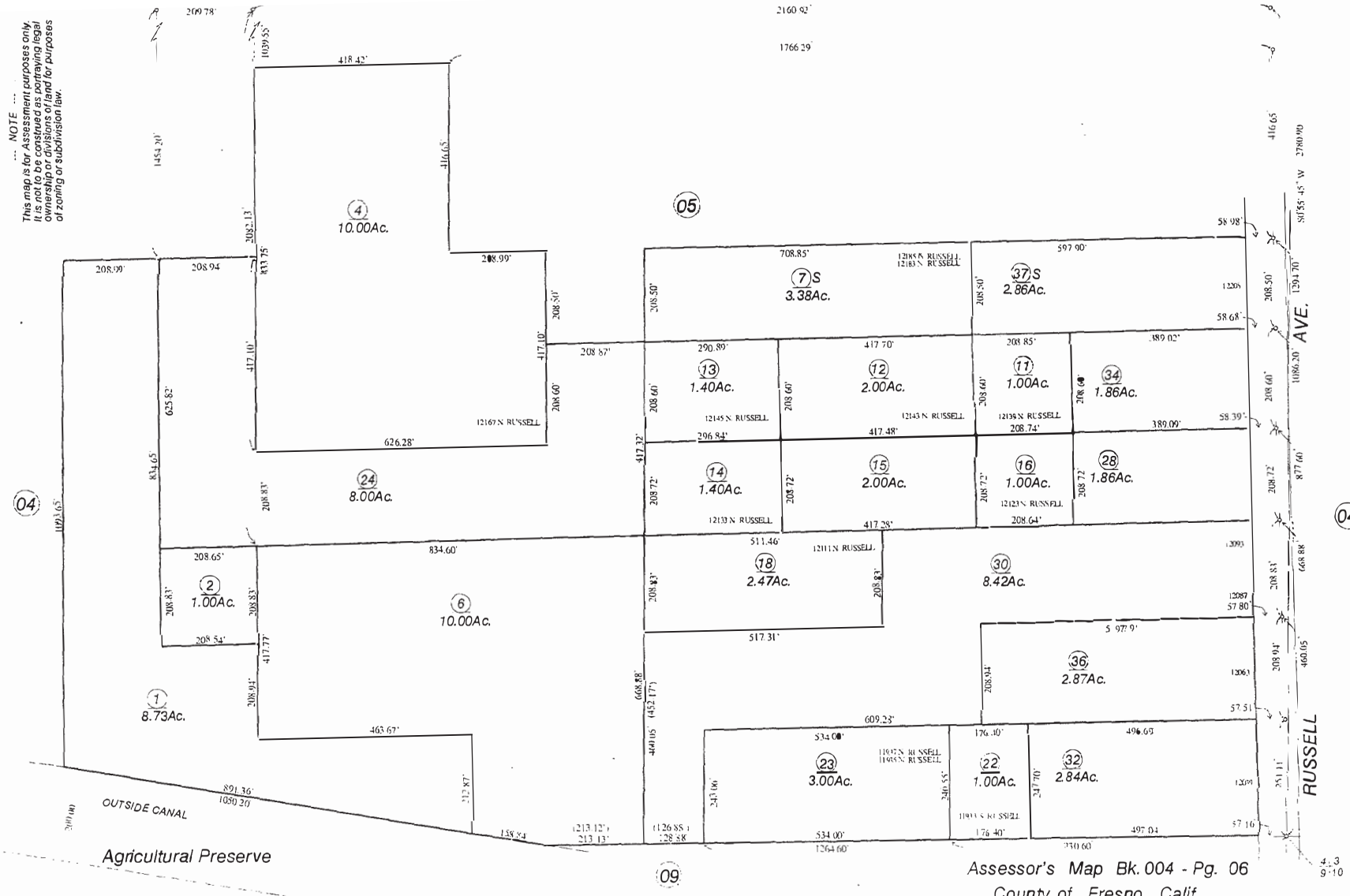
SL'Y. POR. S.E. 1/4 SEC. 4 T.12 S., R.12 E., M.D.B.& M.

Tax Rate Area
84-018

004-06

1" = 200'

... NOTE ...
This map is for Assessment purposes only. It is not to be construed as portraying legal ownership or divisions of land for purposes of zoning or subdivision law.



Assessor's Map Bk. 004 - Pg. 06
County of Fresno, Calif.

NOTE - Assessor's Block Numbers Shown in Ellipses.
Assessor's Parcel Numbers Shown in Circles.

04-20-2006

125/126-04 3/3

GDA003

ORIGINAL
File with DWR 12/12-9

Page 1 of 1

Owner's Well No. _____

Date Work Began 4-18-94, Ended 4-21-94

Local Permit Agency Fresno County

Permit No. 16255 Permit Date 4-4-94

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 574338

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER _____ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc*
0	3	Top Soil
3	18	Brown Clay
18	20	Sand
20	50	Brown Clay
50	80	Brown Clay
80	83	Sand
83	210	Clay
210	214	Sand
214	280	Clay
280	287	Meduim Fine Sand
287	310	Clay
310	318	Sand
318	338	Clay
338	345	Sand
345	357	Clay
357	364	Sand
364	410	Clay
410		Stop

TOTAL DEPTH OF BORING 410 (Feet)

TOTAL DEPTH OF COMPLETED WELL 400 (Feet)

WELL OWNER

Name _____

Mailing Address _____

CITY STATE ZIP

WELL LOCATION

Address 100' North of Althea, ½ Mile West of Russell

City _____

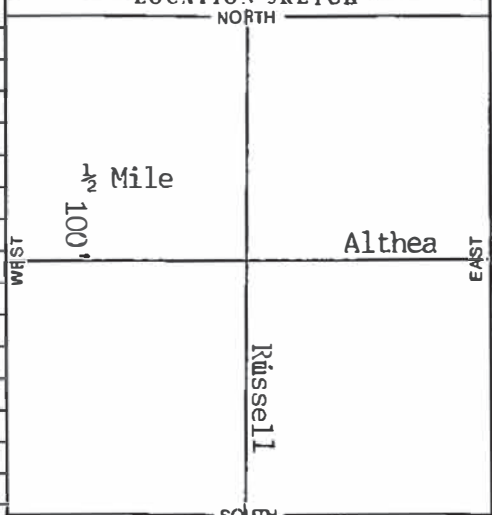
County Fresno

APN Book 04 Page 09 Parcel 36

or Township 12 S Range 12 E Section 9

or Latitude ___ DEG ___ MIN. ___ SEC. NORTH Longitude ___ DEG. ___ MIN. ___ SEC. WEST

LOCATION SKETCH



Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.
PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

___ Domestic

___ Public

X Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Reverse FLUID _____

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL _____ (Ft.) & DATE MEASURED _____

ESTIMATED YIELD* _____ (GPM) & TEST TYPE _____

TEST LENGTH _____ (Hrs.) TOTAL DRAWDOWN _____ (Ft.)

** May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	50	44"			X		Steel	36"	5/16	
0	270	28"	X				Steel	16"	¼"	
270	300	28"		X			Steel	16"	¼"	Ful Flo
300	390	28"		X			Steel	16"	¼"	Std Perf
390	400	28"	X				Steel	16"	¼"	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50	XX			
0	180			XX	5/16 X 2
200	170		XX		
200	410			XX	5/16 X 2

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other _____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Myers Bros. Well Drilling, Inc. RV 2
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 8650 E. Lacey Blvd. Hanford, CA 93230
CITY STATE ZIP

Signed Carla Farrell
WELL DRILLER/AUTHORIZED REPRESENTATIVE

4-15-94
DATE SIGNED

548214
C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

GDA004

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No. E0173400

DWR USE ONLY - DO NOT FILL IN
STATE WELL NO / STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. PACHECO WELL
Date Work Began 12/12/2013 Date Completed 12/13/2013
Local Permit Agency MERCED
Permit No 13-658IR Permit Date 10/31/2013

GEOLOGIC LOG

ORIENTATION: Vertical

DRILLING METHOD Rotary Reverse FLUID

Depth from Surface Ft.	to Ft.	DESCRIPTION
0	5	TOP SOIL
5	36	BROWN CLAY
36	72	BROWN MEDIUM SAND
72	96	BROWN CLAY
96	140	BROWN MEDIUM SAND
140	205	BLUE CLAY

N36 53.645 W120 47.576

TOTAL DEPTH OF BORING: 205 Ft.
TOTAL DEPTH OF COMPLETED WELL 140 Ft.

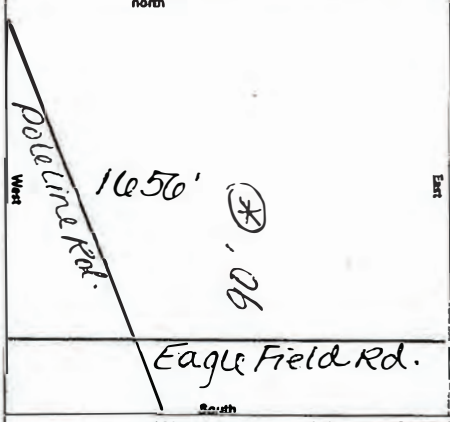
WELL OWNER

Name Pacheco Wa.
Mailing Address
City, St, Zip

WELL LOCATION

Address EAGLE FIELD RD & POLIELINE RD
City, St, Zip , CA County: Merced
APN Book 090 Page 130 Parcel 057
Latitude Longitude
Township 12 Range 11 Section 8

LOCATION SKETCH



ACTIVITY

New Well

PLANNED USES

Irrigation Water Supply

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ FT. BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ___ DATE MEASURED
ESTIMATED YIELD* ___ GPM TEST TYPE
TEST LENGTH (hrs.) TOTAL DRAWDOWN ___ Ft.

* May not be representative of a well's long-term yield

Casings

Depth from Surface Feet	to Feet	Borehole Diameter (Inches)	Type	Material	Thickness (Inches)	Diam (Inches)	Screen Type	Slot (Inches)
0	50	18"	Blank	Steel	1/4"	8"		
50	80	18"	Screen	Steel	1/4"	8"	Louver	.070
80	100	18"	Blank	Steel	1/4"	8"		
100	140	18"	Screen	Steel	1/4"	8"	Louver	.070

Annular Material

Depth from Surface Feet	to Feet	Fill	Description
0	20	Concrete	11 SACK MIX
20	140	Fill	8X16 & 1/4X10

ATTACHMENTS

- [ ] Geologic Log
- [ ] Well ConstructionDiagram
- [ ] Geophysical Log(s)
- [ ] Soil/Water Chemical Analysis
- [ ] Other

CERTIFICATION STATEMENT

NAME MYERS BROS. WELL DRILLING INC.
ADDRESS 8650 E. LACEY BLVD HANFORD, CA 93230

Signed Kimberly Dias Date 12/17/2013
Well Driller/Authorized Representative

548214
C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Confidential - Not for public use. Water Code Section 13752

GDA005

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. _____

Date Work Began 1/22/08 Ended 1/23/08

Local Permit Agency FCHD

Permit No. WP0028145 Permit Date 1/18/08

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 1095504

DWR USE ONLY — DO NOT FILL IN
12S/12E-33 1/2
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ROTARY FLUID BONT

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*	
0	TOP SOIL	
3	CLAY	TOP SOIL
5	GRAVEL COARSE	CLAY
10	CLAY	GRAVEL
13	— GRAVELLY	CLAY
17	SAND + GRAVEL	CLAY
40	—	SAND
46	GRAVEL COARSE	SAND
51	SAND + GRAVEL	SAND
55	CLAY	SAND
59	GRAVEL COARSE	
62	CLAY	
66	— SANDY + GRAVELLY	
74	GRAVEL COARSE	
84	CLAY	
90	— SANDY	
97	—	
99	SAND COARSE	
115	CLAY GRAVELLY	
117	— SANDY	
124	—	
130	GRAVEL COARSE	
136	SAND + GRAVEL	
146	CLAY SANDY	
149	—	
157	SAND + GRAVEL	
168	CLAY SANDY + GRAVELLY	
176	CLAY	
181	— SANDY + GRAVEL	

All Blown Clays

TOTAL DEPTH OF BORING 200' (Feet)

TOTAL DEPTH OF COMPLETED WELL 190' (Feet)

WELL OWNER

WELL LOCATION

Address 48845 W. NEES

City SANGER

County FRESNO

APN Book 005 Page 150 Parcel 08

Township 12 Range 12 Section 33

Lat ___ N DEG. MIN. SEC. Long ___ W DEG. MIN. SEC

~~LOCATION SKETCH~~

NORTH

TDS

4500 MG/L

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER _____ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 8 (Ft.) & DATE MEASURED 1/28/08

ESTIMATED YIELD* SMALL (GPM) & TEST TYPE AIR LIFT

TEST LENGTH 6 (Hrs.) TOTAL DRAWDOWN _____ (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 80	9 7/8	✓				PVC	5	SDR26	
80 130	—	—				—	—	— 21	
130 190	—		—			—	—	— —	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 110		✓		
110 190				#12x20

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
✓ Other PLOT PLAN

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

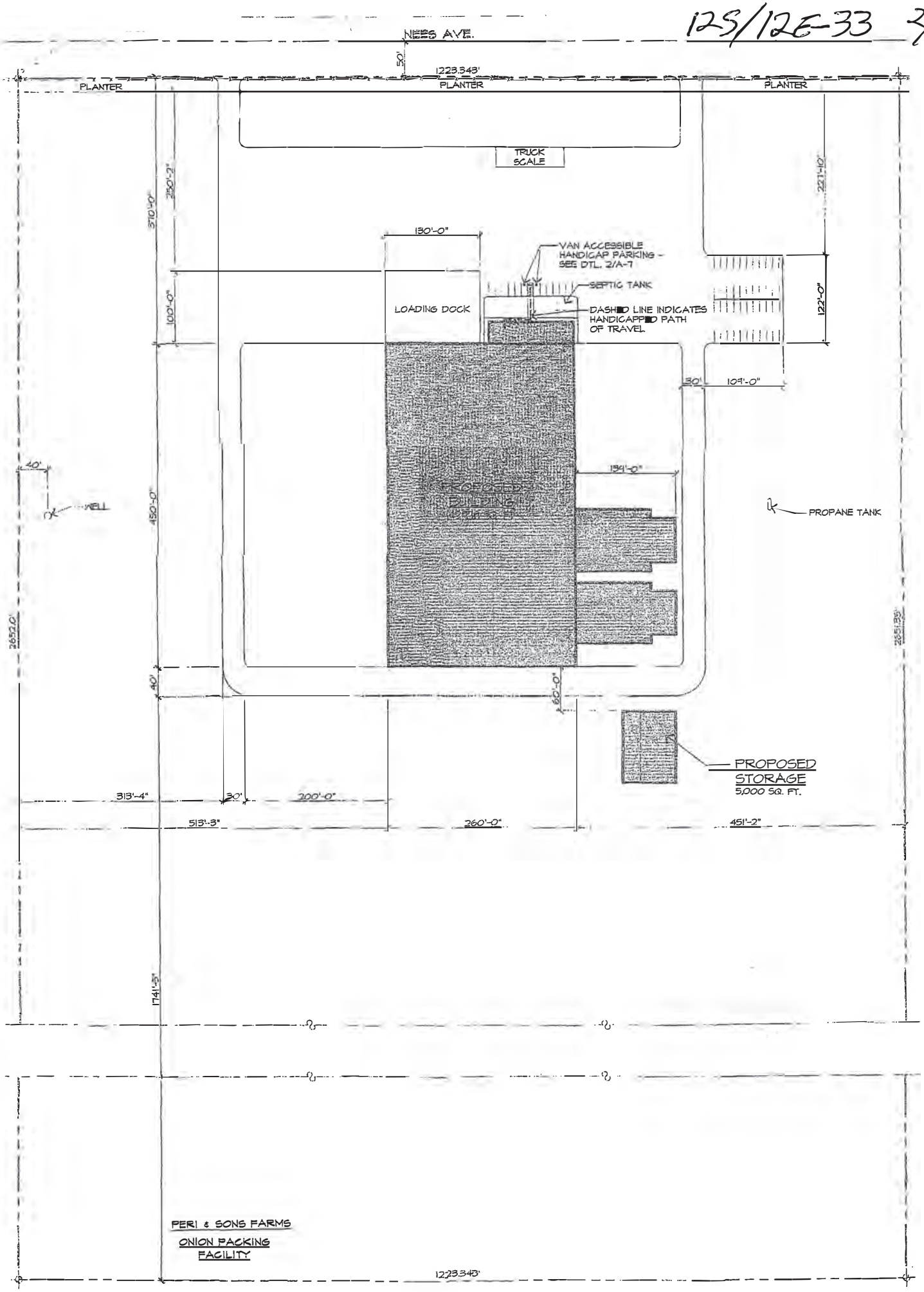
NAME DOS PALOS WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2028 BLOSSOM DOS PALOS CA 93620
ADDRESS CITY STATE ZIP

Signed _____ 1/31/08 471586
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM OSP 03 78836

125/12E-33 2/2



PERI & SONS FARMS

ONION PACKING FACILITY

GDA006 - REMOVED FROM NETWORK

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 783270

DWR USE ONLY — DO NOT FILL IN
125/13E-31
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. FC-7
Date Work Began 9/1/00 Ended 9/2/00
Local Permit Agency FRESNO COUNTY ENV. HEALTH
Permit No. 20146 Permit Date 8/30/00

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD MUD ROTARY FLUID WATER

DEPTH FROM SURFACE Ft	to Ft	DESCRIPTION *Describe material, grain size, color, etc.*
0	5	TOPSOIL, CLAY
5	90	CLAY
90	120	MEDIUM SANDS
120	130	FINE TO MEDIUM SANDS
130	145	FINE SANDS
145	153	MOSTLY CLAY W/FEW FINE SANDS

TOTAL DEPTH OF BORING 153 (Feet)
TOTAL DEPTH OF COMPLETED WELL 104 (Feet)

WELL OWNER

WELL LOCATION

Address NEES & BRANNON S/E CORNER
City FIREBAUGH
County FRESNO
APN Book 006 Page 210 Parcel 09
Township 12S Range 13E Section 31D
Latitude ___ DEG. ___ MIN. ___ SEC. NORTH Longitude ___ DEG. ___ MIN. ___ SEC. WEST

LOCATION SKETCH

NORTH
WEST EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USES (✓)
WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING X
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___
ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	84	10 5/8	X				SCH40 PVC	4		
84	104	10 5/8		X			SCH 40 PVC	4		

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	74	X			
74	80		X		
80	104			X	SAND

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME BRADLEY & SONS
(PERSON, FIRM, CORPORATION) (TYPED OR PRINTED)

ADDRESS 17702 BALDWIN CITY MADERA STATE CA ZIP 93638

Signed Deborra L. Dunn
WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED 9/26/00 C-57 LICENSE NUMBER 414178

DWR 188 REV 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

GDA007 - REMOVED FROM NETWORK

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 783272 M

DWR USE ONLY — DO NOT FILL IN
12S/13E-35
STATE WELL NO./STATION NO
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. FC-5
Date Work Began 9/5/00 Ended 9/6/00
Local Permit Agency FRESNO COUNTY ENV. HEALTH
Permit No. 20145 Permit Date 9/1/00

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD MUD ROTARY FLUID WATER

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	5	TOPSOIL (CLAY)
5	25	CLAY
25	30	MOSTLY CLAY W/SOME SANDS
30	90	CLAYS
90	100	MOSTLY CLAY W/SOME FINE SANDS
100	150	CLAY

TOTAL DEPTH OF BORING 150 (Feet)
TOTAL DEPTH OF COMPLETED WELL 122 (Feet)

WELL LOCATION

Address S/E CORNER OF NEES & JERROLD
City FIREBAUGH
County FRESNO
APN Book 006 Page 190 Parcel 01
Township 12S Range 13E Section 35D
Latitude ___ DEG. ___ MIN. ___ SEC NORTH Longitude ___ DEG ___ MIN ___ SEC WEST

LOCATION SKETCH

NORTH
WEST EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USES (✓)

WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING X
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___
ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	102	10 5/8	X				SCH40 PVC	4		
102	122	10 5/8		X			SCH40 PVC	4		

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	95	X			
95	98		X		
98	122			X	SAND

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME BRADLEY & SONS
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 17702 BALDWIN CITY MADERA STATE CA ZIP 93638

Signed Deborah Dunn
WELL DRILLER/AUTHORIZED REPRESENTATIVE
DATE SIGNED 9/26/00
C-57 LICENSE NUMBER 414178

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

GDA008

ORIGINAL
File with DWR

12/11-36

Page 1 of 1

Owner's Well No. _____

Date Work Began 11-17-92 Ended 11-18-92

Local Permit Agency FRESNO COUNTY

Permit No. 15113 Permit Date 11-12-92

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 410008

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc*
1	TOP SOIL 245 - GRAVEL CLAY
2	CLAY
40	GRAVEL
45	CLAY
58	GRAVEL
61	GRAVEL CLAY
65	CLAY
67	CLAY + GRAVEL
69	GRAVEL
77	CLAY
92	GRAVEL + SAND
116	CLAY
120	GRAVEL
127	CLAY
131	GRAVEL CLAY
133	GRAVEL
145	CLAY
150	GRAVEL
157	SAND CLAY
162	GRAVEL CLAY
163	GRAVEL
164	CLAY
172	SAND CLAY
177	GRAVEL
187	CLAY
195	GRAVEL
200	CLAY
205	GRAVEL
212	CLAY
227	CLAY, GRAVEL

UNCONFINED

TOTAL DEPTH OF BORING 245 (Feet)

TOTAL DEPTH OF COMPLETED WELL 230 (Feet)

WELL OWNER

WELL LOCATION

Address 51579 W NEES

City LINEBAUGH

County FRESNO

APN Book 5 Page 130 Parcel 17

or Township 12S Range 11E Section 36

or Latitude ___ DEG. ___ MIN. ___ SEC. NORTH Longitude ___ DEG. ___ MIN. ___ SEC. WEST

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc
PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

✓ Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD ROTARY FLUID BENTONITE

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 30 (Ft.) & DATE MEASURED 12-1-92

ESTIMATED YIELD* 150 (GPM) & TEST TYPE AIR LIFT

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN <100 (Ft.)

** May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	100	9 7/8	✓				PVC	5	SDR 26	
100	170	✓	✓				✓	✓	SDR 21	
170	230	✓		✓			✓	✓	✓	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	140		✓		
140	230+			✓	#8-20

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

✓ Other PLOT PLAN

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME DOS PALOS WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2028 BLOSSOM ADDRESS — DOS PALOS CITY — CA STATE — 93620 ZIP

Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE — 2-17-93 DATE SIGNED — 471586 C-57 LICENSE NUMBER

DWR 188 REV 7-90

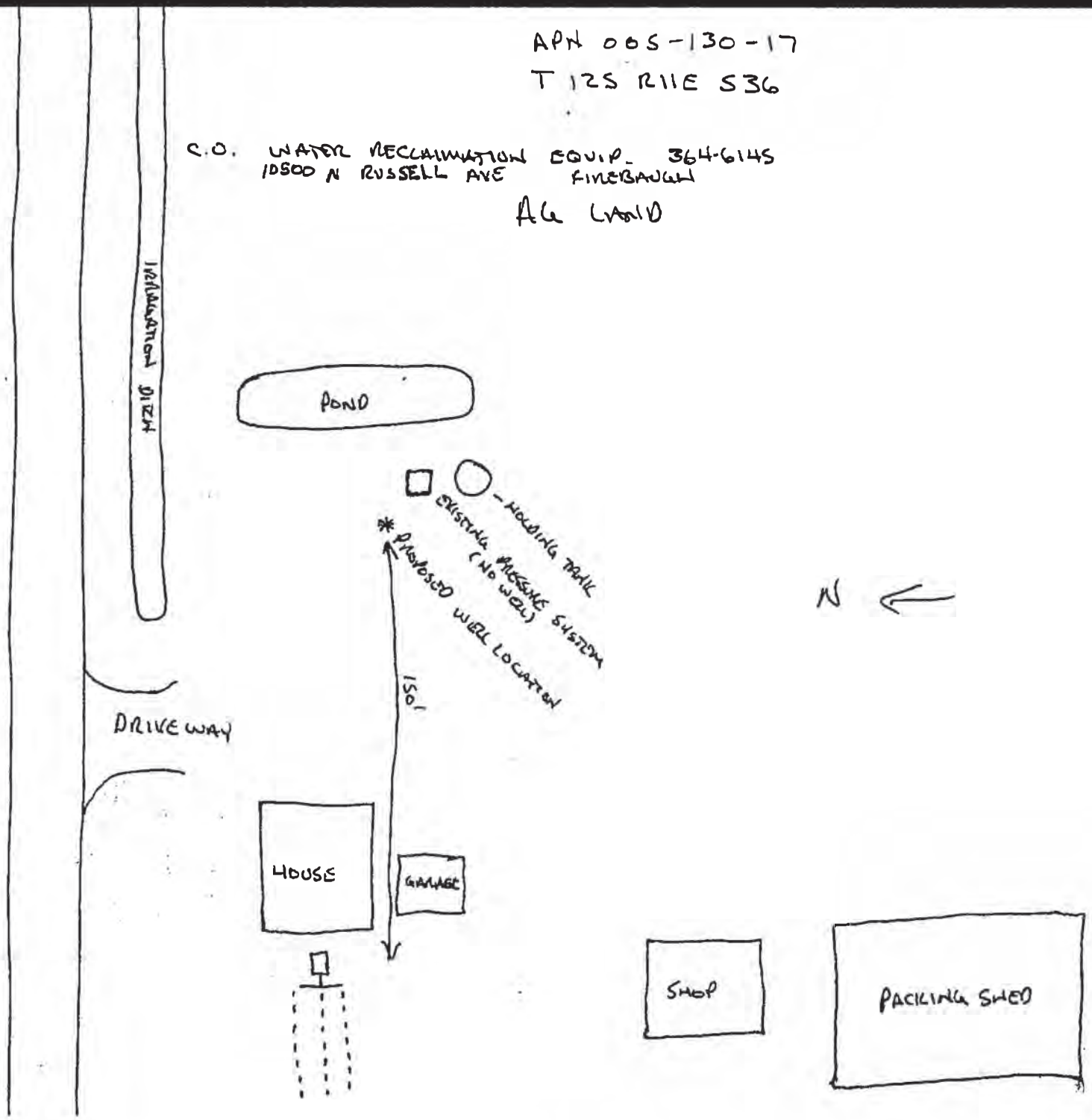
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

APN 005-130-17

T 12S R11E S36

C.O. WATER RECLAMATION EQUIP. 364-6145
10500 N RUSSELL AVE FIREBAUGH

AG LAND



GDA011

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 314244 30G

State Well No. 13/15-

Notice of Intent No. _____

Local Permit No. or Date _____

Other Well No. _____

(1) OWNER: Name _____

City _____ ZIP _____

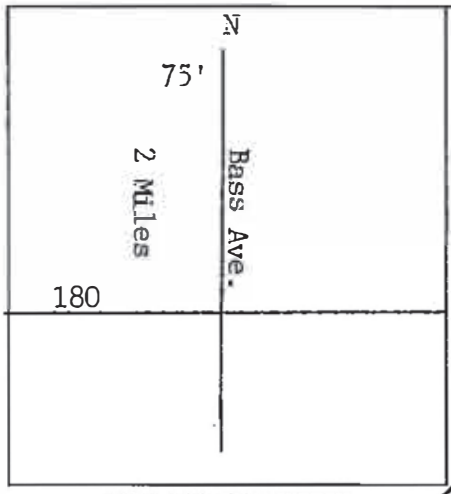
(2) LOCATION OF WELL (See instructions):

County Fresno Owner's Well Number 3

Well address if different from above _____

Township _____ Range _____ Section _____

Distance from cities, roads, railroads, fences, etc. 75' West of Bass and 2 Miles North of 180 near Sewer Farm



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☐ Deepening ☐X
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Municipal ☐X
Other ☐
(Describe)

(5) EQUIPMENT:
Rotary ☐ Reverse ☐X
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size 3/16
Diameter of bore 26
Packed from 150 to 298 ft.

(7) CASING INSTALLED:
Steel ☐X Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
0	298	14½	5/16
			¼

(8) PERFORATIONS: Ful Flo
Type of perforation or size of screen

From ft.	To ft.	Slot size
168	288	.060

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 150 ft.
Were strata sealed against pollution? Yes ☐ No ☐X Interval _____ ft.
Method of sealing Conductor & Cement

(10) WATER LEVELS:
Depth of first water, if known _____ ft.
Standing level after well completion _____ ft.

(11) WELL TESTS:
Was well test made? Yes ☐ No ☐ If yes, by whom? _____
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test _____ ft. At end of test _____ ft.
Discharge _____ gal/min after _____ hours Water temperature _____
Chemical analysis made? Yes ☐ No ☐ If yes, by whom? _____
Was electric log made Yes ☐ No ☐ If yes, attach copy to this report

(12) WELL LOG: Total depth 308 ft. Completed depth 298 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	2	Top Soil
2	22	Clay
22	32	Sand
[illegible]	[illegible]	Clay
35	98	Coarse Sand & Gravel
98	110	Blue Clay
110	128	Medium Sand
128	133	Blue Clay
133	144	Medium Sand
144	148	Blue Clay
148	154	Coarse Sand
154	175	Blue Clay
175	190	Coarse Sand
190	207	Blue Clay
207	226	Coarse Sand
226	229	Blue Clay
229	243	Coarse Sand
243	248	Blue Clay & Coarse Sand
248	264	Coarse Sand
264	273	Blue Clay
273	293	Coarse Sand
293	308	Blue clay
0	38	30" Conductor cemented in place
0	155	3" Gravel Chute
0	150	Cement Seal
0	168	14 ½" X 5/16 Blank Steel Casing
		With a 2' Stickup
168	288	14 ½" X ¼" Stainless Steel Perf.
		Ful Flo .060
288	298	14 ½" X ¼" Blank W/ Bottom
150	168	Compression Section

UNCONFINED

Work started 2-2 1990 Completed 2-17 1990

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Signed _____ (Well Driller)

NAME Myers Bros. Well Drilling, Inc. (Person, firm or corporation) (Typed or printed)

Address 8650 E. Lacey Blvd.

City Hanford, CA ZIP 93230

License No. 548214 Date of this report 2-22-90

CONFIDENTIAL
NOT FOR PUBLIC USE
WATER CODE SEC. 13752

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DWR 188 (REV. 12-86) 86 96355

Appendix B:
Electronic Data Submittal

This appendix is submitted separately as an electronic data submittal containing a variety of data submittal requirements including tabular summary data sheets of sampling results, original laboratory analytical report files, field forms, analytical methods, and GIS files

ATTACHMENT 2
NITROGEN MANAGEMENT PLAN SUMMARY REPORT ANALYSIS

Nitrogen Management Plan Summary Report Analysis

2017 Crop Year

Grassland Drainage Area Coalition

Central Valley Regional Water Board

April 30, 2019

TABLE OF CONTENTS

List of Appendices i
List of Tables i
List of Figures ii
List of Acronyms ii
List of Terms ii
NMP Summary Report Analysis 3
Introduction 3
Available Data 4
Data Quality Control 6
Completeness 6
Data Verification and Corrections 6
NMP Summary Report Analysis Methods 7
Yield Estimation and Units 7
Crop Classification 8
N Removal Calculations 8
Statistical Methods 13
Results 14
Summary Statistics and Outliers 16
Evaluation of A/Y by Soil Type 16
Evaluation of A/Y by Irrigation Practices 20
Caveats 21
Outreach and Education 22
References 23

LIST OF APPENDICES

Appendix I Summary statistics by crop
Appendix II NMP Data by Township-Range

LIST OF TABLES

Table 1. Summary of members and acreages associated with returned NMP Summary Reports 4
Table 2. Summary of crops reported in the GDAC on NMP SRs, including the acreage and number of members reporting. Sorted by acreage. 5
Table 3. Number of reported MUs and associated acreage excluded from the analysis. 6
Table 4. Conversion factor for production units different from pounds. 7
Table 5. C_N coefficients reported by Geisseler (2016) with their range and quality assessment; this is a subset of crops based on GDAC NMP SR results. 10

Table 6. C_N coefficients calculated by the Coalition by averaging coefficients from similar crops evaluated separately by Geisseler (2016). 11
Table 7. C_N coefficients applied to each of the specific crop types used by the Coalition. 12
Table 8. List of crop groups used in the Appendix I and specific crop types reported by growers in the Coalition region. 14
Table 9. Regression statistics for evaluation of standardized A/Y residuals against mean K_{sat} values in the Coalition Region. 18
Table 10. Count of NMP MUs reporting each irrigation type by crop. 20

LIST OF FIGURES

Figure 1. Major crops reported in the Coalition NMP Summary Reports. 4
Figure 2. Box and whisker plots showing the yield (Y) and nitrogen applied (A) per acre for the most common crop groups in the region for the 2017 crop year. 15
Figure 3. Distribution of mean K_{sat} values for MUs throughout the Coalition region based on parcels reported for the 2017 crop year. 17
Figure 4. Linear regression of standardized A/Y residuals across 10 crop types against Ksat values by NMP MU. 19

LIST OF ACRONYMS

A	Total available nitrogen applied per acre
APN	Assessor Parcel Number
A/Y	Total available nitrogen applied over yield per acre
A/R	Total available nitrogen applied over nitrogen removed per acre
A-R	Total available nitrogen applied minus nitrogen removed per acre
GDAC	Grassland Drainage Area Coalition
HVA	High Vulnerability Area
INMP	Irrigation and Nitrogen Management Plan
MPEP	Management Practices Evaluation Program
MU	Management Unit
NMP	Nitrogen Management Plan
SR	Summary Report
NR	Not Reported
R	Nitrogen removed at harvest per acre
TR	Township-Range
Y	Yield per acre

LIST OF TERMS

ArcGIS – Geographic Information Systems mapping software
Coalition –Grassland Drainage Area Coalition
NMP Management Unit – Reporting unit in the NMP Summary Report
C_N coefficient – Crop-specific nitrogen coefficient which represents the amount of nitrogen removed by the harvested crop per unit of yield.
Regional Water Board – Central Valley Regional Water Quality Control Board

NMP SUMMARY REPORT ANALYSIS

INTRODUCTION

The Grassland Drainage Area Coalition (Coalition or GDAC) is required to submit a summary of growers' reported nitrogen applied and removed data as a component of the Coalition's Annual Report. The Waste Discharge Requirements (Order R5-2015-0095-03) requires that the Coalition submit an evaluation comparing the ratio of Nitrogen Applied to Nitrogen Removed and the difference between Nitrogen Applied and Nitrogen Removed for crops in the Grassland Drainage Area Watershed using field level data supplied by growers.

For the 2017 crop year, all Coalition members were required to prepare and implement a Nitrogen Management Plan (NMP) for their farms by April 15 of 2017. Growers in groundwater high vulnerability areas (HVAs) were required to have their NMP Worksheets certified and to submit to the Coalition a Summary Report (SR) of their 2017 NMP data. Worksheets could be certified by either a nitrogen specialist, a crop specialist, or self-certified, if the member passed an NMP self-certification course. NMP SRs were due from Coalition members April 15, 2018 using the template approved on December 23, 2015. Future reports, submitted annually beginning in the 2021 reporting year, will include irrigation and nitrogen management practice information, in accordance with the INMP requirements of the Order revision approved on February 7, 2019.

Growers report their nitrogen use by Management Unit (MU). An NMP Management Unit (NMP MU) is a field, a parcel, or a group of parcels that has (1) the same crop type, (2) the same fertilizer inputs, (3) the same irrigation management, and (4) the same management practices. Each NMP MU can correspond to a single parcel or include multiple parcels. The NMP SRs include the total available nitrogen applied (A) in pounds per acre, and the ratio of total available nitrogen applied to yield per acre (A/Y). Growers may also provide their yield per acre (Y), though this information is not required on the NMP Summary Report used by growers for the 2017 crop year. When possible, the Coalition converts the reported yield to the amount of nitrogen removed (R), and calculates the ratio of Nitrogen Applied to Nitrogen Removed (A/R) and the difference between Nitrogen Applied and Nitrogen Removed (A-R).

This NMP SR Analysis includes a reporting of A and R data by crop type, including an aggregation by TR, summary statistics, and identification of outliers. Outliers refers to the A/R ratios that are within the upper 10% of the distribution for a given crop. All methods and calculations are explained in the section 'NMP Summary Report Analysis Methods'.

Once the data are analyzed, the Coalition will provide a Nitrogen Use Evaluation report to each member. The Nitrogen Use Evaluation reports provide an estimate of the nitrogen removed per acre for each the member's NMP MUs and provides summary statistics that place their nitrogen use and nitrogen removal performance in the context of other growers with the same crop. These efforts are explained in the 'Outreach and Education' section.

AVAILABLE DATA

The Coalition mailed 62 NMP SRs in January 2018 to members in HVAs. NMP SRs were completed and returned to the Coalition from all 62 members (Table 1) for an overall return rate of 100% NMP SRs reporting on the 2017 crop year.

Table 1. Summary of members and acreages associated with returned NMP Summary Reports.

NMP Summary Reports Status	Count of Members	Sum of Acreage
Not Received	0	--
Received - Required	62	43,171
Total Received	**62**	**43,171**

The most abundant crops in the Coalition region are almonds and pistachios. Approximately half of the acreage associated with NMP SRs was from almond or pistachio orchards (Figure 1). Other high acreage crops in the Coalition region include cotton, tomatoes, and grapes (including different varieties). Table 2 includes a summary of the acreage associated with each crop type for returned NMP SRs.

Figure 1. Major crops reported in the Coalition NMP Summary Reports.

"All Other" crops are listed in Table 2.

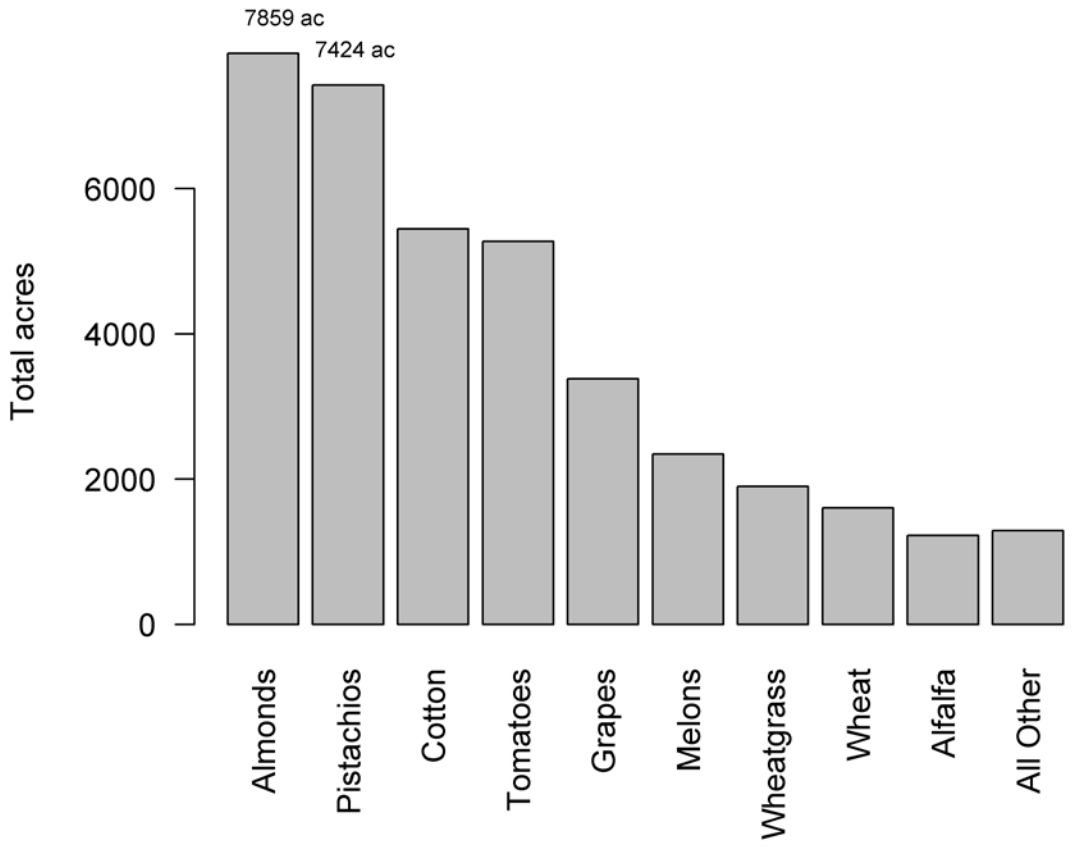


Table 2. Summary of crops reported in the GDAC on NMP SRs, including the acreage and number of members reporting. Sorted by acreage.

Crop	Count of Members	Acreage
Almonds	20	7,859
Pistachios	18	7,424
Cotton	11	5,445
Tomatoes	16	5,273
Grapes	3	3,380
Melons	2	2,346
Wheatgrass	2	1,900
Wheat	5	1,603
Alfalfa	9	1,388
Barley	2	356
Beans	1	300
Garlic	1	275
Asparagus	2	231
Pomegranates	3	129
Total Acreage		**37,908**[1]

[1] Total Acreage does not include 5,263 acres reported as not farmed parcels. See Table 3.

DATA QUALITY CONTROL

Completeness

Coalition members could submit their NMP SRs on a hardcopy that was mailed to them or through the online GDAC Member Portal. Any NMP SR received as a hardcopy was reviewed for completeness. The GDAC Member Portal only allows submission if all required fields are populated. Any data that were considered incomplete were flagged for follow-up. A NMP SR was considered incomplete and required follow-up with the grower if one or more of the following occurred:

1. Not all APNs designated as high vulnerability to groundwater were reported.
2. Insufficient crop information reported (e.g. reporting "row crops", not a specific crop type).
3. Acreage of APN was not provided and could not be determined through enrolled acreage.
4. NMP MU data could not be associated with a specific APN.
5. The NMP SR was missing any of the requisite NMP data, including amount nitrogen applied per acre, A/Y ratio, or a production unit for the yield.

Data Verification and Corrections

The Coalition reviewed the yield per acre (Y) and the nitrogen applied per acre (A) to determine if the reported data appeared reasonable. Yields varied by multiple orders of magnitude between all crops, ranging from 0 pounds per acre to more than 100,000 lbs/acre for some crops. Yields reported at higher than 250,000 lbs/acre and nitrogen application rates higher than 1,000 lbs/acre were determined likely to represent errors in the reporting and were flagged for review and follow up. Additionally, the Coalition estimates that any NMP MU with an A or Y value twice the 75th percentile of all other data for the same crop was most likely reported incorrectly. The MUs identified as having an unlikely A or Y were flagged for review and follow-up. All data flagged for follow-up due to incompleteness, inconsistencies, or unlikely yield or nitrogen applications were reviewed against the original submission to ensure these values were not the result of data-entry errors. Growers submitting suspect or incomplete data were contacted by the Coalition to update or verify the submitted information. At the time of this report, all flagged MUs but one were verified for inclusion in the analysis. The Coalition will continue to attempt to obtain the correct information for this MU, however it is excluded from analysis in this report (Table 3).

Some data received by the Coalition were not analyzed due to the type of crop reported. Parcels excluded from the analyses due to crop type include those that fall within one of the following situations:

1. APNs that were reported as not farmed (i.e. fallow, open, or non-agriculture).
2. Seed crops that do not have a traditional yield that is comparable to the normal production harvests of the same crop.

The number of NMP MUs and acreage excluded are provided Table 3. After follow-ups and exclusions, the Coalition was able to use complete NMP SR data from 58 members farming 37,424 irrigated acres and 14 crops.

Table 3. Number of reported MUs and associated acreage excluded from the analysis.

Crop	Reason for Exclusion	Count of MUs	Total Acres
Alfalfa Seed	Seed Crop	2	165
Grapes	Suspect Data	1	320
Not Farmed	Not Farmed	25	5,263
Total		**28**	**5,748**

NMP SUMMARY REPORT ANALYSIS METHODS

Yield Estimation and Units

Growers are not required to report their yields on their NMP SR. In cases where yield was not provided, the Coalition used nitrogen applied and the A/Y ratio values submitted on the NMP SR to calculate the yield per acre. If the crop yield was reported in a production unit other than pounds, the Coalition converted the yield to pounds using the conversion values in Table 4.

Table 4. Conversion factor for production units different from pounds.

Production Unit	Lbs Conversion
1/2-bushel carton (28 lbs)	28
1/2-bushel carton (30 lbs)	30
12, 1/2-pint baskets (6 lbs)	6
12, 1-pint (12 lbs)	12
15, 1/2-inch wirebound crate (50-53 lbs)	52
2 Layer Carton (22 lbs)	22
2 layer tray pack (20-25 lbs)	22
2/3 Carton (30 lbs)	30
4/5 Bushel Crate (20 lbs)	20
5-Dozen Bunches (20-25 lbs)	22
Bag (100 lbs)	100
Bag (25 lbs)	25
Bag (50 lbs)	50
Bale (200 lbs)	200
Bale (500 lbs)	500
Bin (1050 lbs)	1050
Bin (800 lbs)	800
Bin (850 lbs)	850
Bin (900 lbs)	900
Box (12 lbs)	12
Bundle (6 lbs)	6
Bushel (25 lbs)	25
Bushel (28-32 lbs)	30
Bushel (30 lbs)	30
Bushel (32 lbs)	32
Bushel (40 lbs)	40
Bushel (48 lbs)	48
Bushel (56 lbs)	56
Bushel (60 lbs)	60
Bushel (70 lbs)	70
Bushel Basket (40 lbs)	40
Carton (100 lbs)	100
Carton (13 lbs)	13
Carton (18 lbs)	18
Carton (20 lbs)	20
Carton (23 lbs)	23
Carton (25 lbs)	25
Carton (30 lbs)	30
Carton (33 lbs)	33
Carton (38 lbs)	38

Production Unit	Lbs Conversion
Carton (40 lbs)	40
Carton (50 lbs)	50
Carton (55 lbs)	55
Carton (60 lbs)	60
Carton (85 lbs)	85
Carton of 30 (11-12 lbs)	12
Carton or Lug (22 lbs)	22
Carton/25 Bunches (8 lbs)	8
Crate (30 lbs)	30
Crate (38 lbs)	38
Crate (40 lbs)	40
Crate (50 lbs)	50
Crate (50-60 lbs)	55
Crate (60 lbs)	60
Cwt (100 lbs)	100
Flat (4-6 lbs)	5
Flat (6 lbs)	6
Flat of 12 pots (10 lbs)	10
Lug Box (112 lbs)	112
Lug Box (12-15 lbs)	14
Lug Box (18 lbs)	18
Lug Box (24 lbs)	24
Lug Box (25-30 lbs)	28
Lug Box (28 lbs)	28
Pounds	1
Sack (25 lbs)	25
Sack (50 lbs)	50
Sack (60 lbs)	60
Sacks (100 lbs)	100
Sacks of 8, 5-pound bags (40 lbs)	40
SX (100 lbs)	100
Tons (2000 lbs)	2000
Units	1

Crop Classification

The statistical analysis of NMP SR data and the identification of outliers are strongly dependent on comparing NMP SR data from similar crops, necessitating an accurate classification of crops. In addition to the crop types (e.g., alfalfa, wheat), many of the crops grown in the region can be harvested in different ways (e.g., hay vs. silage) or from different varieties (e.g. wine grapes vs. table grapes). Some of these differences in harvest types and varieties have important implications for the analysis.

In field crops, different harvest types result in very different yields. For example, field crops harvested as hay have lower moisture content (usually around 12%) than the same crop harvested as silage (usually around 70%). As a result, the yields reported for hay harvests are significantly lower than the yields reported for silage harvests, even if both harvests remove the same dry matter and nitrogen content from the field. Therefore, hay and silage harvests cannot be compared to each other. Additionally, different types of harvests remove different amounts of nitrogen per pound of yield. For example, crops harvested as grain have a higher nitrogen content than the same crop harvested as hay. Therefore, field crops harvest types must be reported for the data to be useable in the analysis and correctly calculate A/R and A-R.

Some fruit crops are grown and harvested for different purposes (e.g., wine grapes vs. table grapes; or processing tomatoes vs. fresh market tomatoes). These fruit varieties may differ in moisture content and nitrogen concentration, making the distinction important for the correct analysis of A/R and identification of outliers. Current crop-specific nitrogen (C_N) coefficients and preliminary analysis of the yields suggest that these differences are not as large as the differences seen among field crop harvest types. However, as the quality of the data improves over time, some distinctions may become more apparent.

To account for those crop differences and facilitate an accurate analysis, the Coalition distinguishes crops using a specific crop type that includes the harvest type and crop variety when applicable. When a grower provided an ambiguous crop name associated with a field crop for which different harvest types can result in vastly different yields and nitrogen removal estimates (e.g., “Wheat” with no harvest information), the Coalition excluded these MUs from the analysis. However, when a grower reported ambiguous crop names for crops that are less variable (e.g., grapes or tomatoes), the Coalition included them in the analysis. For example, the specific crop options for grapes are: Grapes, Wine; Grapes, Table; Grapes, Raisins. If a grower just reported “grapes”, the specific crop is recorded as “Grapes, NR” where “NR” indicates not recorded. The Coalition expects that crop classification will become more accurate over time.

Nitrogen Removal Calculations

All C_N coefficients were obtained from Dr. Daniel Geisseler’s 2016 report[1]. In this report, Geisseler performed an extensive literature review of nitrogen concentrations for a wide variety of crops and summarized all data, providing an average nitrogen removal per crop. In addition, Geisseler provided a coefficient of variation to assess the variability of the data around each mean, and an assessment of the

[1] Geisseler, Daniel. 2016. Nitrogen concentrations in harvested plant parts – A literature overview. Prepared for the Central Valley ILRP Water Quality Coalitions.

quality, completeness, and relevance of the dataset. By the author's own assessment, many of the values are poor or unreliable estimates for the Central Valley.

The Coalition is using the average C_N coefficients reported in Geisseler (2016) with the understanding that many of the values are poor estimates and will change in the future. After further review, the Coalition also considers the coefficient of variation provided by Geisseler not to be a proper statistic to estimate variability. Instead, to assess variability, the Coalition used the range of values from all studies reviewed by Geisseler for each crop. A summary of Geisseler's mean C_N coefficients, the range of values, and both Geisseler's and the Coalition's quality assessments, are provided in Table 5. The Coalition plans on updating and improving these values over time, as more, higher quality data become available.

In some cases, the crop types reported by Geisseler were more specific than those used by the Coalition. For example, while the Coalition reports on wheat as a single crop type, Geisseler has two separate (albeit similar) values for durum and common grain wheat. In such cases, the Coalition calculated an average of the multiple values provided by Geisseler. Averages calculated by the Coalition are presented in Table 6.

In some cases where the Coalition calculated average C_N coefficients for groups of similar crops, the Coalition's quality assessment of the average differed from Geisseler's assessment of the more specific crops used to calculate the average. For example, Geisseler considers that there are insufficient data for fresh market tomatoes from the Central Valley, and it is not possible to determine if the average he provides is a good estimate for the region. However, the Coalition observed that those values overlap substantially with values for processing tomatoes, which are considered by Geisseler to be good estimates for the region. Given the strong overlap in means and ranges, the Coalition considers that the average for unspecified tomatoes is likely also a good estimate for the region (Table 6).

The specific C_N coefficients that were applied to each specific crop type reported by Coalition members are included in Table 7. Crops with available C_N coefficients in this report cover 34,220 acres, 92% of the available data (based on the total number of received and complete reports).

Table 5. C_N coefficients reported by Geisseler (2016) with their range and quality assessment; this is a subset of crops based on GDAC NMP SR results.

Commodity	C_N Coefficient			Units	Quality assessment	
	Mean	Min	Max		Coalition	Geisseler Report (2016)
Alfalfa - Hay	0.03115	0.02465	0.04125	lbs N/lbs @ 12% moisture	Good	The dataset used for this report can be considered a very good estimate for alfalfa hay produced in California. However, the range probably includes sites outside the Central Valley.
Almonds	0.068	0.051	0.087	lbs N/lbs of marketable kernels	Good	The value is a good estimate for N removed from almond orchards in the Central Valley.
Asparagus	0.002925	0.00196	0.00444	lbs N/lbs of fresh spears	Poor	The value may not be representative for contemporary asparagus in the Central Valley. More recent data needs to be collected from California.
Barley - Grain	0.0168	0.0098	0.02435	lbs N/lbs of grain @ 12% moisture	Reasonable	Even though the average value reported here may be an acceptable estimate, it needs to be confirmed with a larger set of samples.
Beans, dry - Garbanzo	0.0336	0.0234	0.04785	lbs N/lbs of mature dry beans @ 12% moisture	Poor	It is not possible to determine the degree to which the average value is representative. Needs a more representative sample from the Central Valley. However, values overlap substantially with lima beans from California.
Cotton	0.02185	0.01165	0.0316	lbs N/lbs lint & seed	Good	The value can be considered a very good estimate of the N concentration in cotton from the Central Valley.
Garlic	0.00755	0.004705	0.01024	lbs N/lbs of bulb weight	Poor	The variability within and among studies is high. With no recent values from California, it is not possible to determine how well the values in the table represent N concentrations in garlic harvested in California.
Grapes - Wine	0.0018	0.00098	0.0026	lbs N/lbs of grapes	Poor	It cannot be determined if value is representative for wine grapes from California.
Melons - Cantaloupe	0.002435	0.000985	0.00351	lbs N/lbs of melons	Poor	The variability within and among the studies is large, indicating samples need to be collected from fields in California to generate a more robust estimate.
Melons - Honeydew	0.001475	0.00099	0.002125	lbs N/lbs of melons	Reasonable	It is not possible to determine whether the values reported in the table are a good estimate for honeydew melons in California. Data needs to be collected from California.
Melons, Water	0.000695	0.000475	0.00102	lbs N/lbs of melons	Poor	With no recent data from California, it is not possible to determine if the value is a good estimate of watermelon harvested from the Central Valley.
Pistachios	0.02805	0.02705	0.0288	lbs N/lbs dry yield (CPC)	Good	The value is a good estimate for N removed from pistachio orchards in the Central Valley.
Pomegranate	0.0076	0.00605	0.00935	lbs N/lbs of fruits	Poor	It is not possible to determine the degree to which the value is representative of pomegranates harvested in the Central Valley.
Tomatoes - Fresh market	0.001305	0.000945	0.001695	lbs N/lbs of fresh weight	Poor	It is not possible to determine the degree to which the dataset is representative of tomatoes harvested in the Central Valley. However, means and ranges overlap substantially, with processing tomatoes from the Central Valley.

Commodity	C_N Coefficient			Units	Quality Assessment	
	Mean	Min	Max		Coalition	Geisseler Report (2016)
Tomatoes - Processing	0.001365	0.00095	0.0018	lbs N/lbs of fresh weight	Good	The average value can be considered a very good estimate for the Central Valley.
Wheat - Silage	0.00525	0.00335	0.00725	lbs N/lbs @ 70% moisture	Reasonable	The dataset likely provides a good estimate of the average N concentration in wheat silage produced in the Central Valley. However, the data may not fully capture the variability.

Table 6. C_N coefficients calculated by the Coalition by averaging coefficients from similar crops evaluated separately by Geisseler (2016).

Commodity	C_N Coefficient			Units	Description and Quality Assessment	
	Mean	Min	Max			
Grapes - average	0.00147	0.00089	0.0026	lbs N/lbs of grapes	Reasonable	This value is an average of wine and table grapes. Although N removal might be higher in wine grapes, there is substantial overlap, and this mean value may be reasonable for grapes in the Central Valley. The Coalition applied this value to cases when the grower did not specify the kind of grapes reported.
Melons - average	0.001955	0.0009875	0.0028175	lbs N/lbs of melons	Poor	Geisseler evaluated cantaloupe and honeydew melons separately. Ranges for the two N Removal Factors overlap partly but means are different. The Coalition calculated a melon average C_N coefficient and applied that to cases when the grower did not specify the variety of melon grown.
Tomatoes - average	0.00134	0.000945	0.0018	lbs N/lbs of fresh weight	Good	Geisseler evaluated market and processing tomatoes separately. Means and ranges for the two C_N coefficients overlap substantially. The Coalition created a tomato average C_N coefficient and applied that to cases when the grower did not specify the kind of tomato reported. As values overlap substantially, and there is good representation for processing tomatoes in the Central Valley, this is likely a reasonable estimate for tomato N removal in the region.
Wheat - Grain, average	0.0213	0.0161	0.027	lbs N/lbs of grain @ 12% moisture	Good	Geisseler evaluated grains from common wheat and durum wheat separately. Coalition growers did not differentiate between the two types of wheat. The Coalition applied this average to all wheat reported by the growers. Both values overlap substantially, and results are highly representative of wheat grown in Central Valley.

Table 7. C_N coefficients applied to each of the specific crop types used by the Coalition.

Some of the values used are not good estimates. The quality assessment of C_N coefficients sourced from Geisseler (2016) is provided in Table 5 for crops in the Coalition region. Coalition averages and their quality assessment are explained in Table 6.

Coalition Crop Type	Coalition Specific Crop type	C_N Coefficient Commodity	C_N Coefficient Source	Quality Assessment	C_N Coefficient	Units
Alfalfa	Alfalfa Hay	Alfalfa - Hay	Geisseler (2016)	Good	0.0311	lbs N/lbs @ 12% moisture
Almonds	Almonds	Almonds	Geisseler (2016)	Good	0.068	lbs N/lbs of marketable kernels
Asparagus	Asparagus	Asparagus	Geisseler (2016)	Poor	0.0029	lbs N/lbs of fresh spears
Barley	Barley Grain	Barley - Grain	Geisseler (2016)	Reasonable	0.0168	lbs N/lbs of grain @ 12% moisture
Beans	Beans Garbanzo	Beans, dry - Garbanzo	Geisseler (2016)	Poor	0.0336	lbs N/lbs of mature dry beans @ 12% moisture
Melons	Cantaloupe	Melons - Cantaloupe	Geisseler (2016)	Poor	0.0024	lbs N/lbs of melons
Cotton	Cotton	Cotton	Geisseler (2016)	Good	0.0219	lbs N/lbs lint & seed
Cotton	Cotton Acala	Cotton	Geisseler (2016)	Good	0.0219	lbs N/lbs lint & seed
Cotton	Cotton Pima	Cotton	Geisseler (2016)	Good	0.0219	lbs N/lbs lint & seed
Garlic	Garlic	Garlic	Geisseler (2016)	Poor	0.0076	lbs N/lbs of bulb weight
Grapes	Grapes Wine	Grapes - Wine	Geisseler (2016)	Poor	0.0018	lbs N/lbs of grapes
Grapes	Grapes, NR	Grapes - average	Coalition average	Reasonable	0.0015	lbs N/lbs of grapes
Melons	Honeydew	Melons - Honeydew	Geisseler (2016)	Reasonable	0.0015	lbs N/lbs of melons
Melons	Melons, NR	Melons - average	Coalition average	Poor	0.002	lbs N/lbs of melons
Pistachios	Pistachios	Pistachios	Geisseler (2016)	Good	0.0281	lbs N/lbs dry yield (CPC)
Pomegranates	Pomegranates	Pomegranate	Geisseler (2016)	Poor	0.0076	lbs N/lbs of fruits
Tomatoes	Tomatoes Market	Tomatoes - Fresh market	Geisseler (2016)	Poor	0.0013	lbs N/lbs of fresh weight
Tomatoes	Tomatoes Processing	Tomatoes - Processing	Geisseler (2016)	Good	0.0014	lbs N/lbs of fresh weight
Tomatoes	Tomatoes, NR	Tomatoes - average	Coalition average	Good	0.0013	lbs N/lbs of fresh weight
Melons	Watermelon	Melons, Water	Geisseler (2016)	Poor	0.0007	lbs N/lbs of melons
Wheat	Wheat Grain	Wheat - Grain, average	Coalition average	Good	0.0213	lbs N/lbs of grain @ 12% moisture
Wheat	Wheat Silage	Wheat - Silage	Geisseler (2016)	Reasonable	0.0053	lbs N/lbs @ 70% moisture

Statistical Methods

Statistical analyses were performed using R software for statistical computing[2]. The Coalition calculated summary statistics on the NMP SR values by crop. Summary statistics included the mean and standard deviation of A/R, and A-R (where C_N coefficients are available). All data points (NMP MUs) with A/R values > the 90th percentile within each crop group were flagged as outliers. The 90th percentile was calculated using the R function "quantile", where the quantiles are obtained by linear interpolation between data points (i.e. if only two data points were available, the median is interpolated half way between them, and the 90th percentile is one ninth of the way from the highest value).

NMP data were also aggregated by TR to comply with the Order requirements. Each TR includes 36 sections (23,040 acres). The NMP data were associated with a TR location using ArcGIS by overlaying the TRS layer with the county parcel layers. All NMP MUs analyzed were successfully associated to at least one TR. Some NMP MUs were associated with more than one TR because different parcels or parts of a parcel overlapped with multiple TRs. To avoid having the MUs duplicated in the TR aggregation, these NMP MUs were assigned to the TR that included most of the MU area.

The Coalition used standard box and whisker plots to visualize data grouped by crop (Appendix I). In the box and whisker plots, the "boxes" indicate the 25th, 50th, and 75th percentiles, and "whiskers" the data range. The box and whisker plot method used calculates the percentiles as described above for the quantile calculation.

[2] R Core Team 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

RESULTS

The analysis was performed at the level of NMP MUs, which represents field level management of nitrogen by Coalition members. After QC, there were 146 NMP MUs with complete data (Table 8). Of these, 32 MUs from non-yield (NY) or nonbearing (NB) crops that have no A/Y value due to zero yield. The NY/NB crops cover 9,486 acres and reported applications of 530,052 total lbs of nitrogen (Table 8). In addition, there were 3 MUs (517 acres, Table 8) that were reported with ambiguous crop types in such a way that necessitated excluding them from the analysis (e.g. only reporting "Wheat" without a harvest type). The Coalition determined that some crop types could not be used to calculate summary statistics as their yields could not be reliably compared to similar crops that were properly reported (See Crop Classification Section). With the exclusion of MUs with NY/NB crops or with ambiguous crop types, this analysis reflects the A/Y values of 111 NMP MUs.

Table 8. List of crop groups used in the Appendix I and crop types reported by growers in the Coalition region.

Additional information includes the total number of MUs reported, total nitrogen applied, yield, and acreage for each Specific Crop Type. Sorted alphabetically by Crop Group.

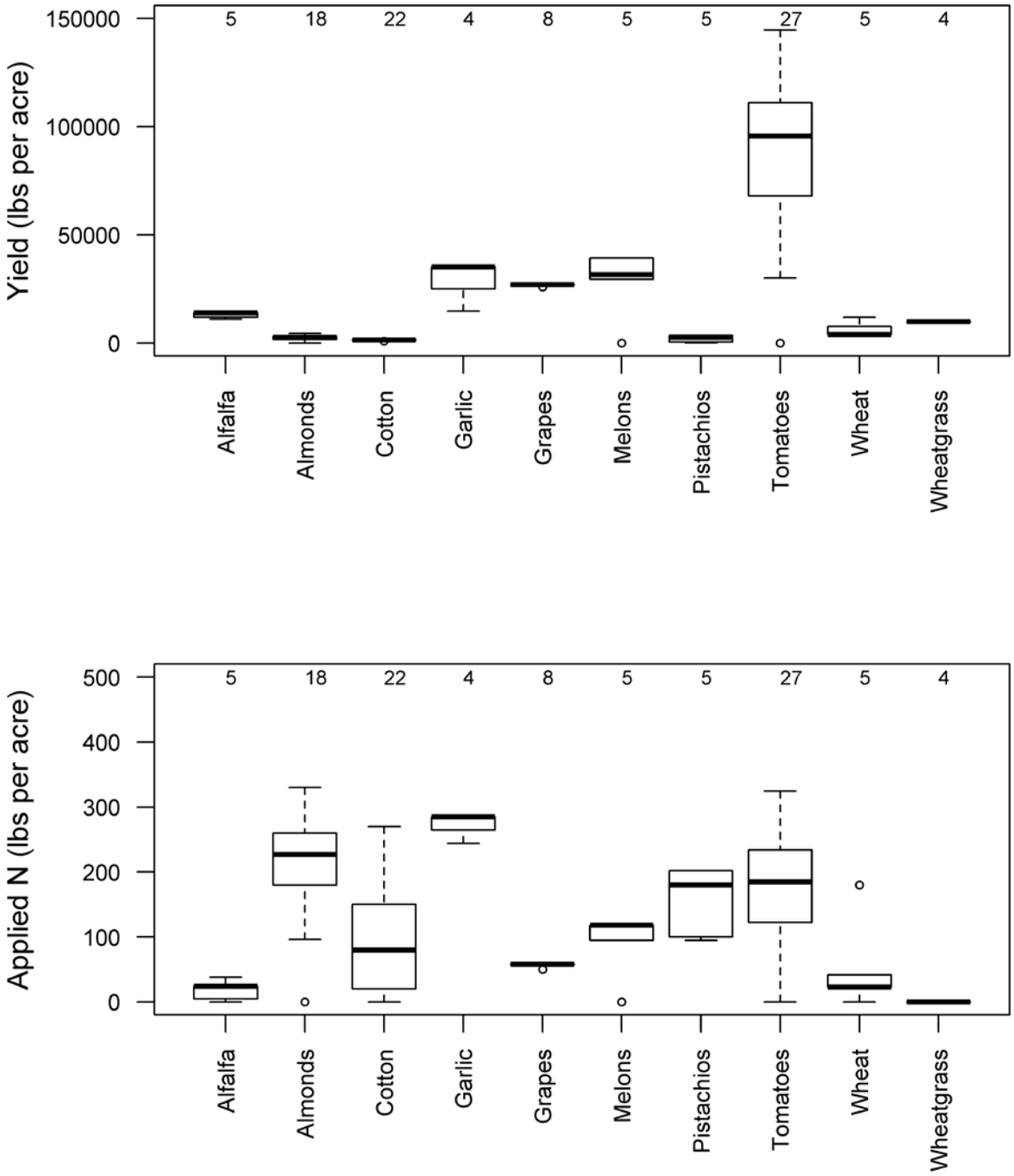
Crop Group	Crop Type	Number of MUs	Total N Applied (lbs)	Total Yield Harvested (lbs)	Total Acres
Field Crops	Alfalfa	5	13,403	9,647,747	739
	Barley	1	9,960	622,500	125
	Beans	2	31,800	1,080,000	300
	Cotton	22	623,679	7,392,243	5,214
	Wheat	5	143,532	9,143,360	1,317
	Wheatgrass	4	0	18,734,000	1,900
Tree and Vine Crops	Almonds	18	1,001,259	12,995,016	5,427
	Grapes	8	163,006	77,789,700	2,907
	Pistachios	5	154,640	1,331,199	1,238
	Pomegranates	3	6,575	2,800,000	129
Vegetable Crops	Asparagus	2	35,267	1,461,968	231
	Garlic	4	74,275	7,640,000	275
	Melons	5	30,353	9,960,394	2,346
	Tomatoes	27	944,354	411,713,512	5,273
Ambiguous Crop Types[1]	Barley, NR	1	41,580	2,125,200	231
	Wheat, NR	2	30,850	6,170,000	286
NB[2]	NON-BEARING	25	521,700	0	8,538
NY[2]	NO YIELD	7	8,352	0	948

NR – Crop variety or harvest type not reported.

[1] Not included in the analysis because the harvest type is necessary to compare data appropriately.

[2] Not included in the analysis because these MUs have no A/Y.

Figure 2. Box and whisker plots showing the yield (Y) and nitrogen applied (A) per acre for the most common crop groups in the region for the 2017 crop year.



Summary Statistics and Outliers

Box and whisker plots and summary statistics by crop type are provided in Appendix I. For each crop group, the Coalition generated plots and statistics for the A/R and A-R metrics, as required by the Order. The Coalition also aggregated A and R data by individual TRs within each crop group (Appendix II). Crop groupings by crop type are listed in Table 8. .

Evaluation of A/Y by Soil Type

The goal of this section is to determine if soil type groupings can be associated with nitrogen efficiency such that members farming on certain soil types (e.g., high infiltration rate soils) tend to have higher efficiency ratios more often than members farming on other soil types. When soil nutrient retention is low, farmers may apply larger amounts of fertilizer (increase A) to compensate for loss due to leaching or may realize lower yields due to the lower availability of fertilizers (decrease Y), although these possible scenarios depend largely on management of nitrogen and irrigation water. To evaluate the possible effect of soil type on A/Y, the Coalition tested for differences in A/Y among NMP MUs with different soil types.

The analysis focused on the 10 crops with at least three MUs that could be satisfactorily associated with soils infiltration data; most common crops in the region; alfalfa, almonds, cotton, grapes, hay, melons, pistachios, pomegranates, tomatoes, and wheatgrass. These 10 crops comprise 95% of the acreage available for analysis in the Coalition region.

The Coalition characterized soil types within the GDAC region based on the saturated hydraulic conductivity (K_{sat}) of the soils. The K_{sat} is a measure of the potential for water percolation and leaching of nutrients through the soil. The K_{sat} values are associated with the soil texture, which determines the rate at which water moves through the soil profile. Lower K_{sat} values are characteristic of clay soils, with low porosity, slow percolation, and low potential for leaching of nutrients to groundwater. Higher K_{sat} values are characteristic of sandy soils with high porosity, percolation, and potential for leaching of nutrients below the root zone and to the groundwater.

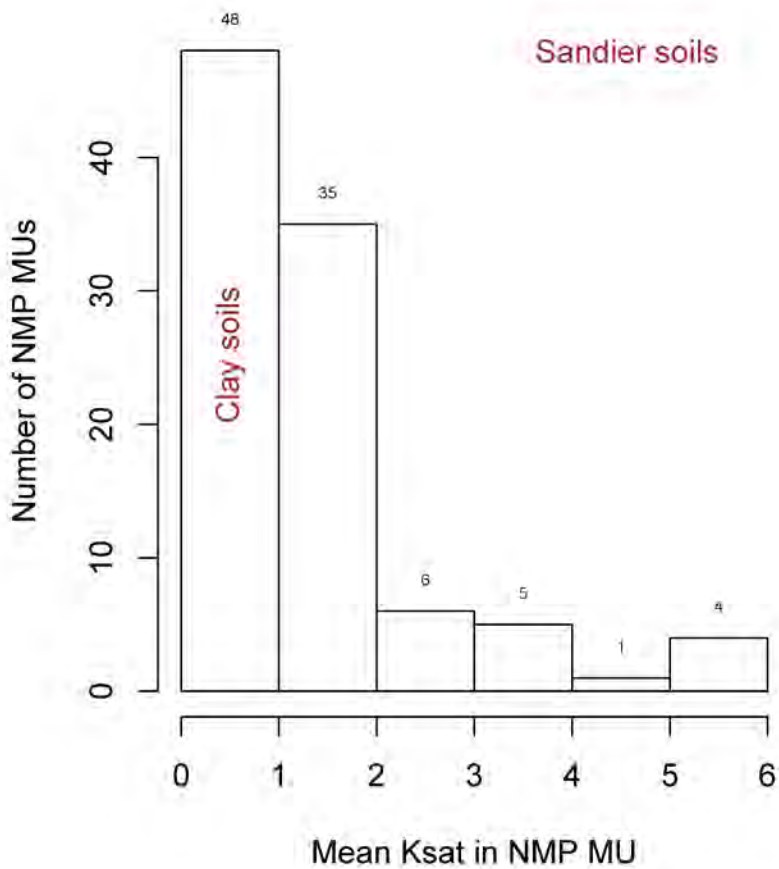
Soils data were obtained from the USDA Soil Survey Geographic Database (SSURGO: http://www.soils.usda.gov/survey/geography/ssurgo/). The “Gridded Soil Survey Geographic (gSSURGO) Database State-tile Package" product is derived from the Soil Survey Geographic (2.2) Database dated November 16, 2015. Parcel layer data were developed by the Coalition. Parcel layer data were overlaid on the SSURGO soil data using the ‘Identify’ processing tool; all soil map units present in each parcel were identified. Soil information was assigned to each NMP MU by linking the map unit from the soil data to each parcel within each NMP MU.

Soil K_{sat} in each parcel and NMP MU can vary vertically with soil depth, and horizontally among different soil types. Vertical variation in K_{sat} was summarized by selecting the minimum value among all horizons down to a 1-meter depth. The horizon with the minimum K_{sat} is the one that will limit the hydraulic conductivity of the soil profile. Summarizing horizontal variation in K_{sat} within a parcel or NMP MU was more challenging. Most NMP MUs had two or more soil types associated to them. Some NMP MUs contained over 10 different soil types. Soil types within one NMP MU could have similar properties or

be dramatically different. For example, some NMP MUs had portions of clay and portions of sandy soils, resulting in K_{sat} highly variable ranges within a single NMP MU.

Due to the horizontal variability in soil types within each NMP MU, it was necessary to use summary statistics to obtain a K_{sat} value representative of each NMP MU. For this analysis, the Coalition calculated the weighted average K_{sat} in each NMP MU (from here on called *mean K_{sat}*). The mean K_{sat} is the average of all K_{sat} values from different soil types inside one NMP MU, weighted by the area of each soil type. This mean K_{sat} satisfactorily identifies NMP MUs with consistently large or small K_{sat} values. The NMP MUs with contrasting soil types produce intermediate mean K_{sat} that cannot be differentiated from soil types with intermediate conductivity. Figure 3 shows the frequency of different mean K_{sat} values among MUs in the Coalition region. Most of the GDAC NMP MUs are characterized by low conductivity soils (Figure 3).

Figure 3. Distribution of mean K_{sat} values for MUs throughout the Coalition region based on parcels reported for the 2017 crop year.



The Coalition evaluated if A/Y differed among the K_{sat} values described above using simple linear models for all of the crops combined (Figure 4). Because of the small sample sizes for each crop, there is not sufficient power to establish any relationships. However, combining crops presents problems because

the mean A/Y values for each crop differ. To adjust for the different ranges of A/Y by crop, each management unit's A/Y value was subtracted from the mean for that crop leading to a standardized residual value. Standardized residuals from all crops were combined into a single dataset for analysis.

Linear models test the hypothesis that the mean standardized residual A/Y differs among any of the soil type categories. To perform the analysis, soil types were characterized by the K_{sat} value and the residual A/Y value was regressed on the K_{sat} value.

Overall, there was limited evidence that soil type influenced the mean A/Y in the GDAC region (Figure 4). The linear fit to the data (red line in Figure 4) is not significant. Neither the intercept nor the slope are significantly different from 0 indicating that there is no relationship between the standardized residual A/Y value and soil saturation (Table 9). The scatter of points around the line suggests that there is no nonlinear relationship between A/Y and K_{sat}.

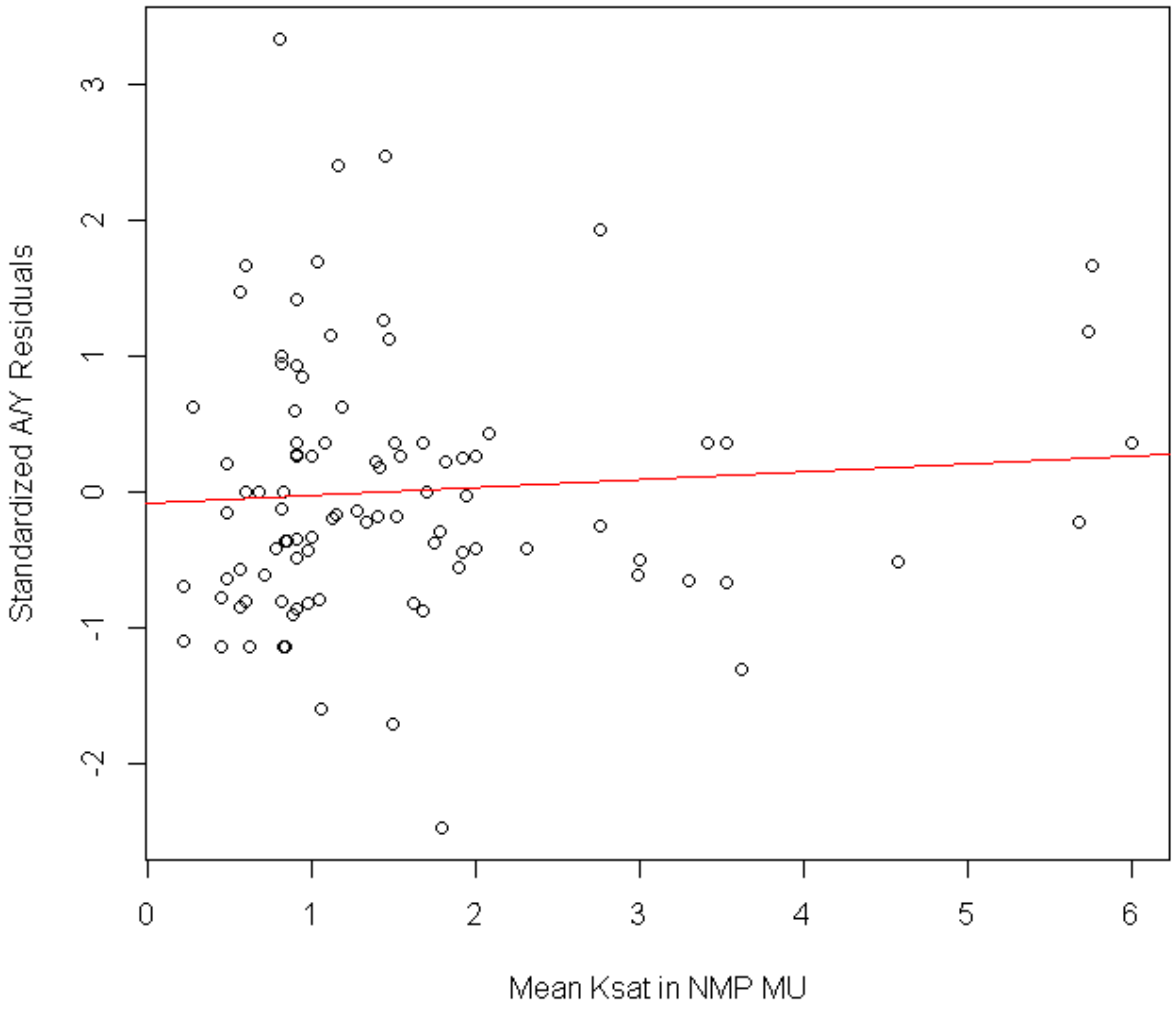
The Coalition concludes that, for the crops that cover 95% of the reported area, the average A/Y and frequency of outliers is unaffected by the soil type based on mean K_{sat}. It is unlikely that differentiating by soil categories could generally improve the calculation or accuracy of the summary statistics and identification of outliers through the Coalition region. Focusing outreach on members farming on specific soils will not be effective in reducing A/Y.

The Coalition recognizes that soil type is important when understanding the potential for nitrogen to leach past the root zone. However, the available data suggest that soil type is not important to understand the frequency of A/Y outliers. This is likely because A/Y depends largely on the management of nitrogen and irrigation water. Properly managed operations on sandy soils are unlikely to differ much in their A/Y from properly managed operations in clay soils. The Coalition will continue to work with its members during grower outreach meetings and the MPEP to better understand the effectiveness of management practices in different soil types.

Table 9. Regression statistics for evaluation of standardized A/Y residuals against mean K_{sat} values in the Coalition Region.

Regression Statistic	Result
x-Intercept	
Value	-0.08878
Standard error	0.15154
t-value	-0.586
p value	0.559
Slope	
Value	0.05869
Standard error	0.07817
t-value	0.751
p value	0.455
Degrees of Freedom	96
Multiple R^2	0.005838

Figure 4. Linear regression of standardized A/Y residuals across 10 crop types and mean K_{sat} values by NMP MU.



Evaluation of A/Y by Irrigation Practices

For some crops, recommended nitrogen application rates can be different for flood vs. pressurized irrigation operations. In some cases, recommended application rates can be higher for flood-irrigated operations to compensate for the different efficiency of the delivery method and the greater potential for loss. As not all Coalition members are able to switch to more expensive, pressurized irrigation systems, irrigation type could contribute to higher A/R ratios. However, all irrigation types can be managed in a way that minimizes leaching of nitrate.

The Coalition obtained a list of management practices implemented by members from the Farm Evaluation (FE) Surveys. As of the 2017 crop year, Coalition members were required to submit FEs annually, to provide information regarding irrigation practices, nitrogen management practices, active and abandoned wells, pesticide practices and sediment/erosion control practices. The Coalition determined which irrigation practices were implemented in each NMP MU by linking the two datasets based on the parcel number. When one parcel included multiple NMP MUs, the corresponding FE data were identified by the specific crop type. In total, 60 NMP MUs were satisfactorily associated with the respective parcel management practices from the FE surveys. A majority of those NMP MUs are associated with pressurized irrigation practices.

The Coalition grouped irrigation practices into two broad categories: flood irrigation (which includes flood and furrow) and pressurized irrigation (which includes drip, sprinkler, and micro-sprinkler); irrigation practice is based on the primary irrigation practice listed on the FE.

Due to the small data set, the Coalition could not conduct a statistical analysis of NMP values with FE irrigation practices. Irrigation practices generally fell within one of the two irrigation type categories within a certain crop type. As such, no comparison of A/R values could be conducted within a specific crop type as there were no significant differences within crops to evaluate. Irrigation practices are summarized in Table 10.

Table 10. Count of NMP MUs reporting each irrigation type by crop.

Crop	Total Number NMP MUs	Number of Pressurized Irrigation MUs	Number of Flood Irrigation MUs
Alfalfa	5	0	5
Almonds	14	14	0
Cotton	7	5	2
Grapes	6	6	0
Melons	1	1	0
Pistachios	2	2	0
Pomegranates	3	2	1
Tomatoes	15	15	0
Wheat	3	2	1
Wheatgrass	4	0	4

Caveats

There are several caveats that compromise our interpretation of the results (and particularly the correct identification of outliers). The primary concern with the 2017 crop year is the small size of the available dataset. Even with all required NMP SRs returned to the Coalition for analysis, many crops still have few (ten or less) MUs available for analysis. Most of the analyses conducted by the Coalition, especially the identification of outliers, are not meaningful evaluations of nitrogen efficiency in these cases. Due the size of the GDAC, small sample sizes will likely continue to limit effective evaluations in future reports. The Coalition will consider effective ways to further aggregate NMP data in the future, allowing more robust analyses of grower information. Additionally, due to phasing in of additional reporting requirements outlined in the Order, the sample size will increase somewhat as low vulnerability growers are also required to submit INMP summary reports, beginning in 2021.

The determination of outliers in this report is based on the 90th percentile calculations, as per previous revisions of the Order. Small sample sizes are problematic when identifying the 90th percentile, especially when less than 3 datapoints are available. For example, if only two data points are available, the default method to calculate quantiles assumes that those are the range (e.g. 0% and 100% percentiles). All other percentiles are then calculated linearly, at the corresponding steps between those two points (i.e., the 90th percentile is one ninth of the way from the highest value). Thus, for any crop with only two MUs in any particular crop type, the highest value will always be considered an outlier (>90th percentile) regardless of the actual value of A/R or the difference in A/R between the two MUs. The larger A/R value is an outlier even if both points have very efficient operations with low A/R values. Generally, summary statistics are more meaningful when calculated from a larger sample size. The Coalition anticipates proposing a more useful statistical method for calculating outliers in the future, per the recent revision to the Order.

Additionally, the Coalition has made a concerted effort to verify the C_N coefficients used in this report. However, Dr. Daniel Geisseler, the author of the document from which the C_N coefficients were obtained, points out that a large number of the coefficients are only rough estimates, and it is unknown the extent to which some values are a good representation of nitrogen removal in the Central Valley. While C_N coefficients are expected to become more accurate over time, many crops covered in this report have R values that are calculated using coefficients that cannot be verified as reasonable estimates of nitrogen removed.

Finally, the association of soils characteristics to a specific NMP MU reported by the members is very inexact. Members can include within a single NMP MU different parcels located some distance from each other, provided they are managed the same way. Soil types can vary substantially, both vertically and horizontally, within a single field. Soils can vary considerably across different fields within a single MU, and can be difficult to assign representative soils properties to an entire MU.

Similarly, the association of irrigation and nitrogen management practices to specific NMP MUs is also inexact. The FE MUs are often recorded by the growers at a different scale than NMP MUs. Every effort was made to associate NMP MUs to FE MUs based on the parcel number and crop name. However, not all MUs were associated satisfactorily, and errors in the association are confounded by inconsistencies in crop naming, which are less stringent for FE reporting. These associations will become more exact as

reporting requirements change and growers must include the information formerly required on the FE in the future INMP summary report.

OUTREACH AND EDUCATION

The 2017 crop year was the first year for which NMP SRs were required to be submitted to the Coalition by growers within the GDAC. The Coalition is currently in the process of developing materials to inform its members regarding the potential effects of nitrogen applications on groundwater quality. The Coalition anticipates that no later than May of 2019, the first set of Nitrogen Use Evaluation Packets for the 2017 crop year will be mailed to all growers who provided the data that were analyzed for this report.

These packets will include the NMP SR data reported for the 2017 crop year, summary statistics by crop type for all MUs across the Coalition, nitrogen removal estimates for crops with available R values, bell curves comparing each member's MUs to others reporting on the same crop across the Coalition, and identification of extreme data points that may be statistical outliers.

Members may have MUs with extreme A/Y values due to various factors including high application rates or low yield. High application rates may be due to not accounting for nitrogen in their irrigation water or over-application of synthetic fertilizer, manure or compost. Low yield may have occurred for reasons outside of the grower's control, including pest damage or drought stress. Having an extreme NMP MU identified in these packets alerts growers if they reported A/Y values that were significantly different from their neighbors and allows growers to consider if they need to re-evaluate their nitrogen application practices or be more thorough in providing correct information back to the Coalition.

The Nitrogen Use Evaluations are meant to illustrate nitrogen use efficiency for each grower with the potential to leach nitrates into groundwater and to place each of these grower's practices within the context of other growers in the Coalition. Additionally, reporting the data back to each grower provides the opportunity for growers to address any data quality concerns that may not have been identified in the quality control and follow-up processes outlined above. Growers are encouraged to contact the Coalition with data change requests, questions, and concerns with their Nitrogen Use Evaluation, and as such, the packets will aid in more accurate and comprehensive data over time.

REFERENCES

Geisseler, Daniel. 2016. Nitrogen Concentrations in Harvested Plant Parts – A Literature Overview.

APPENDIX I

Summary Statistics by Crop

INTRODUCTION

This appendix shows the results of summary statistics calculations for all crops in the region. Each section contains results for one crop type. Each crop type may group multiple specific crops (e.g., different varieties).

Because the focus of this appendix is to report summary statistics representing the relationship between nitrogen applied and nitrogen removed, only management units with complete data and a yield larger than zero are included; this analysis does not include management units with non-bearing crops or with crops that were not harvested. Hence, the total acreage and number of management units reported for each crop here may or may not match the acreage for all the received summary reports.

Each section contains a Box and Whisker plot of A/R for crops with a enough data points (NMP MUs) to allow such a representation. Summary statistics of A/R and A-R are provided in accompanying tables for all crops reported for which a C_N coefficient is available. CN coefficients used for each specific crop type are also provided.

FIELD CROPS

Figure I-1. Box and Whisker plots of A/R for field crop management units grouped by crop type.

Numbers at the top indicate the number of management units within each crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/R > 90% percentile within each crop).

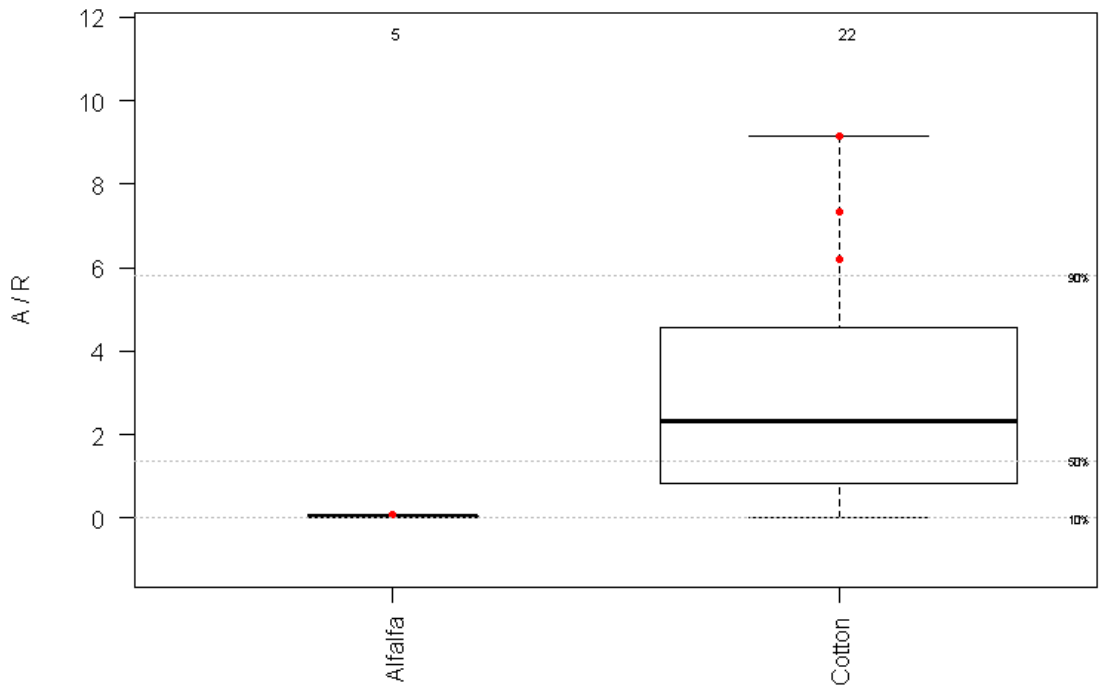


Table I-1. Summary statistics of A/R and A-R for field crop management units grouped by crop type.

See Table I-2 for more information regarding R calculations.

Crop Group	Crop Type	Number NMP MUs	Total Acres	Parameter	Mean	Standard Deviation	Number of Outliers
Field Crops	Alfalfa	5	739	A/R	0.04	0.04	1
	Barley	1	125	A/R	0.95	--	--
	Beans	2	300	A/R	0.88	0	--
	Cotton	22	5214	A/R	2.95	2.59	3
	Wheat[1]	2	210	A/R	0.33	0.47	1
	Alfalfa	5	739	A-R	-391.37	50.37	--
	Barley	1	125	A-R	-4.00	--	--
	Beans	2	300	A-R	-14.96	0	--
	Cotton	22	5214	A-R	62.50	79.87	--
	Wheat[1]	2	210	A-R	-51.13	42.03	--
	Wheat (Hay)[2]	3	1107	A/Y	0.012	0.011	1
	Wheatgrass[2]	4	1900	A/Y	0	0	--

[1]Wheat includes harvest types with available C_N coefficients.
[2]No C_N coefficient currently available.

Table I-2. C_N coefficients applied to field crops to calculate R.

Some values are not good estimates. A quality assessment and the author's description are provided.

Coalition Crop Type	Coalition Specific Crop Type	C_N coefficient	Units	Quality Assessment	Description
Alfalfa	Alfalfa Hay	0.0311	lbs N/lbs @ 12% moisture	**Good**	The dataset used for this report can be considered a very good estimate for alfalfa hay produced in California. However, the range probably includes sites outside the Central Valley.
Barley	Barley Grain	0.0168	lbs N/lbs of grain @ 12% moisture	**Reasonable**	Even though the average value reported here may be an acceptable estimate, it needs to be confirmed with a larger set of samples.
Beans	Beans Garbanzo	0.0336	lbs N/lbs of mature dry beans @ 12% moisture	**Poor**	It is not possible to determine the degree to which the average value is representative. Needs a more representative sample from the Central Valley. However, values overlap substantially with lima beans from California.
Cotton	Cotton	0.0219	lbs N/lbs lint & seed	**Good**	The value can be considered a very good estimate of the N concentration in cotton from the Central Valley.
	Cotton Acala				
	Cotton Pima				
Wheat	Wheat Grain	0.0213	lbs N/lbs of grain @ 12% moisture	**Good**	Geisseler evaluated grains from common wheat and durum wheat separately. Coalition growers did not differentiate between the two types of wheat. The Coalition applied this average to all wheat reported by the growers. Both values overlap substantially, and results are highly representative of wheat grown in Central Valley.
	Wheat Hay	--	--	--	No coefficient currently available.
	Wheat Silage	0.0053	lbs N/lbs @ 70% moisture	**Reasonable**	The dataset likely provides a good estimate of the average N concentration in wheat silage produced in the Central Valley. However, the data may not fully capture the variability.
Wheatgrass	Wheatgrass	--	--	--	No coefficient currently available.

TREE AND VINE CROPS

Figure I-2. Box and Whisker plots of A/R for tree and vine crop management units grouped by crop type.

Numbers at the top indicate the number of management units within each crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/R > 90% percentile within each crop).

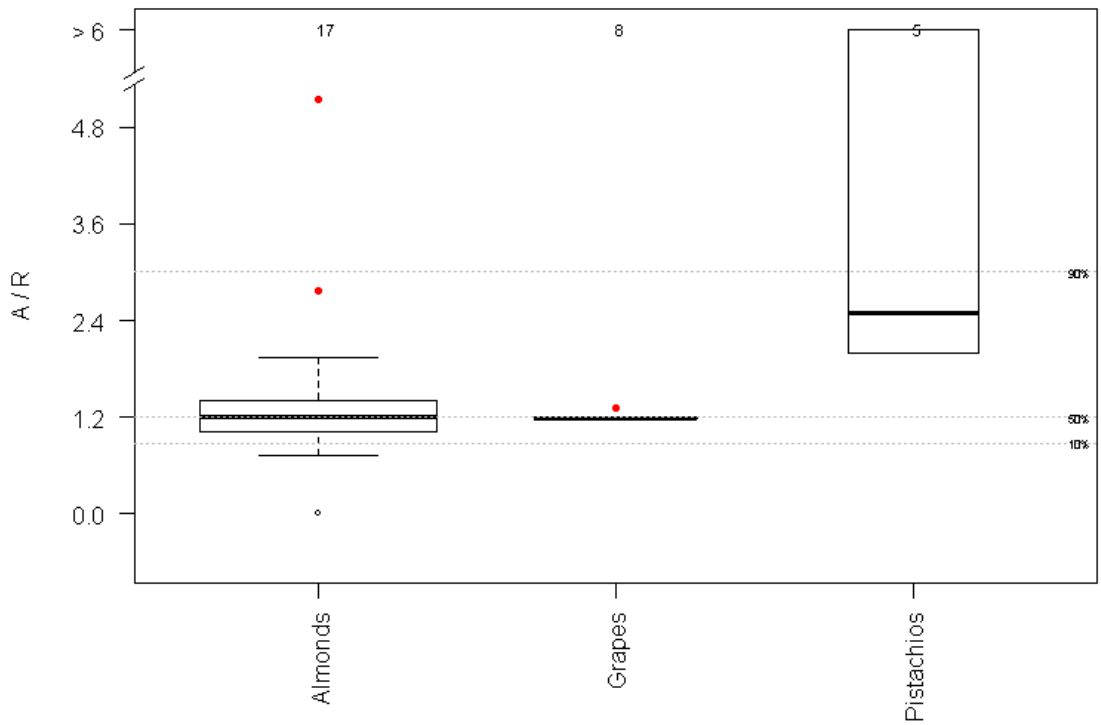


Table I-3. Summary statistics of A/R and A-R for tree and vine crop management units grouped by crop type.

See Table I-4 for more information regarding R calculations.

Crop Group	Crop Type	Number NMP MUs	Total Acres	Parameter	Mean	Standard Deviation	Number of Outliers
Tree and Vine Crops	Almonds	18	5427	A/R	1.46	1.11	2
	Grapes	8	2907	A/R	1.21	0.04	1
	Pistachios	5	1238	A/R	6.83	8.26	1
	Pomegranates	3	129	A/R	0.43	0.55	1
	Almonds	18	5427	A-R	52.79	80.08	--
	Grapes	8	2907	A-R	9.71	0.89	--
	Pistachios	5	1238	A-R	97.08	10.44	--
	Pomegranates	3	129	A-R	-104.26	100.46	--

Table I-4. C_N coefficients applied to tree and vine crops to calculate R.

Some values are not good estimates. A quality assessment and the author's description are provided.

Crop Group	Coalition Crop Type	Coalition Specific Crop Type	C_N coefficient	Units	Quality Assessment	Description
Tree and Vine Crops	Almonds	Almonds	0.068	lbs N/lbs of marketable kernels	**Good**	The value is a good estimate for N removed from almond orchards in the Central Valley.
	Grapes	Grapes Wine	0.0018	lbs N/lbs of grapes	**Poor**	It cannot be determined if value is representative for wine grapes from California.
		Grapes, NR	0.0015	lbs N/lbs of grapes	**Reasonable**	This value is an average of wine and table grapes. Although N removal might be higher in wine grapes, there is substantial overlap, and this mean value may be reasonable for grapes in the Central Valley. The Coalition applied this value to cases when the grower did not specify the kind of grapes reported.
	Pistachios	Pistachios	0.0281	lbs N/lbs dry yield (CPC)	**Good**	The value is a good estimate for N removed from pistachio orchards in the Central Valley.
	Pomegranates	Pomegranates	0.0076	lbs N/lbs of fruits	**Poor**	It is not possible to determine the degree to which the value is representative of pomegranates harvested in the Central Valley.

VEGETABLE CROPS

Figure I-3. Box and Whisker plots of A/R for vegetable crop management units grouped by crop type.

Numbers at the top indicate the number of management units within each crop. The width of the box is proportional to the sample size. Red dots highlight outliers (A/R > 90% percentile within each crop).

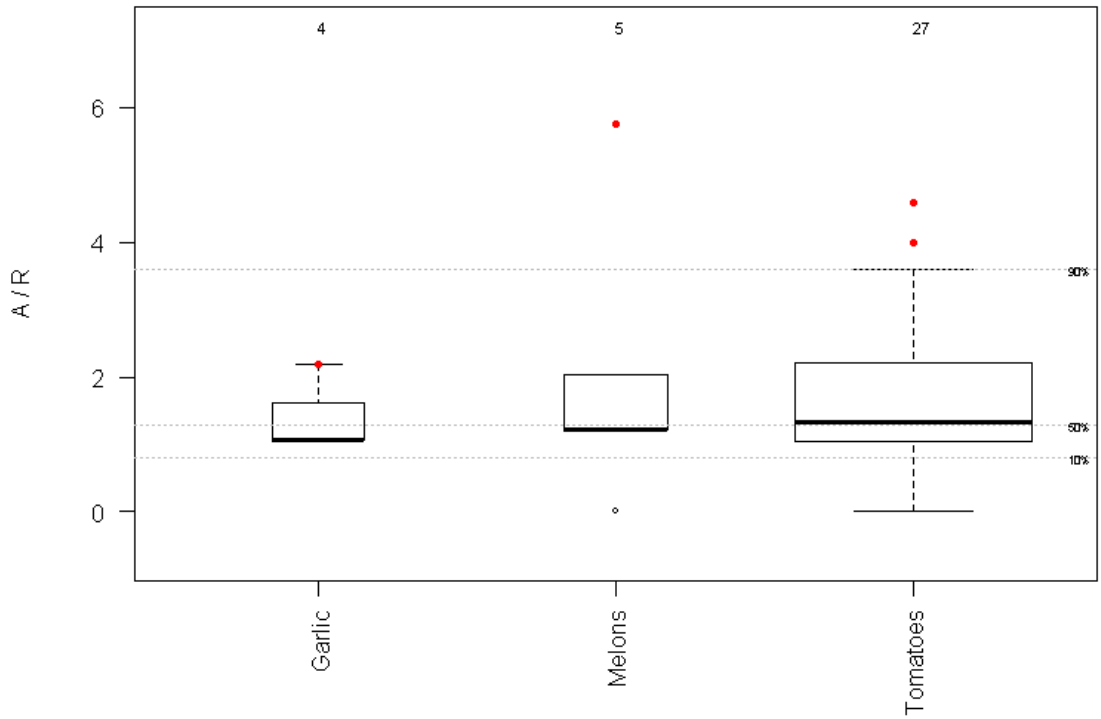


Table I-5. Summary statistics of A/R and A-R for vegetable crop management units grouped by crop type.

See Table I-4 for more information regarding R calculations.

Crop Group	Crop Type	Number NMP MUs	Total Acres	Parameter	Mean	Standard Deviation	Number of Outliers
Vegetable Crops	Asparagus	2	231	A/R	18.47	18.54	1
	Garlic	4	275	A/R	1.35	0.56	1
	Melons	5	2346	A/R	2.05	2.19	1
	Tomatoes	27	5273	A/R	1.76	1.13	2
	Asparagus	2	231	A-R	156.86	78.07	--
	Garlic	4	275	A-R	47.50	56.51	--
	Melons	5	2346	A-R	39.52	39.08	--
	Tomatoes	27	5273	A-R	65.89	75.89	--

Table I-6. C_N coefficients applied to vegetable crops to calculate R.

Some values are not good estimates. A quality assessment and the author's description are provided.

Coalition Crop Type	Coalition Specific Crop Type	CN coefficient	Units	Quality Assessment	Description
Asparagus	Asparagus	0.0029	lbs N/lbs of fresh spears	**Poor**	The value may not be representative for contemporary asparagus in the Central Valley. More recent data needs to be collected from California.
Garlic	Garlic	0.0076	lbs N/lbs of bulb weight	**Poor**	The variability within and among studies is high. With no recent values from California, it is not possible to determine how well the values in the table represent N concentrations in garlic harvested in California.
Melons	Cantaloupe	0.0024	lbs N/lbs of melons	**Poor**	The variability within and among the studies is large, indicating samples need to be collected from fields in California to generate a more robust estimate.
	Honeydew	0.0015	lbs N/lbs of melons	**Reasonable**	It is not possible to determine whether the values reported in the table are a good estimate for honeydew melons in California. Data needs to be collected from California.
	Melons, NR	0.002	lbs N/lbs of melons	**Poor**	Geisseler evaluated cantaloupe and honeydew melons separately. Ranges for the two N Removal Factors overlap partly but means are different. The Coalition calculated a melon average C_N coefficient and applied that to cases when the grower did not specify the variety of melon grown.
	Watermelon	0.0007	lbs N/lbs of melons	**Poor**	With no recent data from California, it is not possible to determine if the value is a good estimate of watermelon harvested from the Central Valley.
Tomatoes	Tomatoes Market	0.0013	lbs N/lbs of fresh weight	**Poor**	It is not possible to determine the degree to which the dataset is representative of tomatoes harvested in the Central Valley. However, means and ranges overlap substantially, with processing tomatoes from the Central Valley.
	Tomatoes Processing	0.0014	lbs N/lbs of fresh weight	**Good**	The average value can be considered a very good estimate for the Central Valley.
	Tomatoes, NR	0.0013	lbs N/lbs of fresh weight	**Good**	Geisseler evaluated market and processing tomatoes separately. Means and ranges for the two C_N coefficients overlap substantially. The Coalition created a tomato average C_N coefficient and applied that to cases when the grower did not specify the kind of tomato reported. As values overlap substantially, and there is good representation for processing tomatoes in the Central Valley, this is likely a reasonable estimate for tomato N removal in the region.

APPENDIX II

NMP Data by Township-Range

Table II-1. Grassland Drainage Area Coalition 2017 crop year nitrogen applied and nitrogen removed data aggregated by Township-Range.

Township-Range	Crop Group	Total Acreage	Total Nitrogen Applied (total lbs)	Nitrogen Removed (total lbs)	A/R	A-R (total lbs)
11S10E	Field Crops	60	7,434	2,032	3.66	5,402
11S11E	Field Crops	458	17,431	19,427	0.90	-1,997
12S11E	Field Crops	1,973	288,805	59,650	4.84	229,155
12S12E	Field Crops	985	11,880	75,475	0.16	-63,595
12S13E	Field Crops	940	88,219	133,965	0.66	-45,746
13S12E	Field Crops	595	53,040	46,923	1.13	6,117
13S14E	Field Crops	1,576	218,163	185,683	1.17	32,480
11S10E	Tree and Vine Crops	399	103,830	73,555	1.41	30,275
12S11E	Tree and Vine Crops	2,907	356,900	345,697	1.03	11,203
12S12E	Tree and Vine Crops	1,085	177,416	167,566	1.06	9,850
12S13E	Tree and Vine Crops	762	81,796	20,998	3.90	60,798
13S12E	Tree and Vine Crops	4,343	568,638	453,606	1.25	115,032
13S13E	Tree and Vine Crops	205	36,900	14,784	2.50	22,116
11S10E	Vegetable Crops	69	10,350	8,100	1.28	2,250
11S11E	Vegetable Crops	525	144,497	83,144	1.74	61,354
12S11E	Vegetable Crops	2,143	312,398	219,773	1.42	92,625
12S12E	Vegetable Crops	3,543	246,330	100,677	2.45	145,653
12S13E	Vegetable Crops	734	142,810	107,455	1.33	35,355
13S11E	Vegetable Crops	158	39,500	10,986	3.60	28,514
13S12E	Vegetable Crops	544	96,423	36,960	2.61	59,463
13S14E	Vegetable Crops	234	42,066	27,336	1.54	14,730
14S12E	Vegetable Crops	175	49,875	46,508	1.07	3,367

ATTACHMENT 3
SUMMARY OF MANAGEMENT PRACTIC INFORMATION COLLECTED FROM FARM EVALUATIONS AND MANAGED WETLAND EVALUATIONS FOR THE 2017 GROWING SEASON

Grassland Basin Drainage Steering Committee

Grassland Drainage Area Coalition

Summary of Management Practice Information
Collected from Farm Evaluations and Managed Wetland Evaluations
For 2017 Growing Season

April 30, 2019

Summers Engineering, Inc
Since 1962

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Table of Contents

Executive Summary 1
Farm Evaluation Participation Summary 2
Coalition Crop Information 3
Part A - Whole Farm Evaluation 3
Part B - Irrigation and Nitrogen Management Practices 5
Part C - Well Information 7
Part D - Sediment Management Practices 8
Data Quality Assessment of Collected Information 9

Table of Tables

Table 1: FE/MWE Participation Summary 2
Table 2: Crop Summary 3
Table 3: Whole Farm Evaluation 4
Table 4: Irrigation Practices 5
Table 5: Secondary Irrigation Practices 5
Table 6: Irrigation Efficiency and Nitrogen Management 6
Table 7: Well Information 7
Table 8: Sediment and Erosion Control Practices 8
Table 9: Data Validation Criteria 9
Table 10: Quality Assessment by Township 9

Executive Summary

The Grassland Drainage Area Coalition (GDA Coalition) serves as the Third Party Group for growers within the Grassland Drainage Area, for the purpose of implementing applicable portions of the Irrigated Lands Regulatory Program (IRLP) as specified in Order Number R5-2015-0095 (Order). Growers in groundwater high vulnerability areas were required to submit a Farm Evaluation Plan (FE) survey in 2017.

To satisfy this requirement, the GDA Coalition prepared and sent FE surveys to all Coalition members in groundwater high vulnerability areas. 65 sets of forms were prepared for approximately 320 parcels and were mailed in January of 2017. The surveys were prepopulated with Assessor's Parcel Number (APN) and included maps of those parcels. The completed forms were due by March 1, 2018.

The purpose of the FE survey is to provide the GDA Coalition and the Central Valley Regional Board (Regional Board) with management practices intended to protect water quality on a site-specific basis. The site-specific information will be used in conjunction with representative groundwater quality information to determine the effects that irrigated agricultural practices have on water quality.

Survey responses including crop, acreage, and associated management practices were recorded in a Microsoft Access database. The crop information was normalized and subsequently summarized on a coalition-wide basis. The data has been compiled in one table, which includes all question/response combinations for each member.

The Farm Evaluation Surveys included these four sections:

- Part A - Whole Farm Evaluation
- Part B - Irrigation and Nitrogen Practices
- Part C - Well Information
- Part D - Sediment and Erosion Control Practices

The FE survey result table includes:

- Township – The township and range in which land resides
- Question – FE survey question
- Response – Management Practice response to each FE survey question
- Result Acreage – Acreage for which the question/response combination applies
- Result Crop – The crop for which each question/response applies
- Normalized Crop – Crop designation assigned to each Result Crop by Coalition
- Valid – Data quality assessment field used to assess data gaps by township

Technical assistance was provided to coalition members in completing the FE forms in the early of 2018 and is summarized as follows:

- Outreach meetings held in early 2018
- Assistance filling out the FE surveys by water district and Coalition staff

Summary of Management Plans covered by this report

General order R5-2015-0095 covers agricultural effects on groundwater quality. Surface water quality is covered under a different general order. At this time, the applicable portions of the following management plans are covered by this report.

- Groundwater Quality Management Plan

Farm Evaluation Participation Summary

The GDA Coalition's 2017 membership roster submitted to the State Water Resources Control Board on July 31, 2017, was used as a baseline. The enrolled acreage of groundwater high vulnerably parcels in the GDA Coalition at the time of the survey was 44,200 acres. All coalition members returned a FE survey. The total response acreage was 45,842 acres. The response acreage includes 132 management units.

The response acreage is greater than the enrolled acreage due to double-cropping, the practice of growing one or more crops on a field during the same growing season. While the response acreage and enrolled acreage do not correlate perfectly, the response acreage is an accurate representation of agricultural practices in the groundwater high vulnerability areas in the Coalition.

Table 1: FE/MWE Participation Summary

FE Surveys Received for Irrigated Land	65	
FE Surveys Received for Non-irrigated Land	0	
FE Surveys Received for Lands covered under alternate WDR	0	
Total Members Surveyed	65	
Total Surveyed Acreage	44,200	acres
Response Acreage	45,842	acres

Coalition Crop Information

Cropping patterns for the 2017 growing season were developed from the FE surveys. The reported crop was normalized so that a meaningful summary could be developed. In many instances, multiple crops were reported for a single acreage. To normalize data reported in this manner, the following criteria were used:

- If a clear summer crop was identified along with a winter crop (ex. tomatoes/ wheat), the summer crop (tomatoes) was assigned as the normalized crop.
- In situations where no clear summer crop was identified (Corn/Tomatoes or Almonds/Cotton), the first crop listed was assigned as the normalized crop.

The resulting data identifies the major crops in the Coalition. However, their rank, relative to each other, is not accurate due to the methodology discussed above.

Table 2: Crop Summary

Primary Crop	Acres
Pistachios	9,644
Almonds	7,473
Tomatoes	5,852
Cotton	4,612
Grapes	2,948
Forage	2,898
Melons	2,386
Jose Tall Wheatgrass	1,347
Wheatgrass	846
Onions	700
Pomegranates	460
Asparagus	218
Watermelons	111
2017 Total Reported Farmed Acreage	39,494
Fallow or Not Farmed	6,348
Response Acreage	45,842

Part A - Whole Farm Evaluation

The management practices reported in Part A of the FE survey are summarized below. These management practices are not crop-specific but apply on an operation-wide basis. Coalition members were asked to list their pesticide application practices, the consultants they utilize and assess their farm's potential to discharge sediment off-site.

Table 3: Whole Farm Evaluation

Question/Response	Acreage
Pesticide Application Practices	
Attend Trainings	44,180
County Permit Followed	44,050
Follow Label Restrictions	44,050
Use PCA Recommendations	43,790
Avoid Surface Water When Spraying	43,588
Use Appropriate Buffer Zones	43,239
Use Drift Control Agents	42,767
Monitor Rain Forecasts	42,739
End of Row Shutoff When Spraying	42,302
Monitor Wind Conditions	40,672
Sensitive Areas Mapped	34,067
Chemigation	29,119
Reapply Rinsate to Treated Field	28,106
Use Vegetated Drain Ditches	17,199
Target Sensing Sprayer used	10,843
No Pesticides Applied	2,259
Other – See Note 1	736

Note 1 – Two growers provided responses in the "other" category under pesticide application practices. One grower noted that the field was organic and the other noted the field was fallow, likely implying that no pesticides were applied.

Who do you have help develop your crop fertility plan?	
Pest Control Advisor (PCA)	36,078
Certified Crop Advisor (CCA)	32,516
Professional Agronomist	14,795
Professional Soil Scientist	8,879
Independently Prepared by Member	6,276
UC Farm Advisor	3,893
None of the above	1,706
Other1 – See Note 2	1,706
No Selection	86
Does your farm have the potential to discharge sediment to off-farm surface waters?	
No	41,612
Yes	4,231

Note 2 –Two growers provided responses in the "other" in this category. One grower noted that no fertilizer was applied. The other grower indicated that the field was fallow.

Part B - Irrigation and Nitrogen Management Practices

The responses from Part B are summarized in Tables 6 and 7. A strong majority of the lands in groundwater high vulnerability areas are irrigated via high-efficiency methods (drip and micro sprinkler). High-efficiency irrigation methods tend to minimize seepage and associated contaminants, such as nitrate, past the root zone.

Table 4: Irrigation Practices

Question/Response	Acreage
Irrigation Practices	
Drip*	40,343
Flood	2,330
Furrow	2,140
No Selection	458
Micro Sprinkler*	310
Sprinkler	140
Border Strip	121

*High-efficiency irrigation method

Table 5: Secondary Irrigation Practices

Secondary Irrigation	
No Selection	25,949
Sprinkler	15,747
Drip	2,017
Furrow	1,500
Border Strip	622
Micro Sprinkler	346
Flood	121

*High-efficiency irrigation method

Table 6: Irrigation Efficiency and Nitrogen Management

Irrigation Efficiency Practices	
Water application scheduled to need	43,455
Use of moisture probe	38,051
Use of ET in scheduling irrigations	36,844
Pressure Bomb	11,526
Soil Moisture Neutron Probe	10,732
Laser Leveling	5,039
No Selection	458
Other (responses included “fallow” and “soil probe”)	5,199
Nitrogen Management Methods to Minimize Leaching Past The Root Zone	
Tissue/Petiole Testing	41,848
Split Fertilizer Applications	40,207
Soil Testing	40,104
Fertigation	36,715
Irrigation Water N Testing	33,161
Foliar N Application	26,620
Cover Crops	6,638
Do Not Apply Nitrogen	2,390
Variable Rate Applications using GPS	2,120
No Selection	25
Other (responses included “No Nitrogen Applied and “Fallow”)	4,422

Part C - Well Information

A total of 59 production wells were reported on the FE/MWE surveys. Some members indicated that the well was abandoned but reported wellhead protection practices. It is assumed these wells are idle and may be used in the future. Wells assumed idle are excluded from the abandoned well count and included in the wellhead protection count. A total of 57 wells were considered protected, meeting the criteria below. The remaining 2 were not protected.

A well is considered protected if the following criteria are met:

1. Either a Backflow Preventer/Check Valve or an Air Gap is reported for a given well.
2. Either the ground is sloped away from or standing water is avoided around the wellhead for a given well.

A total of 6 abandoned wells were reported. Five (5) wells were abandoned in or after 1995. One well was reported to have been abandoned in 1960 and one well did not have an abandoned year reported.

Table 7: Well Information

Question/Response	Count of Wells
Wellhead Protection Practices	
Good "Housekeeping" Practices*	59
Ground Sloped Away from Wellhead	59
Standing water avoided around wellhead	58
Backflow Preventive / Check Valve	52
Air Gap (for non-pressurized systems)	30
Cement Pad	8
Abandoned Well Practices	
No Data Entered	1
Destroyed - Unknown method	4
Destroyed by licensed professional	1
Destroyed – certified by county	0

Part D - Sediment Management Practices

Sediment management practices are summarized below. Surface water in the Grassland Drainage Area is not regulated by the ILRP, but is covered under a separate WDR. As such, growers in the GDA were not required to complete part D of the Farm Evaluation Survey. However, a strong majority of growers did complete this portion of the survey and the data is summarized below.

Table 8: Sediment and Erosion Control Practices

Irrigation Practices for Managing Sediment and Erosion	
Use drip or micro-irrigation to eliminate irrigation drainage.	34,436
The time between pesticide applications and the next irrigation is lengthened as much as possible to mitigate runoff of pesticide residue.	29,682
No irrigation drainage due to field or soil conditions.	22,055
Shorter irrigation runs are used with checks to manage and capture flows.	14,065
Tailwater Return System.	5,003
Catchment Basin.	3,912
In-furrow dams are used to increase infiltration and settling out of sediment prior to entering	3,295
Use of flow dissipaters to minimize erosion at discharge point.	1,973
No Selection	1,785
Use drip or micro-irrigation to eliminate irrigation drainage.	167

Cultural Practices to Manage Sediment and Erosion	
Soil water penetration has been increased through the use of amendments, deep ripping and/or aeration.	37,178
Minimum tillage incorporated to minimize erosion.	27,389
Crop rows are graded, directed and at a length that will optimize the use of rain and irrigation water.	23,285
No storm drainage due to field or soil conditions.	16,294
Berms are constructed at low ends of fields to capture runoff and trap sediment.	13,976
Storm water is captured using field borders.	13,606
Field is lower than surrounding terrain.	9,220
Subsurface pipelines are used to channel runoff water.	8,692
Vegetated ditches are used to remove sediment as well as water soluble pesticides, phosphate fertilizers and some forms of nitrogen.	8,660
Sediment basins / holding ponds are used to settle out sediment and hydrophobic pesticides such as pyrethroids from irrigation and storm runoff.	6,013
Cover crops or native vegetation are used to reduce erosion.	2,287
No Selection	1,670
Hedgerows or trees are used to help stabilize soils and trap sediment movement.	861
Creek banks and stream banks have been stabilized.	557

Data Quality Assessment of Collected Information

The quality of the management practice data was assessed on a township/range (township) level and is summarized in Table 10. The assessment quantifies both missing data and incorrect/inaccurate reporting as an acreage percentage by township. For 2017, only groundwater high vulnerability areas were surveyed, spanning 11 townships.

Table 9: Data Validation Criteria

Criteria	Designation
Single crop listed	valid
Multiple crops listed	
Permanent Crops	
Single permanent crop with grain/forage crop (ex: almonds and wheat)	valid
Multiple permanent crops of same type (ex: nut trees, fruit trees etc.)	valid
Multiple permanent crop types (ex: nut trees and fruit trees, nut trees and vines)	unclear
Permanent crop types with row crops (ex: almonds and tomatoes)	unclear
Row Crops	
Single row crop with grain/forage crop (ex: tomatoes and wheat)	valid
Multiple row crops	unclear
Other Crop Designations	
No Irrigated Agriculture	valid
Fallow	valid
No Crop Specified	unclear

Table 10: Quality Assessment by Township

Township	Percent Complete	Percent Valid
11S 10E	100%	100%
11S 11E	93%	100%
11S 12E	100%	100%
12S 11E	87%	95%
12S 12E	95%	100%
12S 13E	100%	100%
13S 11E	56%	100%
13S 12E	89%	86%
13S 13E	100%	100%
13S 14E	82%	100%
13S 15E	100%	100%

All surveys were received for the 2017 growing season. However, some members omitted parcels from their Farm Evaluation because they did not farm those parcels during the survey period. The resulting data gaps are shown in Table 10.

All management units categorized as “unclear” were assigned this designation because of dissimilar crop type (example Grapes/Pistachios or Melons/Tomatoes). While the individual acreage devoted to each crop is not discernable, the reported management practices are still useful.

Groundwater Quality Management Plan Status Report

On August 31, 2017, the Grassland Drainage Area Coalition submitted a Groundwater Quality Management Plan (GQMP) for the Grassland Drainage Area Coalition (GDAC or Coalition) in response to the approval of the Groundwater Assessment Report (GAR) on January 16, 2017.

The GQMP identified several performance goals listed below.

1. Provide outreach and education to members in HVA
2. Properly destroy abandoned wells
3. Implement wellhead protection practices
4. Implement irrigation water N testing
5. Implement pesticide management practices for groundwater
6. Outreach to nitrogen outliers

The GQMP approach includes three primary actions to achieve these goals and are listed below.

1. Education of Members
2. Implementation of Management Practices
3. Identification and tracking of management practices

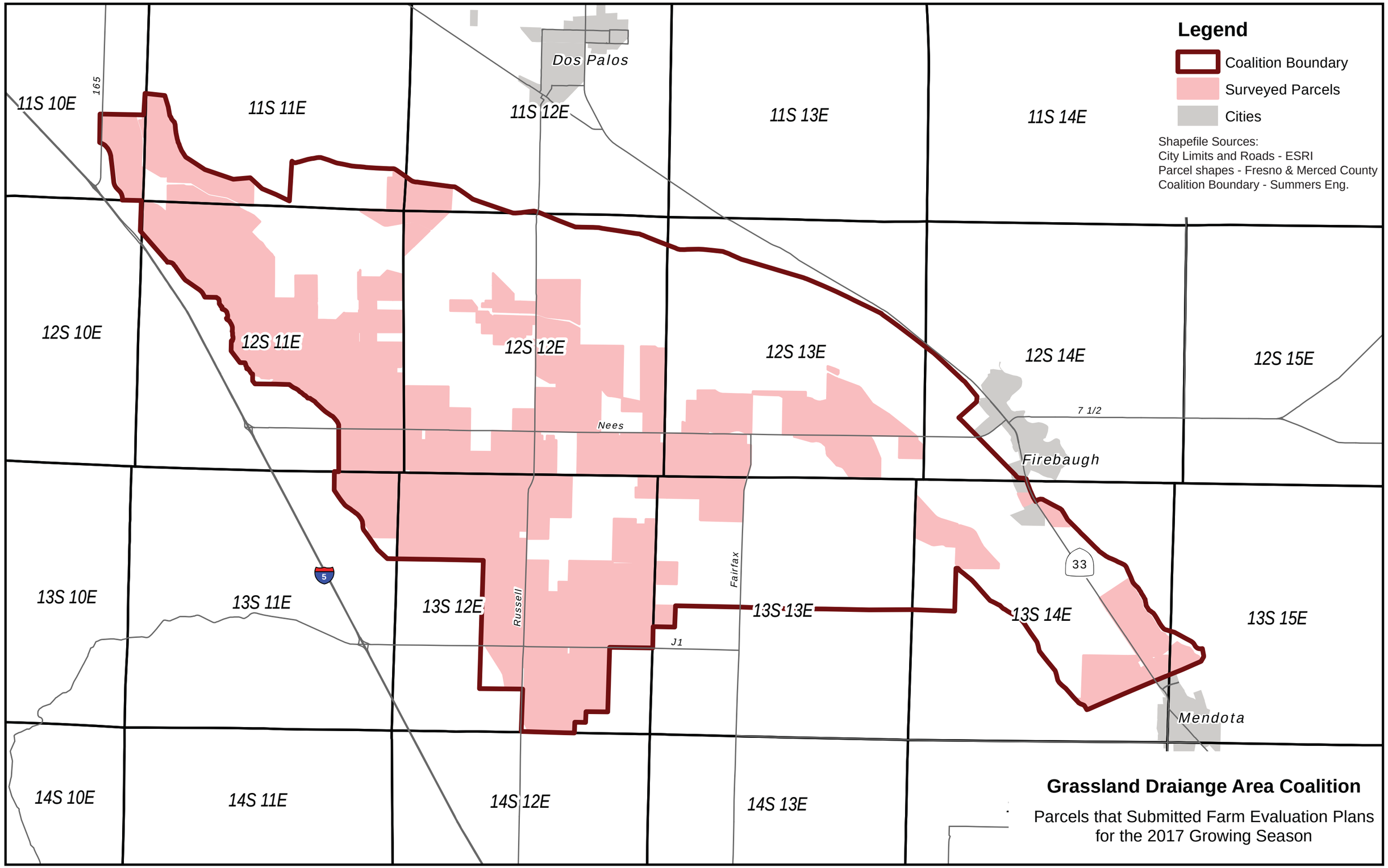
Progress toward performance goals and effectiveness of the Coalition's outreach efforts is currently assessed by analyzing year-to-year changes in management practice implementation, tracked using the annual Farm Evaluation Survey.

Recent updates to the general order have changed the survey interval of the Farm Evaluation Survey from yearly to every five years. Because the FE data will no longer be available on a yearly basis, a new data source is needed to continue tracking of management practices protective of groundwater in a yearly basis. A management practice implementation report (MPIR) will be developed to capture relevant information and more precisely track management practices protective of groundwater. Additionally, the groundwater-specific MPIR will assist growers with identifying new practices protective of groundwater. The GDA Coalition will propose an amendment to GQMP for approval by the Regional Water Quality Control Board in the coming months and a groundwater-specific MPIR template will accompany that proposal.

At this point in time, 2017 Farm Evaluation data is available and will be used to assess progress toward the performance goals listed above. Additionally, Farm Evaluation data was collected for the 2018 growing season and will be reported in on November 30, 2019. A subsequent Groundwater Quality Management Plan Status Report will accompany that report which is due on November 30, 2019.

Following is a summary of progress toward each performance goal and related management practices information obtained from the 2017 Farm Evaluation Survey.

Location Map of parcels for which management practices were obtained for the 2017 growing season.



1. Provide outreach and education to members in HVA

   The GDA Coalition held an annual meeting February 8, 2019. At the meeting, information on management practices identified as protective of groundwater quality were discussed. A strong majority of GDA Coalition members (>95%) were present at this meeting.

2. Properly destroy abandoned wells

   Below are the abandoned well practices obtained from the 2017 Farm Evaluation Plans. A total of 6 abandoned wells were reported. Five of which may not have been destroyed properly. The Coalition will outreach to members who have potentially unprotected wells. A sample of this outreach material is included following this GQMP status update.

2017 - Abandoned Well Practices	
No Data Entered	1
Destroyed - Unknown method	4
Destroyed by licensed professional	1
Destroyed – certified by county	0

3. Implement wellhead protection practices

   The Coalition considers a well "protected" if the following criteria are met:

   1. Either a Backflow Preventer/Check Valve or an Air Gap is reported for a given well.
   2. Either ground is sloped away from or standing water is avoided around the wellhead is reported for a given well.

   A total of 59 production wells were reported on the 2017 FE surveys, 57 wells were considered protected, meeting the criteria above. The remaining 2 were not protected. The Coalition will outreach to members with unprotected wells and provide information on wellhead protection practices. A sample of this outreach material is included following his GQMP status update.

2017 - Wellhead Protection Practices	
Good "Housekeeping" Practices*	59
Ground Sloped Away from Wellhead	59
Standing water avoided around wellhead	58
Backflow Preventive / Check Valve	52
Air Gap (for non-pressurized systems)	30
Cement Pad	8

4. Implement irrigation water N testing

Approximately 70% of the acreage surveyed in 2017 reported irrigation water "N" testing as a nitrogen management practice, and in 2016 around 60% reported this practice. It is important to note that in 2016, all Coalition parcels were surveyed; whereas, in 2017 only parcels in groundwater high vulnerability areas were surveyed. In order to make a consistent comparison between 2016 and 2017, only groundwater high vulnerability acreages were considered when calculating the percentage of growers implementing irrigation water N testing practices for 2016.

Irrigation water N testing is discussed at annual grower meetings. Additionally, handouts are provided to all attending growers providing information on how to determine the amount of nitrogen in their irrigation water and how that information can be resolved to a "pounds per acre" basis for incorporation into the Nitrogen Management Plan (superseded by the Irrigation and Nitrogen Management Plan). The Coalition will to encourage growers to test their irrigation water nitrate during annual meetings. A sample of this handout is included following this GQMP status update.

5. Implement pesticide management practices for groundwater

The GQMP prioritizes pesticide management practices by ease of implementation and cost. Priority 1 practices are considered easiest to implement with Priority 3 practices being most difficult.

A majority of members in groundwater high vulnerability areas have implemented priority 1 practices to a relatively high degree with exception of "reapply rinsate to treated field". It is possible that a majority of growers have dedicated tanks for each chemical and/or they hire professional applicators to apply their chemicals and do not own the spray tanks. Priority 2 & 3 practices are either not applicable or too costly to implement for some crop types in the GDA Coalition.

2017 - Pesticide Handling Management Practices		
Management Practice	2017	Priority
Good Housekeeping*	96%	1
Avoid Surface Water When Spraying	95%	1
Use Appropriate Buffer Zones	94%	1
Monitor Wind Conditions	89%	1
Use Drift Control Agents	93%	1
Use vegetated Darin Ditches	38%	2
Chemigation	64%	3
Reapply Rinseate to Treated Field	61%	1
Target Sensing Sprayer Used	24%	3
End of Row Shutoff When Spraying	92%	1

*Combined category: management practices include Follow County Permit, Label Restrictions & Attend Trainings

6. Outreach to nitrogen outliers

An analysis of nitrogen data collected in 2018 for the 2017 growing season was analyzed and a report was submitted on April 30, 2019. Using results of this report, outreach packets were compiled summarizing a single grower's submitted nitrogen data in comparison to other growers in the Coalition. By the time the packets were available ready mailing, the 2019 growing season was well underway. Because of the large time lag (2017 to 2019) and the fact that nitrogen management plans had already been completed and certified, they were not mailed out at that time. The Coalition plans to mail the 2017 nitrogen outlier reports in early 2020 along with the 2018 nitrogen outlier reports which will accompany the Irrigation and Nitrogen Management Plan.