Kings River Water Quality Coalition

Annual Monitoring Report

Reporting Period:
January 1, 2018 through December 31, 2018

Fresno County, California • August 2019

Prepared for:

KINGS RIVER WATER QUALITY COALITION

Prepared by:

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

Kings River Water Quality Coalition

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Abbreviations

A ..... Nitrogen Applied

Ac ..... Acre

AMR ..... Annual Monitoring Report

A/R ..... Applied Nitrogen/Nitrogen Removed

A/Y Ratio ..... Applied Nitrogen/Actual Yield

Basin Plan ..... Water Quality Control Plan for the Tulare Lake Basin

CCA ..... Certified Crop Advisor

CDEC ..... California Data Exchange Center

Central Valley Water Board ..... Central Valley Regional Water Quality Control Board

cfs ..... cubic feet per second

CGQMP ..... Comprehensive Groundwater Quality Management Plan

CIG ..... Conservation Innovation Grant

CIMIS ..... California Irrigation Management Information System

Coalition ..... Kaweah Basin Water Quality Association

CVGMC ..... Central Valley Groundwater Monitoring Collaborative

CVHM ..... Central Valley Hydrologic Model

CV-SALTS ..... Central Valley Salinity Alternatives for Long-Term Sustainability

Dairy General Order ..... Waste Discharge Requirements for Existing Milk Cow Dairies

DO ..... Dissolved Oxygen

DWR ..... California Department of Water Resources

EC ..... Electrical Conductivity

EO ..... Executive Officer

EPA ..... Environmental Protection Agency

FID ..... Fresno Irrigation District

FKC ..... The Friant-Kern Canal

GAR ..... Groundwater Assessment Report

General Order ..... General Order R5-2013-0120

GPS ..... Global Positioning System

GQTM ..... Groundwater Quality Trend Monitoring

HVA ..... High Vulnerability Area

ILRP ..... Irrigated Lands Regulatory Program

IQR ..... Interquartile Range

KRCD ..... Kings River Conservation District

KRWA ..... Kings River Water Association

KRWQC ..... Kings River Water Quality Coalition

lbs ..... Pounds

MCL ..... Maximum Contaminant Level

MDL ..... Method Detection Limit

MPEP ..... Management Practice Evaluation Program

MRP ..... Monitoring and Reporting Program

N ..... Nitrogen

NB ..... Non-Bearing

NHI ..... Nitrogen Hazard Index

NMP ..... Nitrogen Management Plan

NRCS ..... Natural Resources Conservation Service

NY ..... No Yield

PCA ..... Pest Control Advisor

QAPP ..... Quality Assurance Project Plan

QAPrP ..... CVGMC Quality Assurance Programmatic Plan

RL ..... Reporting Limit

RWQCB ..... Central Valley Regional Water Quality Control Board

SECP ..... Sediment and Erosion Control Plan

SQMP ..... Surface Water Quality Management Plan

SSJV MPEP ..... Southern San Joaquin Valley MPEP

SWAMP ..... Surface Water Ambient Monitoring Program

SWMP ..... Surface Water Monitoring Plan

TDS ..... Total Dissolved Solids

TIE ..... Toxicity Identification Evaluation

TKN ..... Total Kjeldahl Nitrogen

TOC ..... Total Organic Carbon

TSS ..... Total Suspended Solids

WDR ..... Waste Discharge Requirements

Y ..... Actual Yield

Executive Summary

This Annual Monitoring Report (**AMR**) has been prepared on behalf of the Kings River Water Quality Coalition (**KRWQC** or **Coalition**) in response to Waste Discharge Requirements General Order for Growers in the Tulare Lake Basin that are Members of a Third-Party Group, Order No. R5-2013-0120-07 (**General Order**). The KRWQC has been approved by the Executive Officer to conduct monitoring and reporting on behalf of its members as a third-party representative. The purpose of the AMR is to meet reporting requirements of the General Order as described in Attachment B to Order R5-2013-0120-07, Monitoring and Reporting Program (**MRP**) Section V.C which requires the KRWQC to summarize monitoring activities, grower outreach and education, and grower-member submittals to the Coalition. An AMR must be submitted by the Coalition annually to the Central Valley Regional Water Quality Control Board (**RWQCB**).

The Coalition's boundaries extend from the southern limit of the San Joaquin River in the north (left bank or Fresno County side) to the Kings-Kern County line to the south, the western boundaries of the Kaweah and Tule River Coalitions to the east (generally a line parallel to the Kings-Tulare County line), and the boundary of Westlands Water District to the west.

Summary of the 2018 AMR

Surface Water Monitoring Summary

Four different monitoring sites types are available in the General Order for third-party coalitions to meet surface water monitoring requirements. These sites are: 1) fixed, long-term core sites, 2) assessment sites, 3) ephemeral sites, and 4) special project sites. Due to the perennial nature of the Kings River, the Coalition has elected to utilize a rotation of Core and Assessment monitoring for a majority of the KRWQC monitoring sites.

The KRWQC conducted monitoring at 8 surface water sites during the 2018 Calendar Year. There were no surface water quality exceedances during 2018. Precision and accuracy of water quality measurements and analysis of both laboratory and field results were compared against objectives described in the KRWQC Quality Assurance Project Plan (**QAPP**). Water quality data collected during the 2018 Calendar Year meet quality assurance criteria established by the General Order and described in the submitted QAPP. QA/QC completeness reached 99.81% and 2% of the results involved qualified results.

All previously submitted, Surface Water Ambient Monitoring Program (**SWAMP**) formatted data for the 2018 Calendar Year is included in **Appendix A**. This includes analytical reports from the contracted laboratory, field sheets, and monitoring site photos. The data was formatted to be SWAMP comparable, for submittal to the CEDEN database by the RWQCB.

Groundwater Monitoring Summary

The primary objective of the KRWQC's groundwater monitoring efforts is to maintain compliance with requirements of the Irrigated Lands Regulatory Program (**ILRP**) General Order, which requires the KRWQC to characterize groundwater quality within the KRWQC region. Groundwater monitoring is intended to be used to evaluate long term trends in groundwater quality, reflective of potential impacts from agricultural practices. However, collected data may reflect natural conditions associated with larger aquifer characteristics and potential influences from other sources (e.g., septic systems and other dischargers). Additionally,

collected data may also reflect potential legacy impacts, which are not from current land management practices.

The General Order requires the Trend Monitoring Workplan to be submitted to the RWQCB one year from Groundwater Assessment Report (**GAR**) approval. The KRWQC submitted a GAR on November 20, 2014. The RWQCB conditionally approved the GAR on April 26, 2016. The KRWQC submitted a Groundwater Quality Trend Monitoring (**GQTM**) Workplan to the RWQCB on April 26, 2017 and subsequent revisions on May 16, 2018 and July 31, 2018. The GQTM was conditionally approved on August 21, 2018. The KRWQC sampled 80 wells in the fall of 2018. The monitoring network consisted of irrigation, domestic and public utility wells.

Electronic PDF copies of laboratory reports are attached in **Appendix B**. As required in Attachment B, MRP Section IV.E.3 and MRP Section V.B, groundwater monitoring results (formatted as an Excel workbook) of all data records uploaded to the State Water Resources Control Board's GeoTracker database are attached in **Appendix B**.

Groundwater quality data collected during the fall of 2018 met quality assurance criteria established by the General Order and described in the submitted CVGMC Quality Assurance Programmatic Plan (**QAPrP**). While laboratory QA/QC completeness reached 100%, issues preventing the measurement of depth to water resulted in 98.28% parameter completeness. Qualified laboratory results were reported on rare occasions (0.87%).

Grower-Member Reporting

The 2018 calendar year is the third year that both the Farm Evaluation Surveys and Nitrogen Management Plan (**NMP**) Summary Reports were submitted to the KRWQC. The results of those reports are summarized in this AMR.

NMP Summary Reports and Farm Evaluation Surveys were due to the KRWQC by March 1, 2018. NMP Summary Reports and Farm Evaluations were required for all farms of any size with enrolled high vulnerability area (**HVA**) parcels. 4,200 Current Members were required to submit the NMP Summary Report. Of these members, 3,599 members submitted the NMP Summary Report, or 85.6% (as of this writing). Of the 2,246 NMP Summary Reports submitted, a total of 416,378 irrigated acres were included, although only 389,092 irrigated acres of this total were used in this report due to various issues outlined.

The Coalition is required to submit a report summarizing the information provided by the Farm Evaluation Surveys within the Annual Report each year, due August 31 along with the individual data recorded in an electronic format by Township. The members and parcels are not to be identified. The Annual Report period covers data collected from the previous calendar year, defined as 01 January through 31 December. The Farm Evaluation Surveys are required to be submitted by each member on or before March 1 each year covering data of the prior crop year. The Farm Evaluation Survey data provides a summary of the management practices of the previous crop year. Of the members required to complete a Farm Evaluation, 97% of the Coalition members submitted a Farm Evaluation Survey.

Education and Outreach Reporting

As required by the General Order, the KRWQC conducted education and outreach events for enrolled grower members. Presentations included information on the completion and submittal of Farm Evaluations, NMP worksheets and NMP Summary Reports, as well as self-certification training opportunities for the completion of NMPs and Sediment and Erosion Control Plans (**SECP**s). Education and outreach efforts

continued to include outlining the requirements of the General Order, communicating the role of the KRWQC, supporting member compliance, describing the methodologies employed in the various technical reports developed by KRWQC, and assisting members in understanding and meeting the NMP Worksheet, NMP Summary Report, and Farm Evaluation reporting requirements.

ILRP annual re-enrollment and reporting requirements were highly publicized through direct mailings, email blasts, notifications on the KRWQC website, and by holding grower education meetings. Resources for grower education and outreach meetings are routinely posted online at http://www.kingsriverwqc.org. These resources including meeting notifications, PDF copies of Power Point presentations, and video links (if education workshops were filmed). Report templates and instructions are also accessible online.

1 Introduction

This Annual Monitoring Report (**AMR**) has been prepared on behalf of the Kings River Water Quality Coalition (**KRWQC** or **Coalition**) in response to Waste Discharge Requirements (**WDR**) General Order, for Growers in the Tulare Lake Basin that are Members of a Third-Party Group, Order No. R5-2013-0120-07 (**General Order**). The Executive Officer (**EO**) of the Regional Water Quality Control Board (**RWQCB**) has approved the KRWQC as a third-party group to conduct monitoring and reporting on behalf of enrolled grower members within the Coalition's boundaries.

The Kings River Watershed Coalition Authority is a Joint Powers Authority formed by the 28 member agencies of the Kings River Water Association (**KRWA**) plus the Kings River Conservation District (**KRCD**) for the express purpose of assisting member growers in the compliance with the regulations regarding surface and groundwater quality as specified by the RWQCB. Initially formed to monitor surface water, the adoption of the General Order of Waste Discharge for the Tulare Lake Basin (excluding Westlands), R5-2013-0120 on September 19, 2013 and the subsequent approval of the Kings River Watershed Coalition Authority (Kings River Water Quality Coalition or Coalition) on November 20, 2013 has expanded the scope of effort for the Coalition for those interests within the Kings River service area. The KRCD provides staffing support for the Coalition.

In accordance with the specifications detailed in Attachment B, Monitoring and Reporting Program (**MRP**), to the General Order, the AMR must describe and summarize;

1. Monitoring well data.
2. Surface water monitoring data.
3. Quality assurance evaluations.
4. Nitrogen Management Plan summary information.
5. Farm Evaluation information.
6. Mitigation monitoring.
7. Education and outreach activities.

The AMR now includes various reporting periods. Reporting periods for this 2018 AMR are described in **Table 1-1**.

Table 1-1. Reporting Periods for the 2018 Annual Monitoring Report

AMR Section Title	AMR Section Number	Reporting Period Start	Reporting Period End
Surface Water Quality Results	**Section 1**	Jan. 1, 2018	Dec. 31, 2018
Groundwater Quality Results	**Section 3**	Sept. 2018	Dec. 2018
Nitrogen Management Plan Summary Report Analysis	**Section 4**	Jan. 1, 2018	Dec. 31, 2018
Farm Evaluations	**Section 5**	Jan. 1, 2018	Dec. 31, 2018
Education and Outreach	**Section 7**	Jan. 1, 2018	Dec. 31, 2018

1.1 Geographic Area

The Coalition's boundaries extend from the southern limit of the San Joaquin River in the north (left bank or Fresno County side) to the Kings-Kern County line to the south, the western boundaries of the Kaweah and Tule River Coalitions to the east (generally a line parallel to the Kings-Tulare County line), and the boundary of Westlands Water District to the west.

The KRWQC is located on the east side of the south-central portion of the San Joaquin Valley within the Tulare Lake Basin (**Figure 1-1**). The San Joaquin Valley, which is the southerly portion of the great Central Valley of California, extends about 250 miles from the Sacramento-San Joaquin Delta area at the north end to the Tehachapi Mountains at the south end. In the vicinity of the KRWQC, the Central Valley is approximately 65 miles wide. The Valley is bordered on the east by the Sierra Nevada Mountains which range in elevation from about 1,000 feet or less to more than 14,000 feet above sea level. The Coast Range, which borders the Valley on the west, rises to about 6,000 feet above sea level. The southern end of the San Joaquin Valley, also known as the Tulare Lake Basin, is a closed feature separated from the Sacramento-San Joaquin Bay-Delta system and without external surface drainage.

The upper Kings River watershed covers an area of approximately 1,545 square miles above Pine Flat Dam, along the western face of the highest portion of the Sierra Nevada mountain range. Elevations range from a peak of over 14,000 feet to around 400 feet where it meets the Valley floor. The dominant material in the upper watershed is granitic rock. A number of foothill tributaries exist below Pine Flat Reservoir, the largest of which is Mill Creek. All of the foothill tributaries are ephemeral streams that are active during the winter and early spring months. Additional water deliveries to the sub-watershed come from the Friant-Kern Canal (**FKC**) and from the California Aqueduct.

There are approximately 2,747,093 total acres within the coalition boundary. Approximately 786,619 irrigated, commercially farmed acres were enrolled by 4,109 grower members in compliance with the Irrigated Lands Regulatory Program (**ILRP**).

1.1.1 Hydrology & Geology

The Tulare Lakebed is effectively a closed depression with a bottom elevation of about 175 ft. above MSL. The only natural outlet is to the north (at elevation 207 ft. MSL) into the San Joaquin River. The development of intensive irrigated agriculture in the tributary basins, including the reclamation of land in the Lakebed, the construction of reservoirs in the major tributary watersheds, and other flood control measures have significantly reduced the potential for Lakebed filling and flowing north in the future. Flood control releases from Pine Flat are diverted through the North Fork until channel capacity is reached, then flows are diverted into the Tulare Lakebed. Major hydrologic features within the KRWQC boundary are illustrated in **Figure 1-2**.

As described in the KRWQC Groundwater Assessment Report (**GAR**) "The area is defined by a complex geology. Site specific hydrogeologic and aquifer conditions can vary, influencing the degree of confinement, levels of protection at an individual well from surficial sources of contamination and time of travel and flow to a well or well field." The regional geologic setting is further described "The Kings study area is in the Tulare Lake hydrologic region and includes the Kings and Tulare Lake subbasins, as designated in DWR's Bulletin 118." The Kings and Tulare sub-basins are summarized in the GAR. "Both the Kings and Tulare sub-basins filled with material originating from the Coastal Range to the west and the Sierra Nevada to the east. Sediments carried from the two ranges filled the valley trough between the mountain ranges is comprised of marine and continental sediments. To the east of the valley, the Sierra Nevada is composed

primarily of pre-Tertiary granitic rocks and is separated from the valley by a foothill belt of Mesozoic and Paleozoic marine rocks and Mesozoic metavolcanic rocks along the northern one-third of the boundary. The Coast Ranges west of the valley have a core of Franciscan assemblage of late Jurassic to late Cretaceous or Paleocene age and Mesozoic ultramafic rocks. These rocks are overlain by marine and continental sediments of Cretaceous to Quaternary age and some Tertiary volcanic rocks. The alluvial deposits of the western part of the valley tend to be of finer texture relative to those of the eastern part of the valley because they are derived from the Coast Ranges and have a higher clay content. (GEI, 2014)."

"Generally thin, discontinuous lenses of fine-grained sediments (clay, sandy clay, sandy silt, and silt) are distributed throughout the Coalition area, creating areas of perched water or confinement, and affecting the rate and direction of groundwater flow and contaminant transport. The clay layers offer some degree of protection from surface sources of contamination and constrain the time of travel for water and contaminants from the soils zone through the unsaturated zone. The large percentage of fine-grained sediments in the western San Joaquin Valley impedes the downward movement of groundwater and contributes to agricultural drainage problems and to land subsidence in the area (GEI, 2014)." Percent coarse materials from 1-50 feet are illustrated in **Figure 1-3**.

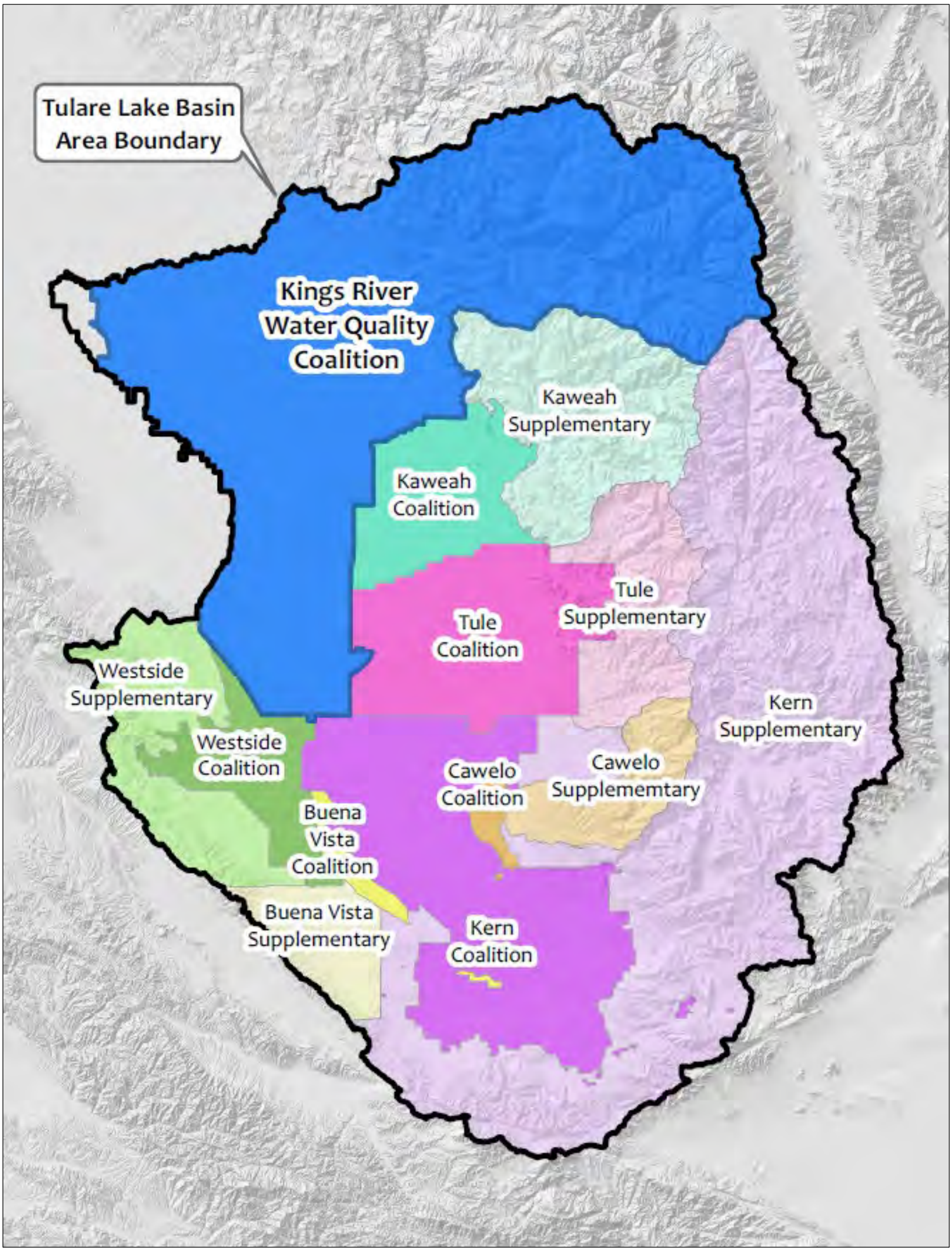

Figure 1-1. KRWQC Vicinity Map

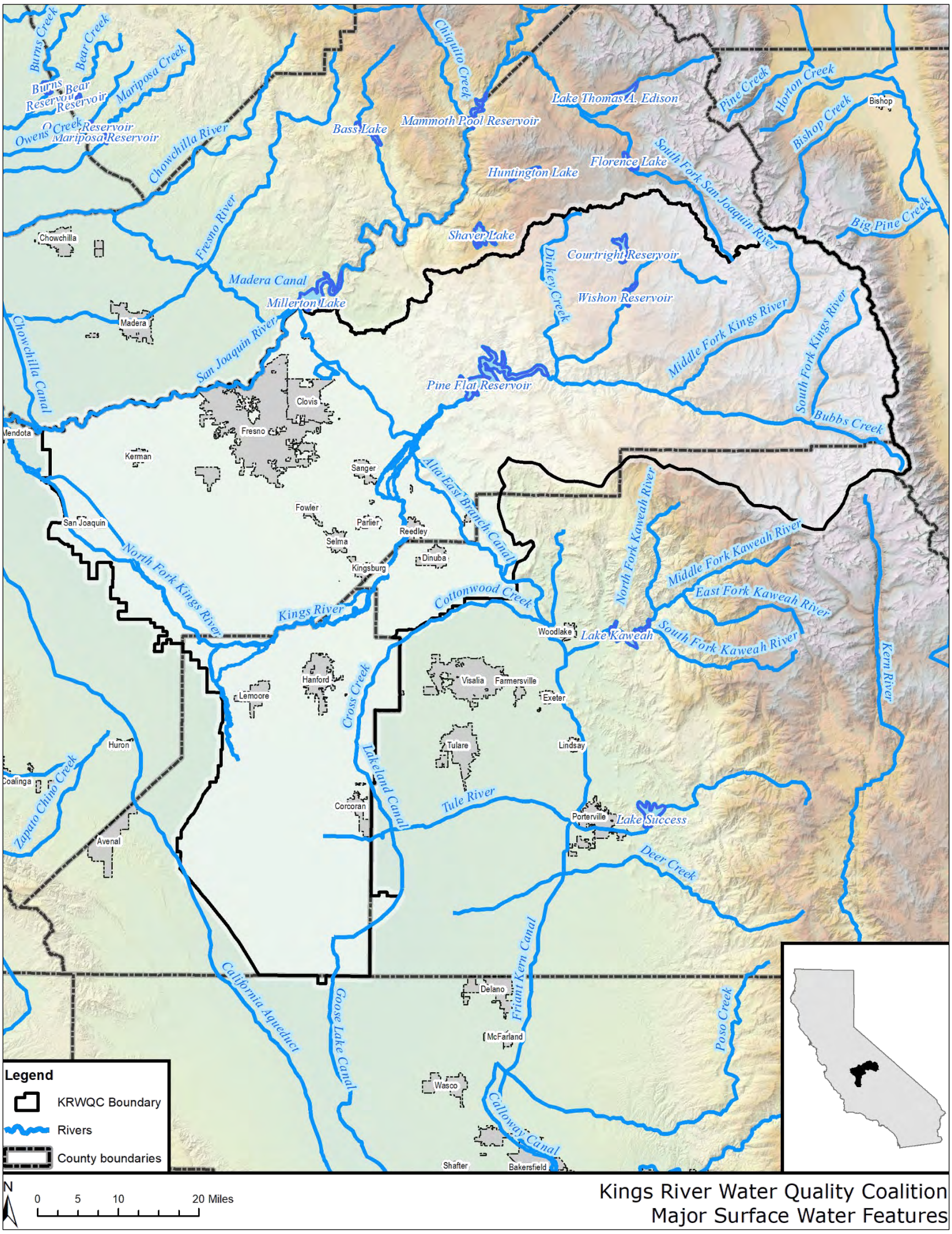

Figure 1-2. KRWQC Area Hydrologic Map

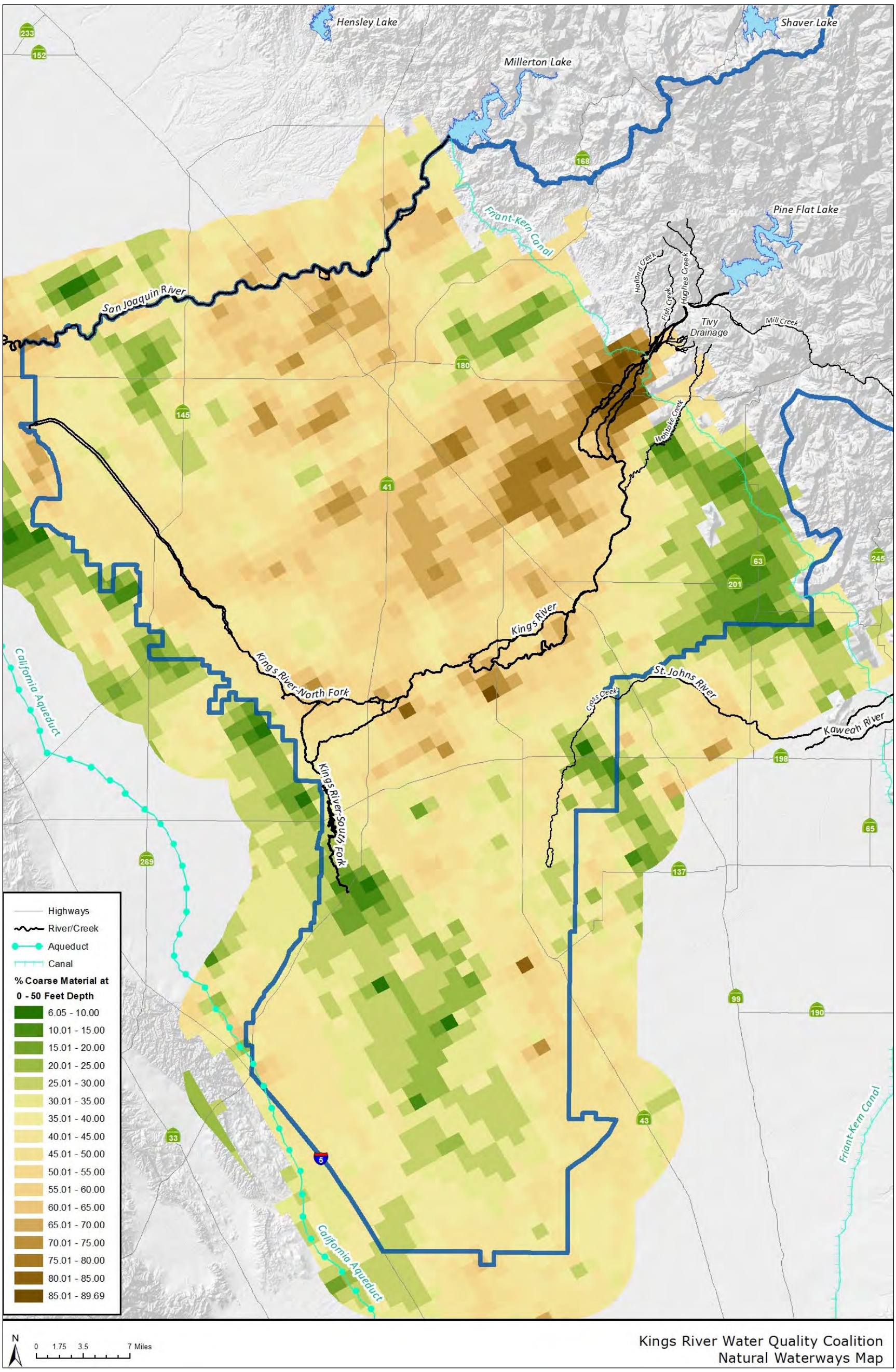

Figure 1-3. KRWQC Percent Coarse Materials 0-50 Feet

1.1.2 Land Use

Figure 1-4 illustrates crop types within the KRWQC. Information on land use within the KRWQC area was obtained from the California Department of Water Resources (**DWR**) 2014 Land Use Dataset and diary location information was obtained from other DWR field surveys.

Irrigated agriculture and dairies are the dominate land uses within the KRWQC's Primary Area. Citrus, deciduous fruits and nuts, and vineyard's make up the majority of the crops grown in the KRWQC. In the eastern portion citrus crops are primarily grown. Within the central portions of the KRWQC deciduous fruit and nut crops are predominately grown. In the southern portion of the KRWQC, pasture and field crops predominate land use. Dairies are regulated under the Waste Discharge Requirements General Order for Existing Milk Cow Dairies (**Order No. R5-2007-0035**) and RWQCB Order R5-2013-0122, Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies (**Dairy General Order**). Many of the forage crops grown are associated with manure waste applications and are also regulated by the Dairy General Order. Large urban areas including the cities of Fresno, Selma, and Hanford are located throughout the area of the KRWQC.

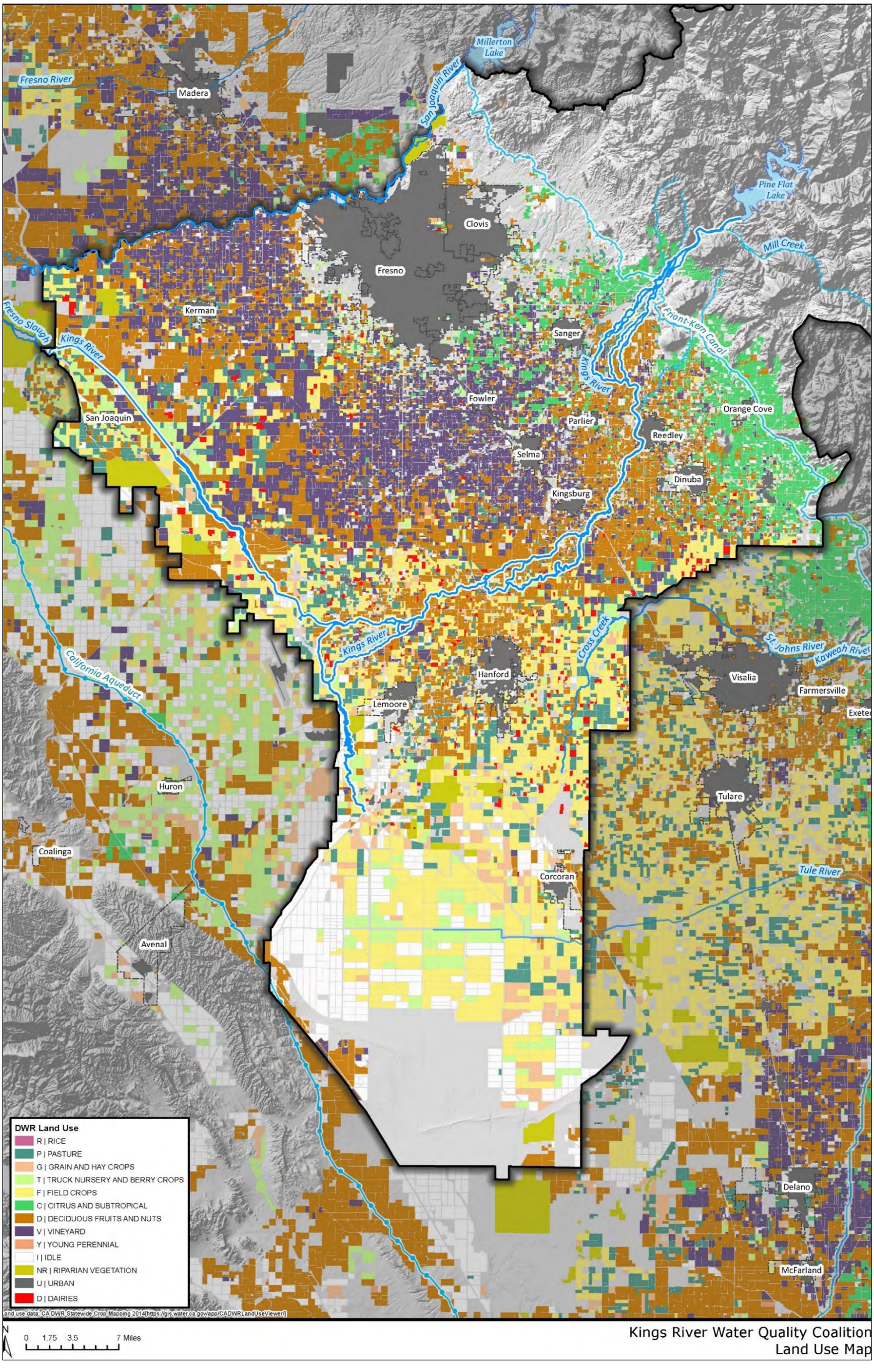

Figure 1-4. KRWQC Area Crop Map (DWR_2014)

1.1.3 Soils

Soil information for the KRWQC Area is well documented in the GAR. As described in the KRWQC GAR, both the Kings and Tulare Lake sub-basins are filled with material originating from the Coastal Range to the west and the Sierra Nevada to the east. **Figure 1-5** depicts soil textures within the KRWQC as defined by the Natural Resource Conservation Service (**NRCS**).

> "Sediments carried from the two ranges filled the valley trough between the mountain ranges is comprised of marine and continental sediments. To the east of the valley, the Sierra Nevada is composed primarily of pre-Tertiary granitic rocks and is separated from the valley by a foothill belt of Mesozoic and Paleozoic marine rocks and Mesozoic metavolcanic rocks along the northern one-third of the boundary. The Coast Ranges west of the valley have a core of Franciscan assemblage of late Jurassic to late Cretaceous or Paleocene age and Mesozoic ultramafic rocks. These rocks are overlain by marine and continental sediments of Cretaceous to Quaternary age and some Tertiary volcanic rocks. The alluvial deposits of the we stern part of the valley tend to be of finer texture relative to those of the eastern part of the valley because they are derived from the Coast Ranges and have a higher clay content (USGS, 1998) (USGS, 2006).
>
> The sediments influence the geochemistry and resultant water quality; and time of travel through the vadose zone and in saturated portion of the aquifer. The coarse materials lie at the edges of the mountains along the alluvial fans in the east side of the valley and these areas contain more coarse and permeable materials originating from the Sierra Nevada Range than do the less well-developed fans originating the Coastal Range. The San Joaquin, Kings, Tule and Kaweah Rivers have cut through the deposited materials and resulted in higher permeability zones that are able to more readily transmit water and any dissolved contaminants through preferential flow paths. The sediments in the Kings Study area are saturated with freshwater range in thickness from 100 to more than 4,000 ft. The Coastal Range is composed of marine sediments and water moving through these aquifer materials dissolve and transport salts. Saline water with a minimum dissolved-solids concentration of 2,000 mg/L occurs at depth (GEI, 2014)."

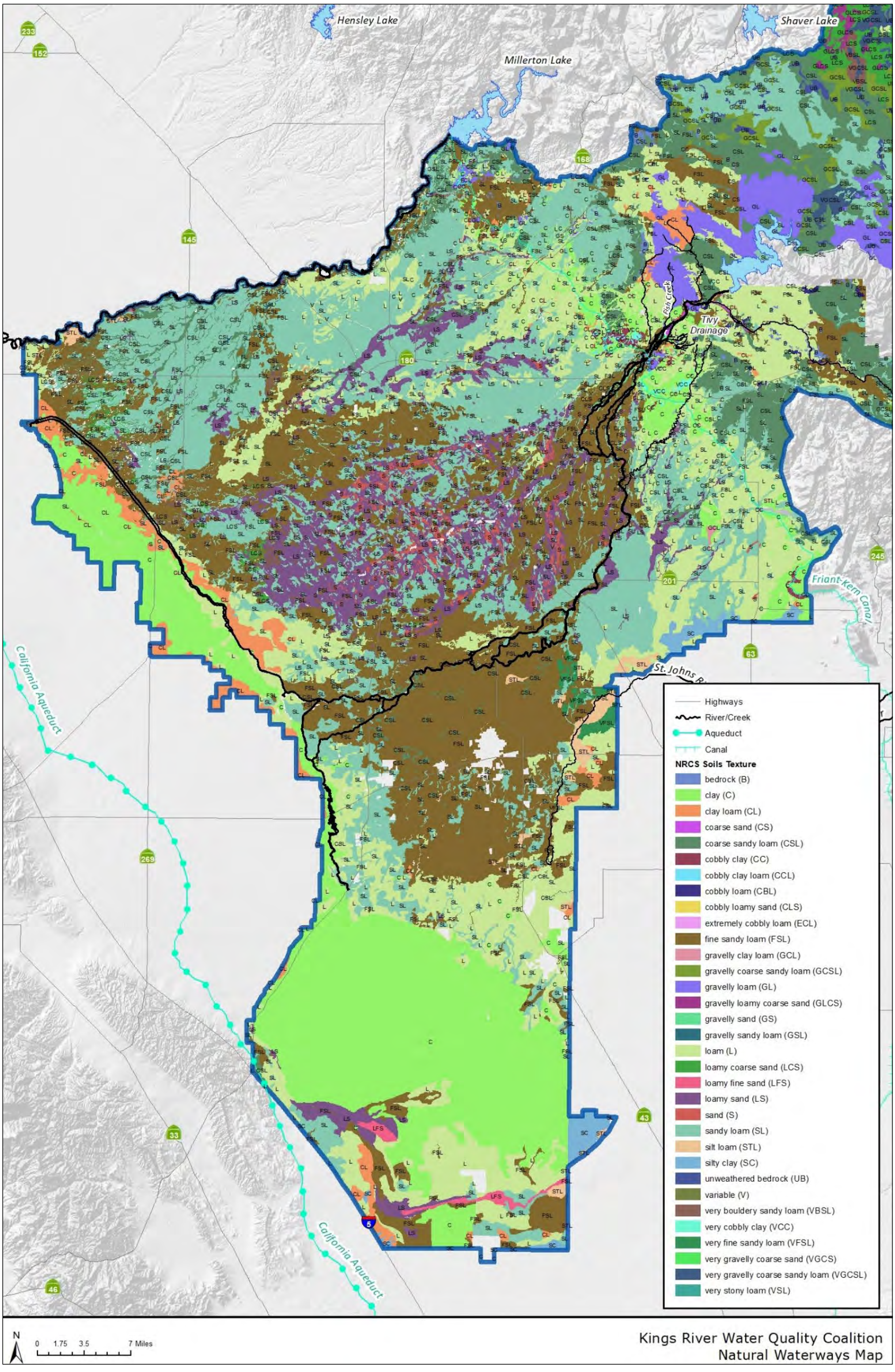

Figure 1-5. Soil Texture Map

2 Surface Water Monitoring Report

2.1 Surface Water Monitoring Objectives & Design

The primary objective of the KRWQC's surface water monitoring efforts is to maintain compliance with requirements of the ILRP General Order. The MRP requires the KRWQC to characterize water quality within the coalition region, track any trends, and identify any irrigated agricultural practices which may potentially impact water quality.

As required by the General Order the KRWQC initially submitted a Surface Water Monitoring Plan (**SWMP**) on August 4, 2014. Comments were received on December 2, 2014 from the RWQCB. A revision of the SWMP was submitted to the RWQCB on February 2, 2015 (Revision 1) and subsequent comments were received from the RWQCB on October 22, 2018. A second revision (Revison2) was submitted to the RWQCB outside of the 2018 Calendar year reporting period.

Four different monitoring sites types are available in the General Order for third-party coalitions to meet surface water monitoring requirements. These sites are: 1) fixed, long-term core sites, 2) assessment sites, 3) ephemeral sites, and 4) special project sites. Due to the perennial nature of the Kings River, the Coalition has elected to utilize a rotation of Core and Assessment monitoring for a majority of the KRWQC monitoring sites. Monitoring sites were selected based on their distribution throughout the watershed area and existing monitoring history. The KRWQC believes that maintaining the current monitoring sites will continue to develop trends and document potential impacts to water quality.

2.2 Surface Water Monitoring Site Descriptions

The KRWQC conducted monitoring at 8 surface water sites during the 2018 Calendar Year. Monitoring site locations are represented in **Figure 2-1**. **Table 2-1** provides a summary of the Surface Water Ambient Monitoring Program (**SWAMP**) codes and global positioning system (**GPS**) coordinates for each site. Monitoring site location and California Irrigation Management Information System (**CIMIS**) station information is illustrated in **Figure 2-1**. Monitoring site locations and hydrology are further described below.

Table 2-1. Surface Water Monitoring Site Locations

Site	SWAMP Codes	Classification	Latitude	Longitude
Tivy Creek	551TVAPR	Ephemeral	36.778543	-119.409816
Gould Canal	551GCARBA	Core	36.761009	-119.510943
Manning Ave	551KRAMAV	Assessment	36.613131	-119.464883
Lemoore Weir	551KRALMW	Assessment	36.418295	-119.724272
Crescent Weir	551KRACRW	Core	36.386084	-119.877422
Stinson Weir	551KRASTW	Core	36.460275	-119.994085
Jackson Ave	551KRAJAV	Special Study	36.256057	-119.853877
Empire Weir #1	551EMPH41	Core	36.238422	-119.858138

2.2.1 Tivy Creek

Tivy Creek is an ephemeral stream in the foothills above the Kings River. The surrounding irrigated land is planted in citrus. Management practices in use differ from other areas of similar crops. Normal frost protection methods are not required due to increased elevation. Tivy Creek is a relatively small watershed; therefore, the creek is subject to rapid rises and falls during rainfall events making timing of sample collection critical. The high clay content of the soil inhibits infiltration of surface water and results in increased sediment loads when the stream is flowing. The creek enters a channel that parallels the Kings River and finally enters the river further downstream.

2.2.2 Gould Canal

Gould Canal is a distribution canal for Fresno Irrigation District (**FID**) that was constructed in the late 1800's. Like Tivy Creek, it also lies in an area of citrus production, but in a region that requires active frost protection measures. The canal can be subject to surface runoff due to its low construction and high clay content soils, and it has multiple sources of water (Kings River water at the headgate or through a connection to the Fresno Main, plus a turnout from the FKC). Runoff risks are primarily from the north side of the canal (right bank, looking downstream) and only for the first 7 miles of its run through the KRWQC. Potential for runoff varies along the course of the canal and generally decreases substantially downstream of this sampling site.

The Gould Canal sampling site is located in close proximity to other primary distribution canals used by FID: Enterprise Canal (serving the northeast corner of the district and Clovis' surface water treatment plant), and the Fresno Main. The monitoring site location, located between the two canals, was selected because it provides the safest access to the water stream.

2.2.3 Manning Avenue

Manning Avenue is one of the oldest monitoring sites in the program and is located on the Kings River below the confluence with Wahtoke Creek near Reedley College. Water is present year-round at this site. Crops have transitioned from citrus to stone fruit, with limited areas of field crops. Soil textures differ from those found in the lower foothills with high clay content and transition to sandy and silty loams which have been deposited in the alluvial fan. Local topography is gently undulating to flat, and the river has formed a channel of varying depths compared to the surrounding lands. Adequate sediment is typically available for sampling.

2.2.4 Lemoore Weir

Lemoore Weir is a major diversion point on the lower Kings River and is also one of the oldest monitoring sites in the program. Water samples can be collected at two locations, depending upon flow conditions. Water being diverted only for Lemoore Canal Company is handled upstream of the weir, while water being delivered to the North Fork and/or South Fork is sampled below the weir structure. Surrounding crops include nut trees and field crops.

Sediment sample collection is dependent on previous season water flows. If water has only been delivered to Lemoore Canal Company, then the sediments are collected in the river channel upstream of the weir. If deliveries have been made to water users below Lemoore Weir, sediment is collected in the basin between the weir and the gauging station.

2.2.5 Crescent Weir

Crescent Weir is a major diversion structure on the North Fork and a gauging station for flood control operations. Field crops (cotton and dairy related) dominate this region of the river system, although permanent plantings of almonds, vines, and pistachios are also present.

Water samples are collected in a location where flowing water exists, either on the right bank of the channel or near the Crescent Canal intake on the left bank. Sediment can be collected easily from the river channel.

2.2.6 Stinson Weir

Stinson Weir is considered the last practical diversion point on the lower North Fork of the Kings River due to the high channel losses incurred in bringing water to this point. Field crops are the dominant crop type in this region, although permanent plantings are also present. Water samples can be collected in much the same way as at Crescent Weir, either on the right bank or near the intake for Stinson Canal on the left.

2.2.7 Jackson Avenue

Samples collected at the Jackson Avenue monitoring site are representative of water impounded behind Empire Weir #1 on the South Fork of the Kings River. The site is listed as impaired under the Clean Water Act section 303(d) list for multiple water quality criteria (toxaphene, molybdenum, electrical conductivity [**EC**]). The site is listed as a special study site and is monitored for physical parameters and tested for toxaphene and molybdenum levels on a monthly basis, as conditions permit.

Samples for this site will be collected from the main channel of the river. As conditions change throughout the course of the year, isolated pools may form in higher reaches of the river channel. The KRWQC intends to collect samples from the actively moving channel at all river stages. This requires that the exact location of sample collection vary by approximately 20 feet. Other variations in sampling location will be noted on the field sheets, as necessary.

2.2.8 Empire Weir #2

Empire Weir #2 is the last diversion point on the South Fork of the Kings River. Here, water is split into three canals: the Tulare Lake Canal along the north rim, the Blakely Canal along the west rim, and the remaining channel of the Kings River which flows into Tulare Lake. Field crops are the dominant crop type in this region. Both Jackson Ave and Empire Weir #2 are impacted by high salt soils due to the perched groundwater in the region and the deposits that have formed in the area due to flooding and drying cycles.

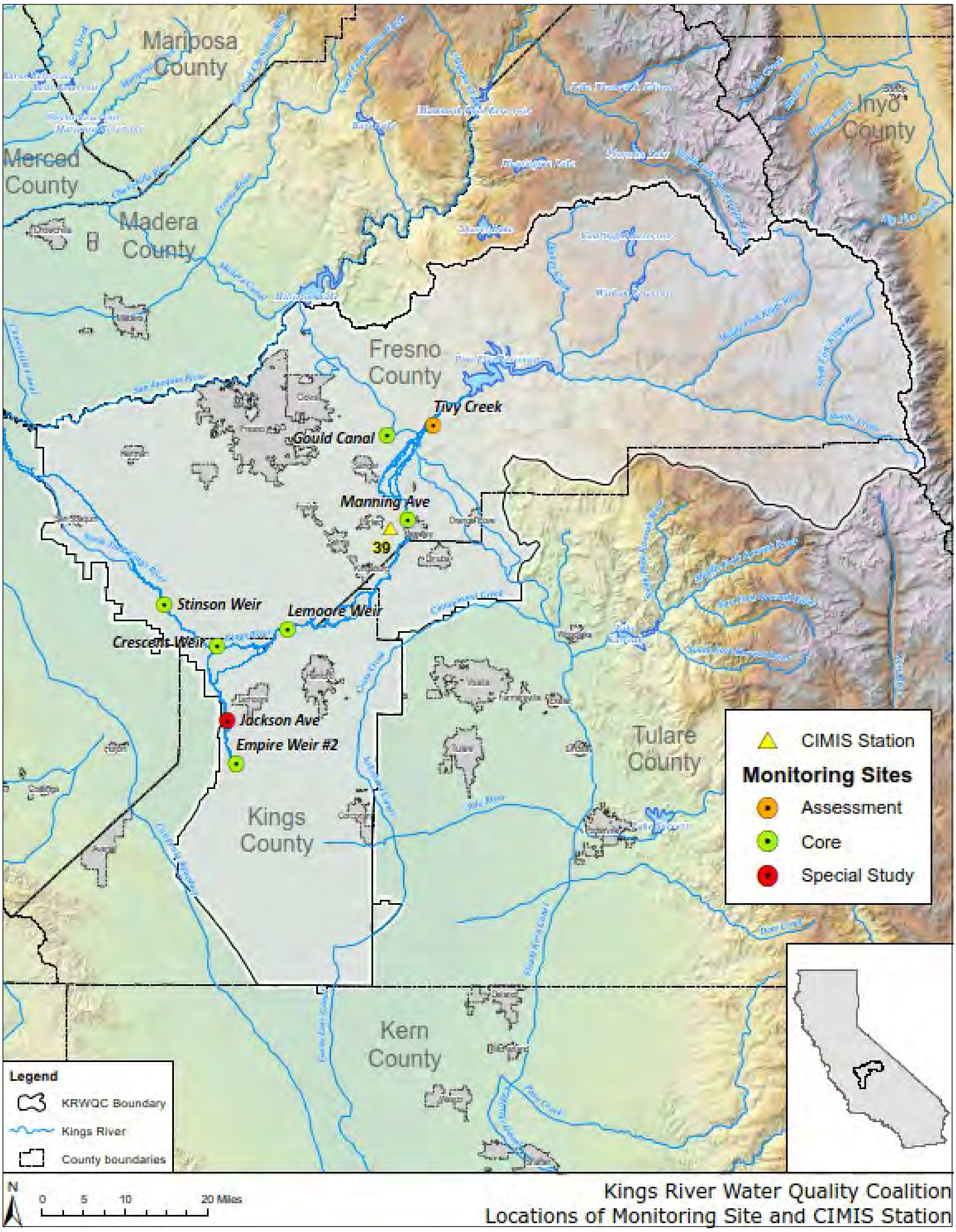

Figure 2-1. Monitoring Site Locations & CIMIS Station

2.3 Surface Water Monitoring Schedule

Assessment sites are monitored for all Assessment parameters in year 1 and then Core parameters in years 2 and 3. This schedule allows for determining trends and potential impacts to surface water quality from agricultural operations. The KRWQC has elected to conduct monitoring based on a calendar year as its annual reporting period (January 1st to December 31st).

Assessment monitoring parameters are summarized in **Table 2-2**. The Core and Assessment monitoring cycle is described in **Table 2-3**. The Assessment and Core monitoring schedule is detailed in **Table 2-4**.

Table 2-2. Assessment Monitoring Parameters

Parameters	Monitoring Frequency
Photo monitoring (digital)	Every monitoring event (wet or dry)
General Physical Parameters	Monthly
Nutrients	Monthly
Pathogens	Monthly
Water Column Toxicity	Monthly
Metals	Monthly
Pesticides	Monthly
Sediment Toxicity	Twice per year[1]

1 One sample shall be collected between March 1 and April 30; the other sample shall be collected between August 15 and October 15, in conjunction with channel flow events

Table 2-3. Core Monitoring Cycle

Monitoring Type	Year 1	Year 2	Year 3
Assessment	X		
Core		X[1]	X

1 Core will include assessment parameters exceeding trigger limit in Year 1 and 2.

Table 2-4. Assessment and Core Sampling Schedule

Site	2014	2015	2016	2017	2018	2019	2020
Gould Canal	Core +*	Core +	Assessment	Core +	Core +	Assessment	Core +
Manning Ave	Core	Assessment	Core	Core	Assessment	Core	Core
Lemoore Weir	Core	Assessment	Core	Core	Assessment	Core	Core
Crescent Weir	Core	Core	Assessment	Core	Core	Assessment	Core
Stinson Weir	Core	Core	Assessment	Core	Core	Assessment	Core
Empire Weir #2	Core	Core	Assessment	Core	Core	Assessment	Core

*Core + indicates that Assessment parameters are being monitored under the Core requirements

2.4 Surface Water Monitoring Parameters

Table 2-5 provides a summary of the constituents monitored and associated analytical methods, units, reporting limits (**RL**), and method detection limits (**MDL**).

Pesticides were monitored as required by the 2008 ILRP conditional waiver. Future pesticide monitoring will be submitted following the Pesticide Evaluation Protocol (**PEP**), which was issued by the EO in November 2016. The PEP is required to be used by coalition groups to determine appropriate pesticides to monitor under the Monitoring and Reporting Program for surface water.

As described in the Protocol, coalitions must annually update and submit a list of pesticides to be monitored using the most recent three years of pesticide use data. Pesticide use data are required to be evaluated to create monitoring prioritization based on aquatic life and human health reference values, as well as evaluating existing monitoring data, environmental fate factors, and availability of analytical methods. The resulting list is intended to be watershed-specific and updated annually with the submittal of the Surface Water Monitoring Plan Update. Monitoring Plan Updates are due 60 days prior to the start of the coalition's monitoring year.

Table 2-5. Summary of Constituents Monitored

Constituent	Matrix	Analyzing Lab	Units	RL	MDL	Analytical Method
Field Measurements						
Flow	Fresh Water	Field Measure	cfs	1	NA	
pH	Fresh Water	Field Measure		0.1	NA	EPA 150.1
Electrical Conductivity (EC)	Fresh Water	Field Measure	µmhos/cm	50	NA	EPA 120.1
Dissolve Oxygen (DO)	Fresh Water	Field Measure	mg/L	0.1	NA	SM 4500-O
Temperature	Fresh Water	Field Measure	°C	0.1	NA	SM 2550
Physical Parameters						
Turbidity	Fresh Water	BSK	NTU	0.05	0.02	SM 2130B
Total Dissolved Solids (TDS)	Fresh Water	BSK	mg/L	10	4	SM 2540C
Total Suspended Solids (TSS)	Fresh Water	BSK	mg/L	10	NA	SM 2540D
Hardness (as $CaCO_3$)	Fresh Water	BSK	mg/L	2.5	1	EPA 200.7, Calc
Total Organic Carbon (TOC)	Fresh Water	BSK	mg/L	0.5	0.13	SM 5310C
Pathogens						
E. Coli	Fresh Water	BSK	MPN/100 mL	1	1	SM 9221 B, F
Fecal Coliform	Fresh Water	BSK	MPN/100 mL	1	1	SM 9221 E
Nutrients						
Total Kjeldahl Nitrogen (TKN)	Fresh Water	BSK	mg/L	0.5	0.27	EPA 351.2
Nitrate-N	Fresh Water	BSK	mg/L	0.1	0.01	EPA 300.0
Nitrite-N	Fresh Water	BSK	mg/L	0.1	0.01	EPA 300.0
Ammonia	Fresh Water	BSK	mg/L	0.1	0.05	SM 4500-NH3 G
Unionized Ammonia (calculated value)	Fresh Water	BSK	mg/L	0.1	0.05	SM 8010F
Orthophosphate	Fresh Water	BSK	mg/L	0.1	0.01	SM 4500-P E

Constituent	Matrix	Analyzing Lab	Units	RL	MDL	Analytical Method
Phosphorus	Fresh Water	BSK	mg/L	0.1	0.01	EPA 365.4
Metals						
Arsenic	Fresh Water	BSK	µg/L	1	0.09	EPA 200.8
Boron	Fresh Water	BSK	µg/L	50	5	EPA 200.8
Cadmium	Fresh Water	BSK	µg/L	0.1	0.02	EPA 200.8
Copper	Fresh Water	BSK	µg/L	1	0.1	EPA 200.8
Lead	Fresh Water	BSK	µg/L	0.2	0.1	EPA 200.8
Molybdenum	Fresh Water	BSK	µg/L	1	0.05	EPA 200.8
Nickel	Fresh Water	BSK	µg/L	1	0.2	EPA 200.8
Selenium	Fresh Water	BSK	µg/L	1	0.1	EPA 200.8
Zinc	Fresh Water	BSK	µg/L	1	0.1	EPA 200.8
Carbamates						
Aldicarb	Fresh Water	BSK	µg/L	0.40	0.20	EPA 8321A
Carbaryl	Fresh Water	BSK	µg/L	0.07	0.05	EPA 8321A
Carbofuran	Fresh Water	BSK	µg/L	0.07	0.05	EPA 8321A
Methiocarb	Fresh Water	BSK	µg/L	0.40	0.20	EPA 8321A
Methomyl	Fresh Water	BSK	µg/L	0.07	0.05	EPA 8321A
Thiobencarb	Fresh Water	BSK	µg/L	0.50	0.06	EPA 8321A
Oxamyl	Fresh Water	BSK	µg/L	0.40	0.20	EPA 8321A
Organochlorines						
DDD	Fresh Water	BSK	µg/L	0.01	0.003	EPA 8081A
DDE	Fresh Water	BSK	µg/L	0.01	0.004	EPA 8081A
DDT	Fresh Water	BSK	µg/L	0.01	0.007	EPA 8081A
Dicofol	Fresh Water	BSK	µg/L	0.1	0.01	EPA 8081A
Dieldrin	Fresh Water	BSK	µg/L	0.01	0.005	EPA 8081A
Endrin	Fresh Water	BSK	µg/L	0.01	0.007	EPA 8081A
Methoxychlor	Fresh Water	BSK	µg/L	0.01	0.008	EPA 8081A
Toxaphene	Fresh Water	BSK	µg/L			EPA 8081A
Organophosphates						
Azinphos-methyl	Fresh Water	BSK	µg/L	0.1	0.02	EPA 8270C
Chlorpyrifos	Fresh Water	BSK	µg/L	0.02	0.003	EPA 8270C
Demeton-S	Fresh Water	BSK	µg/L	0.1	0.01	EPA 8270C
Diazinon	Fresh Water	BSK	µg/L	0.02	0.004	EPA 8270C
Dichlorvos	Fresh Water	BSK	µg/L	0.1	0.02	EPA 8270C
Dimethoate	Fresh Water	BSK	µg/L	0.1	0.08	EPA 8270C
Disulfoton	Fresh Water	BSK	µg/L	0.1	0.02	EPA 8270C
Malathion	Fresh Water	BSK	µg/L	0.1	0.05	EPA 8270C
Methamidophos	Fresh Water	BSK	µg/L	0.2	0.01	EPA 8270C

Constituent	Matrix	Analyzing Lab	Units	RL	MDL	Analytical Method
Methidathion	Fresh Water	BSK	µg/L	0.1	0.04	EPA 8270C
Methyl Parathion	Fresh Water	BSK	µg/L	0.1	0.075	EPA 8270C
Phorate	Fresh Water	BSK	µg/L	0.1	0.072	EPA 8270C
Phosmet	Fresh Water	BSK	µg/L	0.2	0.06	EPA 8270C
Herbicides						
Atrazine	Fresh Water	BSK	µg/L	0.5	0.07	EPA 8270C
Simazine	Fresh Water	BSK	µg/L	0.5	0.08	EPA 8270C
Cyanazine	Fresh Water	BSK	µg/L	0.5	0.09	EPA 8270C
Diuron	Fresh Water	BSK	µg/L	0.4	0.2	EPA 8321A
Molinate	Fresh Water	BSK	µg/L	0.5	0.1	EPA 8270C
Glyphosate	Fresh Water	BSK	µg/L	5	4	EPA 547
Paraquat	Fresh Water	BSK	µg/L	0.4	0.2	EPA 549.2
Linuron	Fresh Water	BSK	µg/L	0.4	0.2	EPA 8321A
Trifluralin	Fresh Water	BSK	µg/L	0.05	0.03	EPA 8270C
Water Column Toxicity						
Ceriodaphnia dubia (water flea)	Fresh Water	PER	48h % survival	NA	NA	EPA 821-RO2-012
Pimephales promelas (fathead minnow)	Fresh Water	PER	48h % survival	NA	NA	EPA 821-RO2-012
Selenastrum capricomutum (green algae)	Fresh Water	PER	96h % survival	NA	NA	EPA 821-RO2-013
Sediment Toxicity – As needed						
Hyalella azteca	Sediment	PER	10d % survival	NA	NA	EPA 600-R99-064
Pesticides and & Sediment Parameters (Pyrethroids) – As needed						
Bifentrhin	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Chlorpyrifos	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Cyfluthrin	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Cypermethrin	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Deltamethrin	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Esfenvalerate/Fenvalerate	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Fenpropathrin	Sediment	PER	µg/kg	0.3	0.05	EPA 8270C
Lamda Cyhalothrin	Sediment	PER	µg/kg	0.3	0.05	EPA 8270C
Permethrin	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Piperonyl butoxide (PBO)	Sediment	PER	µg/kg	0.3	0.1	EPA 8270C
Total Organic Carbon (TOC)	Sediment	PER	mg/kg	200	100	Walkley Black
Grain size	Sediment	PER	%	NA	NA	ASTM D422

2.5 Surface Water Sample Collection Methods

Sites are identified on field sheets with target latitude and longitude coordinates, which were verified in the field by sampling crews with actual latitude and longitude coordinates of the collected sample. Sampling crews make every effort to maintain the same location of sample withdraw from the water body, to avoid inadvertent sample bias or any future complications in comparison of data. During extreme high flow events field crews document on field sheets any modifications necessary for sample collection. Safety of sampling crews is critical and site conditions must be evaluated routinely for any potential safety concerns.

Photo documentation of the monitoring site will be performed at all monitoring events, regardless of whether water is present and/or flowing. Photos will be submitted with field sheets to document site conditions. Site observations are also recorded regardless of whether water is present and/or flowing. Site observations include time on site, weather observations, water and sediment characteristics, and any additional site descriptions or comments. Surface water samples will be collected with associated field data sheets as required by the General Order. These field data sheets follow a standardized format as prescribed by CEDEN and associated "Look-Up Lists."

Where possible field crews collect grab samples from the centroid of the stream. For water bodies where sampling the centroid of the stream is not feasible (due to safety concerns, high flow conditions, etc.) sample collection is from the bank, which is appropriate in areas where water is adequately mixed and not impeded by any obstructions (natural or man-made) and where the flow of water is not disturbed (i.e. eddy). Grab samples for water sampling are collected in laboratory provided containers. Containers that do not include a preservative are briefly filled, dumped and refilled prior to capping and sealing for transport. Containers that do include a preservative are filled, capped, and sealed for transport. The sampler remains downstream of the sample containers during this process to avoid contamination of the sample. Sediment samples are collected as composite samples with a clean stainless-steel scoop. The sampler works from downstream to upstream to be compliant with SWAMP protocols and to avoid contamination. The contracted laboratory homogenizes sediment samples prior to performing analyses.

Samples are collected by hand grab method whenever feasible. Field crews communicate with the Laboratory Coordinator if any site should become inaccessible either permanently or temporarily. Once samples are collected and sealed, they are transported from the field to the local laboratory office using "blue ice" to keep the samples cool. Any samples needing to be sent to a different office for analysis (i.e. main office or subcontract office) will be quickly packaged with "wet ice" for transport. This is done to meet various hold times and keep samples at the proper temperature (< 6 °C).

2.6 Surface Water Quality Results Summary

All previously submitted, SWAMP formatted data for the 2018 Calendar Year is included in **Appendix A**. This includes analytical reports from the contracted laboratory, field sheets, and monitoring site photos. The data was formatted to be SWAMP comparable, for submittal to the CEDEN database by the RWQCB.

Tabulated surface water monitoring results collected during the 2018 Calendar Year are in **Appendix A**. Total collected water quality samples for the 2018 Calendar Year are summarized in **Table 2-6**. Results showed no exceedances of surface water quality standards during 2018.

Table 2-6. Summary of Sampling Events During 2018

Monitoring Site	Site Code	Number of 2018 Sampling Events
Tivy Creek	551TVAPR	0
Gould Canal	551GCARBA	9
Manning Ave	551KRAMAV	12
Lemoore Weir	551KRALMW	5
Crescent Weir	551KRACRW	2
Stinson Weir	551KRASTW	0
Jackson Ave	551KRAJAV	12
Empire Weir #2	551KREWPH41	3

2.6.1 2018 Precipitation

Table 2-7 summarizes the monthly precipitation for the 2018 Calendar Year at the lone CIMIS station in the KRWQC region. **Table 2-8** summarizes additional precipitation data gathered through the California Data Exchange Center (**CDEC**).

Table 2-7. CIMIS Station #39 – Parlier Station

Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	June 2018	July 2018	Aug 2018	Sept 2018	Oct 2018	Nov 2018	Dec 2018	Total
1.19	0.40	3.43	0.61	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.44	**7.60**

Source: http://www.cimis.water.ca.gov/UserControls/Reports/MonthlyReportViewer.aspx

Table 2-8. Additional Precipitation Data (CDEC) - 2018

Station	2018												Total
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	
Hanford Refinery	1.37	0.30	2.33	0.29	0.00	0.00	0.00	0.00	0.00	0.04	1.41	0.42	**6.16**
Fresno Airport	1.23	0.26	4.19	0.64	0.00	0.00	0.00	0.00	0.00	0.10	1.67	0.56	**8.65**

Source: http://cdec.water.ca.gov/cgi-progs/queryWY

2.6.2 Surface Water Flow Estimates

The KRWQC does not take real-time flow measurements during sampling events at the surface water monitoring sites. Flows are developed through estimates from flow measurement locations and irrigation delivery information on the Kings River System that is compiled by KRWA. Flow data is reported in **Table 2-9**.

Table 2-9. Surface Water Flow Estimates (Cubic Feet per Second)

Monitoring Site	1/15/18	2/20/18	3/19/18	4/16/18	5/14/18	6/18/18	7/16/18	8/13/18	9/17/18	10/15/18	11/13/18	12/17/18
Lemoore Weir	0	0	0	0	164	600	635	240	*BW*	0	0	0
Crescent Weir	0	0	0	0	0	15	98	0	0	0	0	0
Jackson Ave.	0	0	0	0	0	415	325	240	0	0	0	0
Empire Weir 2	0	0	0	0	0	320	325	310	0	0	0	0
Stinson Weir	0	0	0	0	0	0	0	0	0	0	0	0

Values are estimates based on various other measured flows and their degree of accuracy is subjective.
All units are cubic feet per second
Jackson Ave. data are estimated based on flows from Empire Weir 1
BW-Below Weir

2.6.3 Surface Water Tabulated Data

Tabulated surface water monitoring data are included as **Appendix A**.

2.6.4 Explanation of Missing Components

To the KRWQC's knowledge, there are no missing components for compliance with the MRP data collection requirements during the 2018 Calendar Year.

2.7 Surface Water Exceedances

There were no surface water quality exceedances during 2018.

A statistically significant reduction in algal (*Selenastrum capricornutum)* growth was reported in December 2018, but the level of reduction did not require the performance of a Toxicity Identification Evaluation (**TIE**). Since the results did not reach the threshold toxicity to trigger a TIE, the cause of the toxicity is unknown. Analytical chemistry samples failed to show detection of a potential cause. Summary tables of all surface water quality data are included in **Appendix A**.

2.8 Surface Water Pesticide Exceedances

Surface water monitoring conducted by the KRWQC did not detect any pesticide exceedances during 2018.

2.9 Spatial Trends & Patterns

Drought conditions in 2014, 2015, and 2016 make evaluating trends or patterns nearly impossible. Minimal sample results due to dry conditions do not provide enough data to identify any statistically significant trends.

2.10 Surface Water Management Plans

As required by Attachment B, Section V.B of the General Order, Surface Water Quality Management Plans (**SQMP**s) are triggered if during a three (3) year period more than one exceedance of the same parameter occurs at the same monitoring location. If this occurs, a schedule for SQMP development and implementation will be provided by the KRWQC to Regional Board staff. For a SQMP to be approved, several components needed for inclusion are: physical setting, plan strategy, monitoring methods, and data evaluation methodology. Each component is discussed further in Appendix MRP-1 of Attachment B of the Order. Approved SQMPs will be updated on an annual basis on August 31st of each year the plan is in effect. The annual report will review all data collected, landowner outreach, management practice implementation, and any other actions taken during the previous year will be reported and reviewed.

2.11 Additional Surface Water Monitoring

The KRWQC is working with the Fresno RWQCB staff to approve a revised SWMP. No additional monitoring constituents or monitoring sites are proposed at this time.

2.12 Surface Water Quality Assurance Evaluation

Results for quality control samples are included with the data results and reports in **Appendix A**. Surface water sample collection follows protocols described in the revised and updated Quality Assurance Project Plan (**QAPP**). A QAPP is required to be submitted to the RWQCB to describe quality assurance and quality control practices to be used by the Coalition and contracted laboratories for monitoring programs required by the General Order. In compliance with these requirements, a QAPP dated August 16, 2016 was submitted by the KRWQC to the RWQCB for approval. The KRWQC is currently waiting for approval of the previously submitted revised QAPP.

2.12.1 Summary of Precisions and Accuracy

Precision and accuracy of water quality measurements and analysis of both laboratory and field results were compared against objectives described in the KRWQC QAPP. Water quality data collected during the 2018 Calendar Year meet quality assurance criteria established by the General Order and described in the submitted QAPP. QA/QC completeness reached 99.81% and 2% of the results involved qualified results. For reference, the laboratory's most current approved eQAPP has been included in **Appendix A**.

2.12.2 Results Not Meeting QAPP Criteria

For the 2018 calendar year, nearly all KRWQC results appear to meet the QAPP criteria. While some results were qualified, the results were within all other acceptance criteria and are considered acceptable. Results failing to meet QAPP criteria represented less than 1% of results.

2.12.3 Data Validity and Completeness

Over 99% of results met QAPP criteria and were valid. The KRWQC and the contracted laboratory will take any corrective action necessary if a problem is encountered following procedures outlined in the QAPP. Results for 2018 reached 99.81% completeness and 2% of the results involved qualified results. The 99.81% completeness exceeds the minimum completeness requirement of 90% as specified in the General Order. Tables showing the quality control completeness are provided in **Appendix A**.

Data validity and percent completeness is summarized in **Table 2-10**.

Table 2-10. Completeness Evaluation

Quarter	No. of Samples	Qualified Results	QA/QC Failures	Percent Completeness[1]
2018 1st Quarter	282	2	0	100
2018 2nd Quarter	484	9	0	100
2018 3rd Quarter	589	14	0	100
2018 4th Quarter	249	5	3	99.80

1 (1-(QA/QC Failures)/Required Samples) * 100

3 Groundwater Monitoring Report

The primary objective of the KRWQC's groundwater monitoring efforts is to maintain compliance with requirements of the ILRP General Order, which requires the KRWQC to characterize water quality within the KRWQC region. Groundwater monitoring is intended to be used to evaluate long term trends in groundwater quality, reflective of potential impacts from agricultural practices. However, collected data may reflect natural conditions associated with larger aquifer characteristics and potential influences from other sources (e.g., septic systems and other dischargers). Additionally, collected water quality data may reflect legacy impacts which are not from current agricultural land management practices.

The General Order requires a Trend Monitoring Workplan to be submitted to the RWQCB one year following GAR approval. The KRWQC submitted a GAR to the RWQCB on November 20, 2014. The RWQCB conditionally approved the GAR on April 26, 2016. The KRWQC submitted a Groundwater Quality Trend Monitoring (**GQTM**) Workplan to the RWQCB on April 26, 2017 and subsequent revisions on May 16, 2018 and July 31, 2018. The GQTM was conditionally approved by the RWQCB on August 21, 2018. The KRWQC sampled 80 wells in the fall of 2018. The monitoring network consisted of irrigation, domestic and public utility wells.

3.1 HVA and Prioritization

High Vulnerability Area (**HVA**) lands were identified and prioritized in the KRWQC GAR, which was prepared by GEI Consultants, under the direction of the Kings River Conservation District. As described in GAR the Kings GAR methodology focuses on using the best available information to inform decision making on where groundwater is most vulnerable while acknowledging uncertainty. The GAR Analysis Tool was developed to aggregate to a one square mile grid based on the USGS Central Valley Hydrologic Model (**CVHM**) grid. The CVHM is the best source of information on aquifer parameters and is a calibrated model accepted through the USGS peer review process. The gridded maps of risk can then be overlaid and a cumulative risk score can be determined for the coalition area. The Index Overlay Grid (IOG) preserves the detailed database of risk factors at the highest level of resolution and can be queried to understand what measurable attributes make the cell more or less vulnerable than the other. Risk values for each IOG cell are based on the weighted average of the different variables found within the grid.

To determine areas of vulnerability the following risk factors were ranked and evaluated:

- Depth to groundwater;
- Land use cover;
- Soil drainage.

The Kings GAR Index Overlay analysis tool uses other susceptibility and vulnerability variables not applied in the Nitrogen Hazard Index (**NHI**). The results of the Index/Overlay analysis or risk is compared to the observed groundwater quality conditions to evaluate where the risk evaluation is consistent with the groundwater quality exceedance values at observation wells, primarily drinking water wells. Where the risk does not reflect the observed exceedance, the locations of other potentially contaminating activities are evaluated to explain uncertainty and seek to explain why these wells exceed standards.

High, medium and low drinking water priorities were evaluated to determine risk to drinking water systems as a basis for prioritizing subsequent Management Practice Evaluation Program (**MPEP**) action and groundwater trend monitoring. Once the risk indices are assigned using the methods discussed above, the overlay analysis of the four risk categories is conducted using the GAR Analyst, illustrated in **Figure 3-1**. The GAR Analyst is not a model, but rather, a tool for numerically, statistically and visually interpreting available data, whether from external modeling or derived from primary data sets (GEI, 2014). HVA and LVA designations are illustrated in **Figure 3-2**.

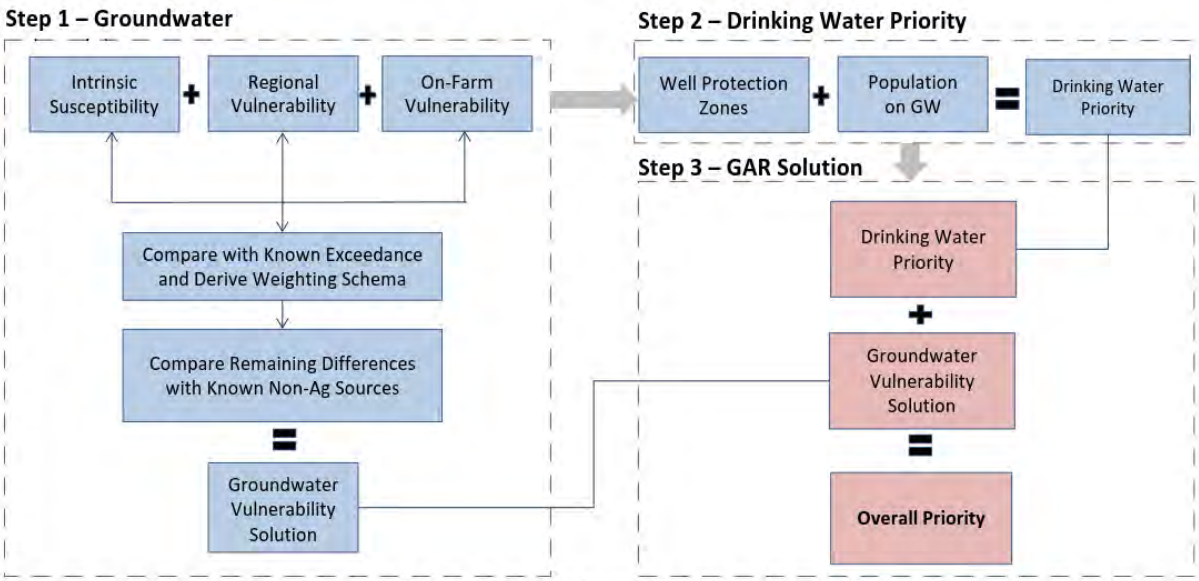

Figure 6-2. Overlay Process and Getting to GAR Priorities

Figure 3-1. GAR Prioritization Overlay Process (GEI, 2014)

3.2 Basin Plan Amendment Workplan Update

Portions of the historic Tulare Lakebed, within KRWQC boundary, no longer have Municipal (MUN) or Agricultural (AGR) beneficial use designations. The following is described on the RWQCB's website.

> "In order to ensure appropriate beneficial use protection, the Central Valley Regional Water Quality Control Board (**Central Valley Water Board**), in conjunction with the Central Valley Salinity Alternatives for Long-Term Sustainability (**CV-SALTS**) initiative, adopted an amendment to the Water Quality Control Plan for the Tulare Lake Basin (**Basin Plan**) removing MUN and AGR designations from a horizontally and vertically delineated portion of the groundwater in the historic Tulare Lakebed. The amendment was subsequently approved by the State Water Resources Control Board on 6 September 2017 and by the Office of Administrative Law on 26 December 2017, the effective date of the Basin Plan Amendment.
>
> The Board completed the multi-year process under which it evaluated the beneficial uses assigned to surface and groundwaters by the Board's Basin Plans. As a part of that process, the Board:

- Evaluated whether a portion of the groundwater in the historical Tulare Lakebed (within the South Valley Floor hydrologic unit 558.30, Figure II-1 of the Tulare Lake Basin Plan) actually supported the Municipal and Domestic Supply (MUN) beneficial use, and determined it was eligible for de-designation consistent with State Water Board Resolution No. 88-63 (Sources of Drinking Water Policy).
- De-designated the MUN and Agricultural supply (AGR) beneficial uses in portions of the Tulare Lakebed where those beneficial uses have not been historically supported and/or where those beneficial uses are not currently supported.
- Considered the adoption of site-specific objectives or the development of subcategories of the AGR beneficial use where a full range of AGR beneficial uses (for example, irrigation of salt-sensitive crops using groundwater) have not historically been supported and/or where a full range of AGR beneficial uses are not currently supported.
- Considered amending the Tulare Lake Basin Plan to incorporate a framework for evaluating the applicability of the MUN and AGR beneficial uses and associated water quality objectives, including implementation provisions applicable in specific groundwater basins (RWQCB, 2019)."

As part of the de-designation process the RWQCB found that the MUN beneficial use was not justified based on existing criterion established by the Sources of Drinking Water Policy. Therefore, the KRWQC has proposed to eliminate the de-designated area from groundwater quality trend monitoring. The de-designated portion of the historic Tulare Lakebed is represented in **Figure 3-3**.

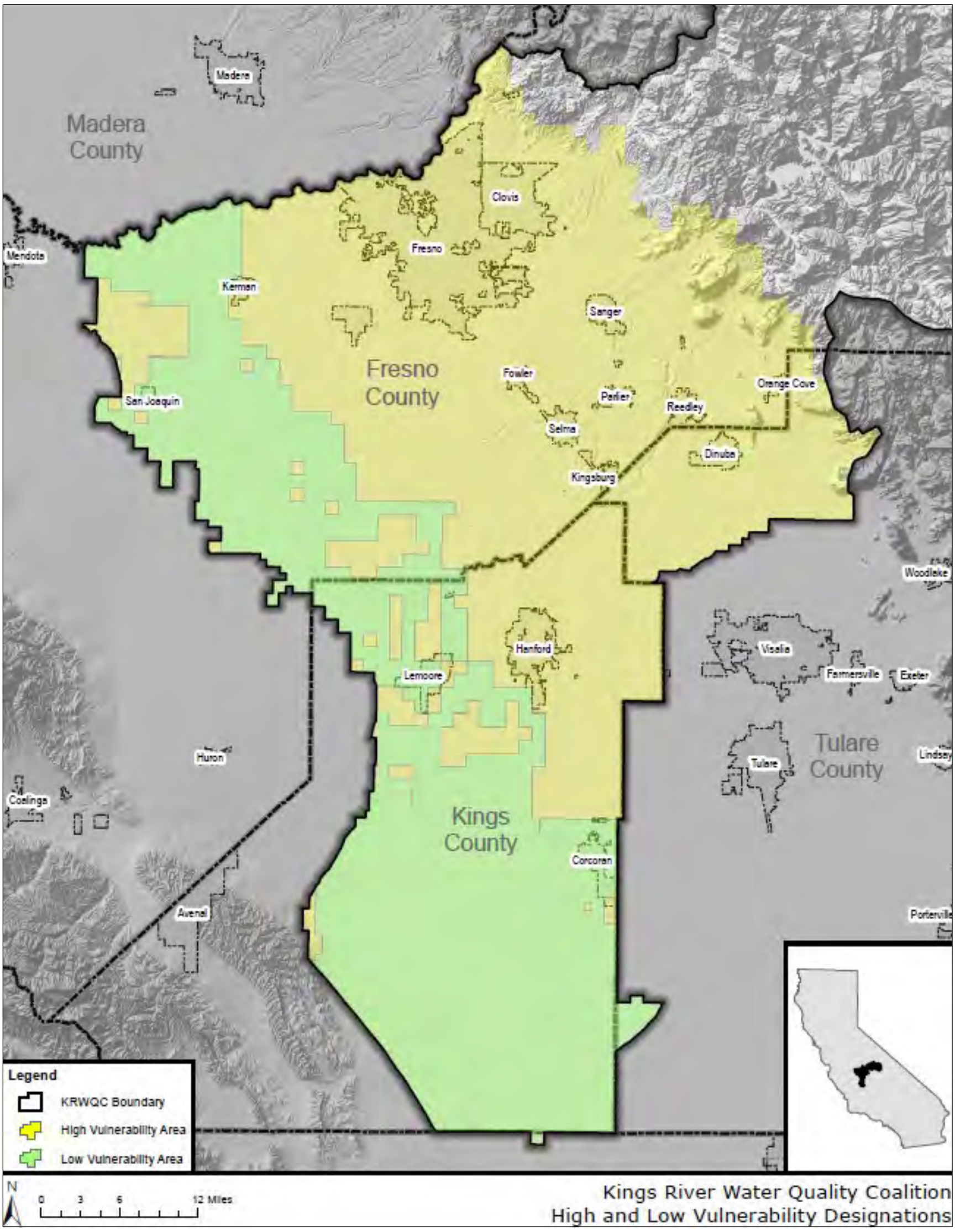

Figure 3-2. KRWQC High and Low Vulnerability Designations

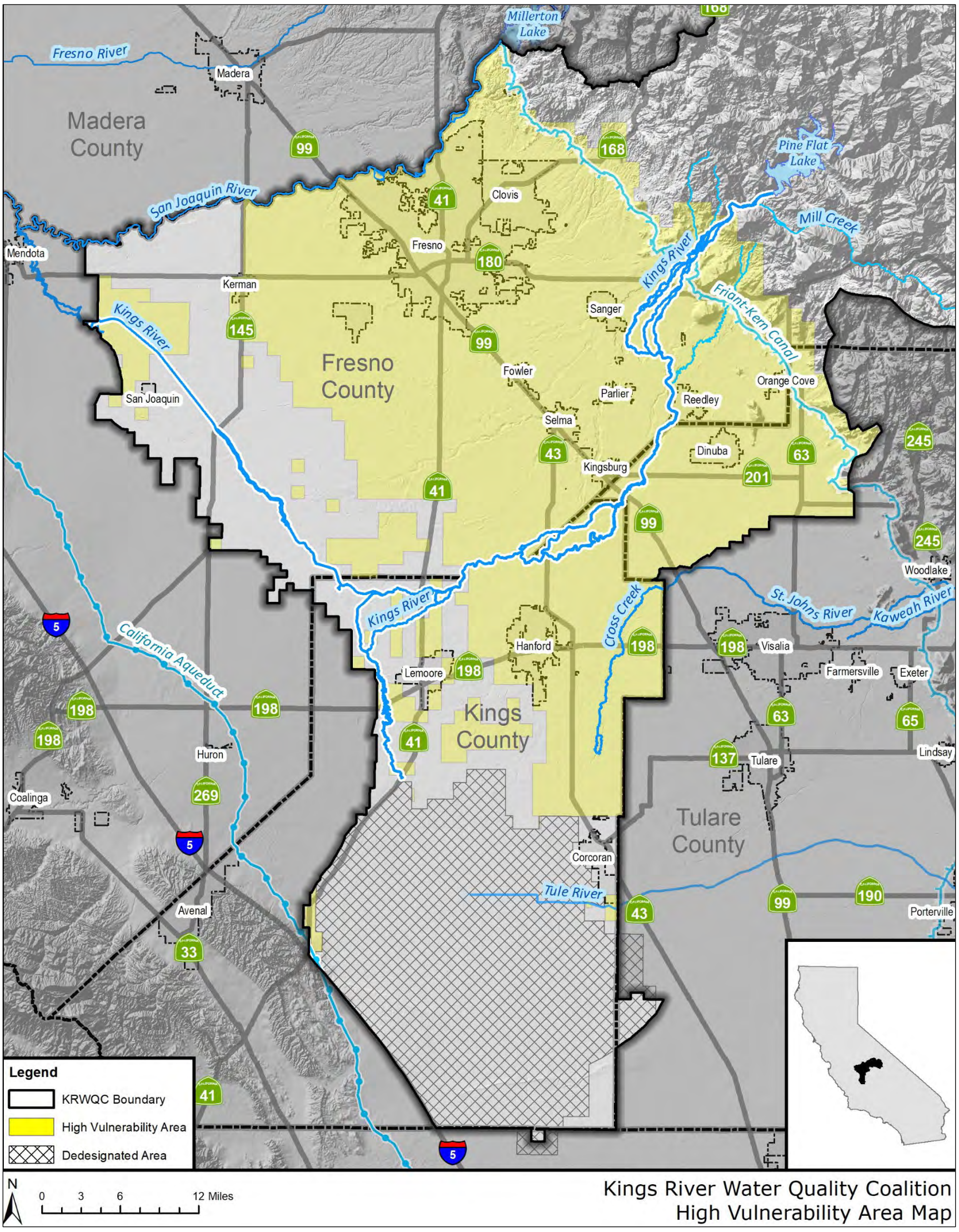

Figure 3-3. High Vulnerability Area and De-Designated Area Map

3.3 Groundwater Monitoring Objectives & Design

The General Order requires the GQTM network to include: the variety of agricultural commodities produced within the third-party's boundaries (particularly those commodities comprising the most irrigated agricultural acreage), 2) the conditions discussed/identified in the GAR related to the vulnerability prioritization within the third-party area, and 3) the areas identified in the GAR as contributing significant recharge to urban and rural communities where groundwater serves as a significant source of supply.

Table 3-1 describes methods and reporting units for monitoring constituents required by Attachment B, MRP Section IV.E.

Table 3-1. Groundwater Trend Monitoring Constituent Sampling Schedule

Frequency			Indicator Parameter	Reporting Units	Field Measurement	Laboratory Analysis	Analysis Method
Initial Sample	5-Year	Annual	Electrical Conductivity (EC)	µmhos/cm	•		Field Instrument
			pH	pH units	•		Field Instrument
			Dissolved Oxygen (DO)	mg/L	•		Field Instrument
			Temperature	°C	•		Field Instrument
			Nitrate as Nitrogen	mg/L		•	Method 300.0
			Total Dissolved Solids (TDS)	mg/L		•	Method 2540C
			General Minerals - Anions (carbonate, bicarbonate, chloride, sulfate)	mg/L		•	Method 2320B
			General Minerals - Cations (boron, calcium, sodium, magnesium, potassium)	mg/L		•	Method 200.7

3.4 Groundwater Monitoring Well Network

Attachment B, Section IV.E.2 of the General Order requires details for wells proposed for trend monitoring to include:

- GPS coordinates
- California State Well Number (if known)
- DWR Well Completion Report/Driller's Log Number
- Well depth
- Top and bottom perforation depths
- A copy of the well driller's log (if available)
- Depth of standing water (static water level), if available

- Well seal information (type of material and length of seal)

3.4.1 Groundwater Well Monitoring Site Selection

Attachment B, Section IV.C.2 of the General Order requires the Trend Monitoring Workplan to implement a groundwater monitoring network that represents both high and low vulnerability areas and employs relatively shallow wells or existing monitoring well networks. The network must consist of a sufficient number of wells to provide adequate coverage in the KRWQC area to assess water quality conditions of groundwater and regional effects of irrigated agriculture. In order to ensure that the trend monitoring network design was as representative as possible, both LVAs and HVAs were considered, as proposed in the GAR. A map depicting the proposed monitoring areas overlaid on the HVAs and LVAs, as defined in the GAR, is presented as **Figure 3-2**.

Where available, selected wells draw water from the upper zone, as defined in Section 3.3 of the Central Valley Groundwater Monitoring Collaborative (**CVGMC**) Workplan. The upper zone includes the area from the bottom of the vadose zone to any confining layers (specifically the Corcoran Clay, if present).

Due to the long-term monitoring requirement, it is anticipated that the well network will need to be modified over time. Necessary changes will be made to maintain a regional representation of groundwater quality. The KRWQC will maintain information for backup wells to ensure the continuity of the trend monitoring program. In addition, the KRWQC supports the concept presented in Section 3.6, "Dynamic Network: Adaptive Design and Refinement", of the CVGMC Technical Workplan. The initial well network design will require ongoing evaluation of the spatial representation and sufficiency to fulfill the requirements of the General Order.

The KRWQC's GQTM was developed by 4 Creeks, Inc. and certified by registered professions engineers. As described in the GQTM, the rationale for the determination of the spatial coverage of existing groundwater wells to be monitored under the coordinated KRWQC Groundwater Quality Trend Monitoring Program considered the following:

- Agricultural Crops
- Vulnerability Priority
- Well Characteristics
- Hydrogeological Characteristics

Based upon the aforementioned characteristics, the KRWQC determined the initial spatial coverage to be at least two wells per township. Additional well sites will need to be added in future years to meet this target.

During the selection process, the following evaluation criteria was utilized for identification of existing groundwater wells that qualify as a candidate for the long-term monitoring program. Given the relatively uniform orientation of land use in the Coalition, the stability of the cropping patterns over many years, the widespread adoption of high efficiency irrigation methods and the projected groundwater flow gradients as determined by on-going groundwater elevation monitoring conducted by the Kings River Conservation District, at least two wells per township shall provide an adequate initial network to determine groundwater quality.

Due to the long-term monitoring requirement, it is anticipated that the well network will need to be modified over time. Necessary changes will be made to maintain a regional representation of groundwater quality. The KRWQC will maintain information for backup wells to ensure the continuity of the trend monitoring program. In addition, the KRWQC supports the concept presented in Section 3.6, "Dynamic Network: Adaptive Design and Refinement" of the CVGMC Technical Workplan. The initial well network design will require ongoing evaluation of the spatial representation and sufficiency to fulfill the requirements of the General Order.

3.4.1.1 Criteria for Well Selection

As described in the Trend Monitoring workplan, the following evaluation criteria was utilized for identification of existing groundwater wells that qualify as a candidate for the long-term monitoring program:

- Well Type: the selected wells to be used for the trend monitoring program were chosen from existing domestic wells. If an existing domestic well was unavailable for a monitoring area, a shallow agricultural well was selected.
- Selection of wells used in other groundwater trend monitoring programs (GAMA, CASGEM, Public Drinking Water Systems, etc.)
- Well Depth: Existing wells constructed within the upper aquifer were prioritized for selection.
- High and Low Vulnerability Areas: Two selected wells along with two secondary wells per township, within both the High and Low Vulnerability areas, were identified, provided adequate existing wells were available. Priority was given to those wells located nearest to a community or a public water system within each township.
- Well Completion Reports: A well completion report for each candidate selected and secondary well was required. Each candidate well will be identified in tabular form by: GPS Coordinates, address of the property (if available), CA State Well Number, Well depth, casing top and bottom perforation depths, depth of standing water (static water level, if available) and well seal information (type of material and length of seal).

Candidate wells were verified in the field to ensure adequate accessibility for sampling and acceptable physical condition of wells. After the candidate wells were verified to meet the physical requirements and permission has been granted to monitor the well by landowner, initial depth and quality samples are taken. As described in the Trend Monitoring Workplan, well verification occurs in a phased approach over 3 years until wells within all 74 townships of the KRWQC have been verified for inclusion in the trend monitoring network (4 Creeks Inc., 2018).

3.4.2 Groundwater Monitoring Well Information

Following the process described in the GQTM, the KRWQC secured agreements to sample the selected wells. The KRWQC identified 91 wells in the fall of 2018. The monitoring network consisted of irrigation, domestic and public utility wells. Information specific to each groundwater monitoring well is provided in **Table 3-2**, including; well depth, static groundwater depth, and well location. Construction details are also provided. **Figure 3-4** depicts targeted monitoring well locations for Fall 2018. Illustrated in **Figure 3-5** are targeted monitoring well locations and vulnerability designations.

Table 3-2. Monitoring Well Information – Fall 2018

Well ID/Field Point Name	GQTM Well Name	State Well Number	Well Completion Report Number	Well Type	Well Depth	Well Depth Unit	Year Drilled	Latitude	Longitude	Datum
KRWQC00001	TM13S16E02	13S16E25D	NN_img00150882	Irrigation	350	ft	1997	36.7778	-120.184099	WGS 1984
KRWQC00002	TM13S17E01	13S17E25C	NN_img40351372	Irrigation	150	ft	1950	36.778535	-120.070451	WGS 1984
KRWQC00003	TM13S20E01	13S20E12D	426677	Irrigation	270	ft	1993	36.821601	-119.753881	WGS 1984
KRWQC00004	TM13S20E02	13S20E12J	500030	Public	398	ft	1997	36.814862	-119.740734	WGS 1984
KRWQC00005	TM13S21E01	13S21E07D	37829	Irrigation	142	ft	1956	36.822846	-119.731576	WGS 1984
KRWQC00006	TM13S21E03	13S21E07F	191800	Domestic	140	ft	1986	36.816169	-119.729638	WGS 1984
KRWQC00007	TM13S21E04	13S21E36P	146882	Irrigation	140	ft	1980	36.753439	-119.638877	WGS 1984
KRWQC00008	TM13S22E01	13S22E05G	E0182371	Domestic	240	ft	2013	36.831147	-119.596673	WGS 1984
KRWQC00009	TM13S22E03	13S22E27M	286183	Domestic	140	ft	1990	36.771275	-119.572618	WGS 1984
KRWQC00010	TM13S22E04	13S22E26M	E0033654	Irrigation	200	ft	2006	36.769254	-119.555683	WGS 1984
KRWQC00011	TM13S23E01	13S23E34M	146351	Irrigation	118	ft	1975	36.756751	-119.462468	WGS 1984
KRWQC00012	TM14S16E01	14S16E33N	E0273458	Monitoring	310	ft	2015	36.663502	-120.238889	WGS 1984
KRWQC00013	TM14S18E01	14S18E07B	815050	Public	800	ft	1999	36.733118	-120.051223	WGS 1984
KRWQC00014	TM14S18E02	14S18E01P	614	Domestic	120	ft	1950	36.735396	-119.961194	WGS 1984
KRWQC00015	TM14S19E01	14S19E15L	21605	Irrigation	248	ft	1976	36.713575	-119.890169	WGS 1984
KRWQC00016	TM14S19E02	14S19E19F	57660	Irrigation	249	ft	1962	36.698946	-119.943376	WGS 1984
KRWQC00017	TM14S19E03	14S19E31A	48768	Irrigation	170	ft	1958	36.676935	-119.934578	WGS 1984
KRWQC00018	TM14S20E01	14S20E20A	22233	Irrigation	188	ft	1977	36.704961	-119.80955	WGS 1984
KRWQC00019	TM14S20E02	14S20E30E	E0086963	Irrigation	202	ft	2009	36.685572	-119.84236	WGS 1984
KRWQC00020	TM14S21E01	14S21E20N	394552	Public	405	ft	1992	36.695441	-119.716957	WGS 1984
KRWQC00021	TM14S21E02	14S21E21J	574355	Public	460	ft	1994	36.698414	-119.684302	WGS 1984
KRWQC00022	TM14S22E01	14S22E06P	E0095950	Irrigation	300	ft	2009	36.736431	-119.620487	WGS 1984
KRWQC00023	TM14S22E02	14S22E16G	1095880	Public	440	ft	2006	36.71419	-119.578771	WGS 1984
KRWQC00024	TM14S22E03	14S22E22F	243328	Municipal	265	ft	1984	36.701419	-119.565613	WGS 1984
KRWQC00025	TM14S22E04	14S22E30P	E0031780	Domestic	78	ft	2006	36.678545	-119.62125	WGS 1984
KRWQC00026	TM14S23E01	14S23E28B	E0091044	Irrigation	154	ft	2009	36.691407	-119.473375	WGS 1984
KRWQC00027	TM15S16E01	15S16E15K	E0273459	Monitoring	350	ft	2015	36.624577	-120.215841	WGS 1984
KRWQC00028	TM15S16E02	15S16E34M	E0186246	Domestic	300	ft	2013	36.579697	-120.224186	WGS 1984
KRWQC00029	TM15S18E01	15S18E27D	E0277691	Monitoring	280	ft	2015	36.603992	-120.002708	WGS 1984
KRWQC00030	TM15S18E02	15S18E34A	344731	Domestic	350	ft	1991	36.587443	-119.990175	WGS 1984
KRWQC00031	TM15S18E03	15S18E34B	E0332805	Irrigation	500	ft	2016	36.585939	-119.994433	WGS 1984
KRWQC00032	TM15S19E01	15S19E26B	E0277697	Monitoring	280	ft	2015	36.604831	-119.871765	WGS 1984
KRWQC00033	TM15S21E01	15S21E28B	21108	Irrigation	160	ft	1976	36.602904	-119.687052	WGS 1984
KRWQC00034	TM15S21E02	15S21E35B	32249	Irrigation	137	ft	1955	36.589012	-119.655148	WGS 1984
KRWQC00035	TM15S22E01	15S22E10A	146348	Irrigation	178	ft	1981	36.648519	-119.556885	WGS 1984
KRWQC00036	TM15S22E02	15S22E10J	E0295101	Irrigation	240	ft	2015	36.641007	-119.557116	WGS 1984
KRWQC00037	TM15S22E03	15S22E18B	E0271176	Irrigation	300	ft	2015	36.631082	-119.616246	WGS 1984
KRWQC00038	TM15S22E04	15S22E18L	E0361185	Irrigation	340	ft	2018	36.624072	-119.620696	WGS 1984
KRWQC00039	TM15S22E05	15S22E14K	E0264016	Domestic	220	ft	2015	36.623859	-119.547211	WGS 1984
KRWQC00040	TM15S22E06	15S22E14J	1956 well log.tif	Irrigation	170	ft	1956	36.626526	-119.539156	WGS 1984
KRWQC00041	TM15S22E07	15S22E27M	582518	Irrigation	200	ft	1994	36.594297	-119.574709	WGS 1984
KRWQC00042	TM15S23E01	15S23E08D01	915269	Domestic/ Irrigation	235	ft	2006	36.647538	-119.501057	WGS 1984
KRWQC00043	TM15S23E02	15S23E08D03	574399	Irrigation	240	ft	1994	36.644535	-119.500653	WGS 1984
KRWQC00044	TM15S23E03	15S23E10C	568797	Irrigation	340	ft	1994	36.645859	-119.459964	WGS 1984
KRWQC00045	TM15S23E04	15S23E21M	723772	Public	260	ft	2000	36.609345	-119.483817	WGS 1984
KRWQC00046	TM15S24E01	15S24E17H	E0089481	Irrigation	380	ft	2009	36.627308	-119.376597	WGS 1984
KRWQC00047	TM16S17E01	16S17E15R	568617	Public	610	ft	1994	36.533268	-120.100071	WGS 1984
KRWQC00048	TM16S18E01	16S18E15F	82212	Irrigation	570	ft	1981	36.539353	-119.998594	WGS 1984
KRWQC00049	TM16S18E02	16S18E02N	381724	Municipal	555	ft	1991	36.491201	-119.989214	WGS 1984
KRWQC00050	TM16S19E01	16S19E13H	27446	Public	402	ft	1978	36.543295	-119.846255	WGS 1984
KRWQC00051	TM16S19E02	16S19E25D	E0273451	Monitoring	280	ft	2015	36.517903	-119.863315	WGS 1984
KRWQC00052	TM16S20E01	16S20E32A	E0273440	Monitoring	300	ft	2015	36.503585	-119.809123	WGS 1984
KRWQC00053	TM16S20E02	16S20E36D	E0273439	Monitoring	270	ft	2015	36.503568	-119.755203	WGS 1984
KRWQC00054	TM16S21E01	16S21E09A	33576	Irrigation	111	ft	1955	36.55981	-119.682899	WGS 1984
KRWQC00055	TM16S21E02	16S21E10N	246607	Public	504	ft	1982	36.548709	-119.682379	WGS 1984
KRWQC00056	TM16S21E03	16S21E33R	31314	Irrigation	138	ft	1954	36.492508	-119.684411	WGS 1984
KRWQC00057	TM16S23E01	16S23E13M	943200	Public	245	ft	2006	36.53885	-119.428395	WGS 1984
KRWQC00058	TM16S24E01	16S24E07J	749117	Public	630	ft	2002	36.552324	-119.399413	WGS 1984
KRWQC00059	TM16S24E02	16S24E07P	220415	Municipal	572	ft	1984	36.548227	-119.408561	WGS 1984
KRWQC00060	TM16S24E03	16S24E07N	398827	Public	615	ft	1992	36.54691	-119.412421	WGS 1984
KRWQC00061	TM16S24E04	16S24E18M	1095744	Public	585	ft	2005	36.538522	-119.408633	WGS 1984
KRWQC00062	TM16S24E05	1624E17N	411490	Public	650	ft	1992	36.531591	-119.393509	WGS 1984
KRWQC00063	TM16S24E06	16S24E20B	943191	Public	595	ft	2005	36.530569	-119.382337	WGS 1984
KRWQC00064	TM16S24E07	16S24E17H	460846	Public	540	ft	1997	36.540548	-119.378293	WGS 1984
KRWQC00065	TM16S24E08	16S24E16A	145303	Irrigation	199	ft	1976	36.544839	-119.358798	WGS 1984

Well ID/Field Point Name	GQTM Well Name	State Well Number	Well Completion Report Number	Well Type	Well Depth	Well Depth Unit	Year Drilled	Latitude	Longitude	Datum
KRWQC00066	TM16S25E01	16S25E33R	87530	Public	440	ft	1972	36.487202	-119.253117	WGS 1984
KRWQC00067	TM17S18E01	7S18E02B	112141	Domestic	240	ft	1975	36.487846	-119.983778	WGS 1984
KRWQC00068	TM17S18E02	17S18E01K	70193	Irrigation	552	ft	1980	36.477452	-119.966055	WGS 1984
KRWQC00069	TM17S18E03	17S18E02P	75683	Irrigation	630	ft	1971	36.474752	-119.986511	WGS 1984
KRWQC00070	TM17S18E04	17S18E08Q	568660	Irrigation	560	ft	1994	36.459222	-120.035936	WGS 1984
KRWQC00071	TM17S18E05	17S18E12K	394140	Irrigation	510	ft	1992	36.46612	-119.968046	WGS 1984
KRWQC00072	TM17S18E06	17S18E13C	22362	Irrigation	450	ft	1977	36.457393	-119.968369	WGS 1984
KRWQC00073	TM17S19E01	17S19E10C	E0273452	Monitoring	266	ft	2015	36.474352	-119.896635	WGS 1984
KRWQC00074	TM17S19E02	17S19E36J	1095357	Domestic	240	ft	2005	36.409005	-119.852826	WGS 1984
KRWQC00075	TM17S20E01	17S20E11Q	54811	Domestic	264	ft	1980	36.460679	-119.771358	WGS 1984
KRWQC00076	TM17S20E02	17S20E14H	399463	Dairy	425	ft	1992	36.453582	-119.762914	WGS 1984
KRWQC00077	TM17S21E01	17S21E07P	E0031570	Irrigation	520	ft	2006	36.461624	-119.736817	WGS 1984
KRWQC00078	TM17S21E02	17S21E23H	E0273438	Monitoring	280	ft	2015	36.438167	-119.654629	WGS 1984
KRWQC00079	TM17S22E01	17S22E20D	E0005962	Domestic	233	ft	2004	36.442603	-119.618292	WGS 1984
KRWQC00080	TM17S22E03	17S22E33A	E0091259	Domestic	300	ft	2009	36.415551	-119.586879	WGS 1984
KRWQC00081	TM17S23E01	17S23E17Q	718280	Domestic	295	ft	1999	36.445452	-119.500285	WGS 1984
KRWQC00082	TM17S24E01	17S24E02D	426821	Domestic	240	ft	1992	36.486744	-119.344456	WGS 1984
KRWQC00083	TM17S24E02	17S24E02K	490591	Irrigation	340	ft	1991	36.477739	-119.335564	WGS 1984
KRWQC00084	TM18S20E01	18S20E04C	67806	Irrigation	520	ft	1971	36.400958	-119.808446	WGS 1984
KRWQC00085	TM18S20E02	18S20E11D	1086597	Public	773	ft	2007	36.38404	-119.776177	WGS 1984
KRWQC00086	TM18S20E03	18S20E23N03	E016557	Monitoring	60	ft	2004	36.346053	-119.780567	WGS 1984
KRWQC00087	TM18S20E04	18S20E23N01	E016558	Monitoring	280	ft	2004	36.346092	-119.780547	WGS 1984
KRWQC00088	TM19S20E01	19S20E11C	480739	Public	505	ft	1991	36.296828	-119.775716	WGS 1984
KRWQC00089	TM19S20E02	19S20E31A	E016560	Monitoring	360	ft	2004	36.240529	-119.834585	WGS 1984
KRWQC00090	TM19S21E01	19S21E23P	49287	Irrigation	440	ft	1957	36.254935	-119.663932	WGS 1984
KRWQC00091	TM20S20E01	20S20E26M	E019097	Monitoring	315	ft	2004	36.159834	-119.775815	WGS 1984

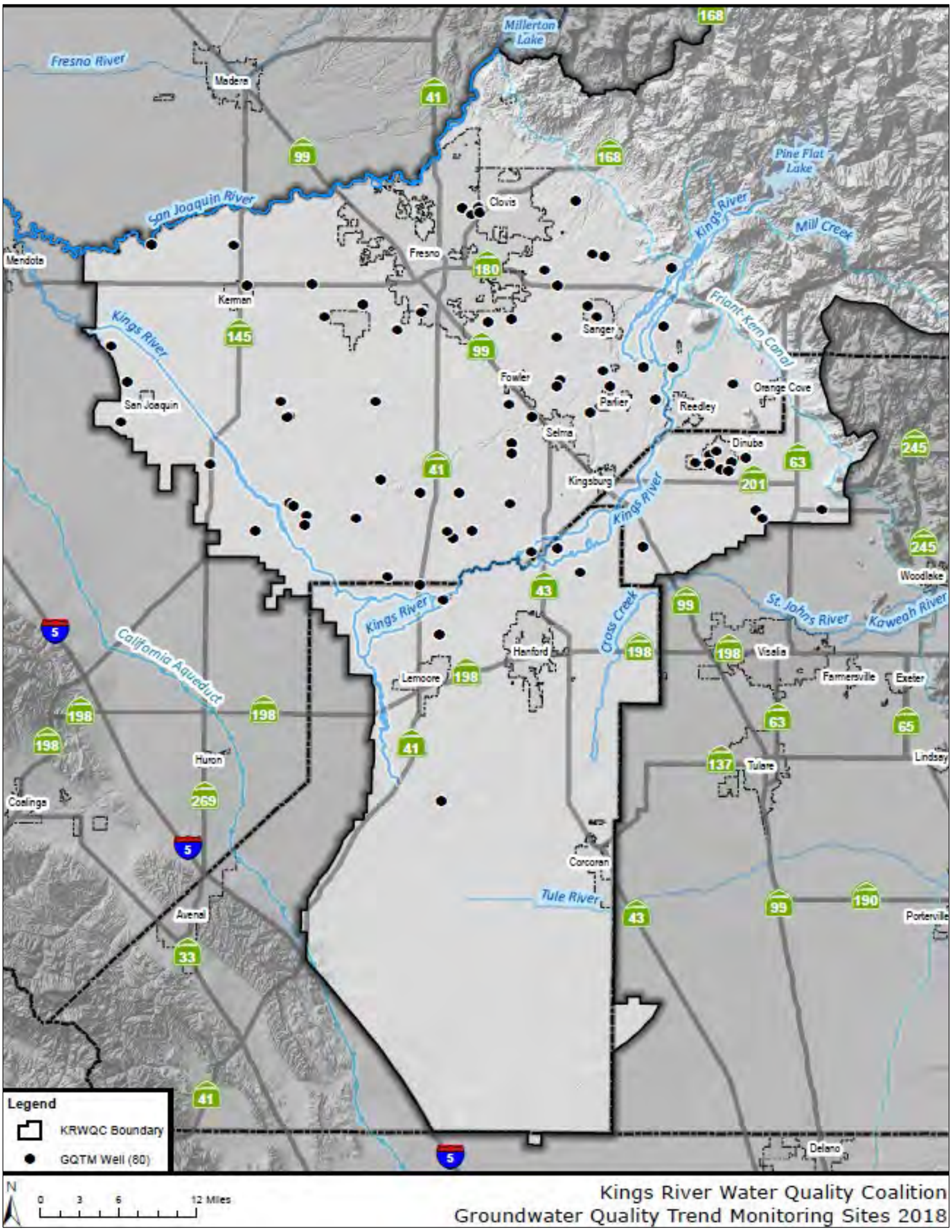

Figure 3-4. Targeted Monitoring Well Locations – 2018

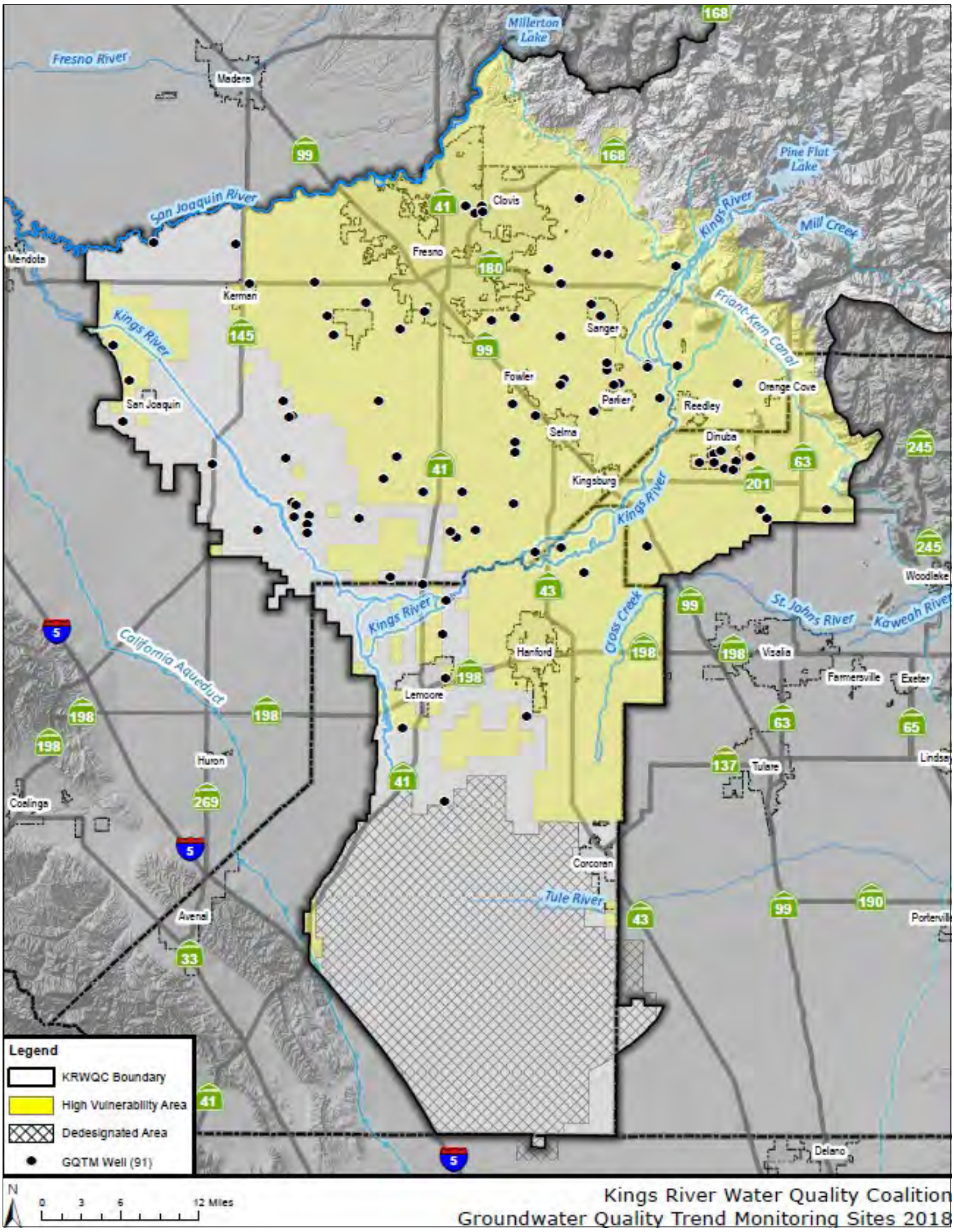

Figure 3-5. Vulnerability Areas & Targeted Well Locations - 2018

3.5 Groundwater Trend Monitoring Sampling Timeline

As specified in Attachment B, MRP Section IV.E.3 of the General Order, trend monitoring wells must be sampled, at a minimum, annually at the same time of year. Sampling of the initial network was conducted during the fall of 2018 in accordance with the terms provided in the Regional Board's letter "Conditional Approval of Kings River Water Quality Coalition's Groundwater Trend Monitoring Workplan dated August 22, 2018. Moving forward, the KRWQC will sample annually in coordination with the CVGMC, between the months of May and August.

As a member of the CVGMC, the KRWQC began sampling of the GQTM network in fall of 2018. As requested by the RWQCB, in the Conditional Approval, these results will be reported and evaluated with the Coalition's Annual Monitoring Report by August 31, 2019. The KRWQC has coordinated with other CVGMC members to schedule the annual sampling for 2019 from May 1 to August 31. Well sampling will recur at each well location during the same timeframe each year.

3.6 Groundwater Quality Results

Electronic PDF copies of laboratory reports are attached in **Appendix B**. As required in Attachment B, MRP Section IV.E.3 and MRP Section V.B, groundwater monitoring results (formatted as an Excel workbook) of all data records uploaded to the State Water Resources Control Board's GeoTracker database are attached in **Appendix B**.

3.6.1 Tabulated Data

Groundwater quality results in a tabulated format are attached in **Appendix B** for both analytical data and field parameters. Exceedances of applicable water quality standards are indicated by an asterisk.

Collected field parameters required by the MRP include pH, EC, temperature, and dissolved oxygen (**DO**). Additionally, field notes and purge volumes are recorded on field sheets.

3.6.2 Summary of Groundwater Quality Exceedances

Groundwater monitoring data are included as **Appendix B**. The KRWQC collected groundwater quality samples during the fall of 2018. A total of 80 wells were sampled; 1 dairy well, 15 domestic wells, 32 irrigation wells, 1 domestic/irrigation well, 12 monitoring wells, 3 municipal wells, and 16 public wells. For nitrate, results were compared against the Primary Maximum Conaminant Level (**MCL**) for nitrate as nitrogen (**N**).

3.6.3 Groundwater Spatial Trends & Patterns

The first year that groundwater quality samples were collected was 2018, therefore, there are no trends or patterns to report at this time.

3.6.4 Explanation of Missing Components

The KRWQC initially submitted to the RWQCB 95 wells intended to be sampled in the fall of 2018. Well logs could not be located for 2 of the proposed wells, 1 well log had incorrect GPS coordinates, and 1 well was no longer in service. The remaining 91 wells were targeted for fall 2018 sampling. Due to the constant

fluctuation of groundwater conditions and changes in well suitability, the submitted GQTM network was, and continues to be, considered dynamic. During the 2018 sampling season 80 wells identified in the GQTM network were successfully sampled. **Table 3-3** describes sample failure rationale for wells that were targeted to be sampled in 2018.

Table 3-3. KRWQC Well ID and Sampling Status for 2018

KRWQC Well ID	Sampled in 2018?	Rationale
KRWQC0001	Yes	
KRWQC0002	Yes	
KRWQC0003	Yes	
KRWQC0004	Yes	
KRWQC0005	Yes	
KRWQC0006	Yes	
KRWQC0007	Yes	
KRWQC0008	Yes	
KRWQC0009	Yes	
KRWQC0010	Yes	
KRWQC0011	Yes	
KRWQC0012	Yes	
KRWQC0013	Yes	
KRWQC0014	Yes	
KRWQC0015	Yes	
KRWQC0016	Yes	
KRWQC0017	No	Electrical issues-Unable to start pump
KRWQC0018	Yes	
KRWQC0019	Yes	
KRWQC0020	Yes	
KRWQC0021	Yes	
KRWQC0022	Yes	
KRWQC0023	Yes	
KRWQC0024	Yes	
KRWQC0025	Yes	
KRWQC0026	Yes	
KRWQC0027	Yes	
KRWQC0028	Yes	
KRWQC0029	Yes	
KRWQC0030	Yes	
KRWQC0031	Yes	
KRWQC0032	Yes	

KRWQC Well ID	Sampled in 2018?	Rationale
KRWQC0033	Yes	
KRWQC0034	Yes	
KRWQC0035	No	Behind locked fence.
KRWQC0036	Yes	
KRWQC0037	Yes	
KRWQC0038	Yes	
KRWQC0039	Yes	
KRWQC0040	No	No power.
KRWQC0041	Yes	
KRWQC0042	Yes	
KRWQC0043	Yes	
KRWQC0044	Yes	
KRWQC0045	Yes	
KRWQC0046	Yes	
KRWQC0047	Yes	
KRWQC0048	No	Electrical issues-Unable to start pump
KRWQC0049	Yes	
KRWQC0050	No	Not in Service
KRWQC0051	Yes	
KRWQC0052	Yes	
KRWQC0053	Yes	
KRWQC0054	Yes	
KRWQC0055	Yes	
KRWQC0056	Yes	
KRWQC0057	Yes	
KRWQC0058	Yes	
KRWQC0059	Yes	
KRWQC0060	No	Municipal--Not in service.
KRWQC0061	Yes	
KRWQC0062	Yes	
KRWQC0063	Yes	
KRWQC0064	Yes	
KRWQC0065	Yes	
KRWQC0066	Yes	
KRWQC0067	Yes	
KRWQC0068	Yes	
KRWQC0069	No	No power.

KRWQC Well ID	Sampled in 2018?	Rationale
KRWQC0070	Yes	
KRWQC0071	Yes	
KRWQC0072	No	No power.
KRWQC0073	Yes	
KRWQC0074	Yes	
KRWQC0075	Yes	
KRWQC0076	Yes	
KRWQC0077	Yes	
KRWQC0078	Yes	
KRWQC0079	Yes	
KRWQC0080	Yes	
KRWQC0081	Yes	
KRWQC0082	Yes	
KRWQC0083	Yes	
KRWQC0084	Yes	
KRWQC0085	Yes	
KRWQC0086	Yes	
KRWQC0087	Yes	
KRWQC0088	No	Pump failure at startup.
KRWQC0089	No	Water level below installed pump intake.
KRWQC0090	No	No power.
KRWQC0091	Yes	

3.7 Groundwater Quality Assurance Evaluation

Data quality objectives were evaluated using criteria defined in the CVGMC Quality Assurance Programmatic Plan (**QAPrP**).

3.7.1 Summary of Precision, Accuracy, and Completion

Groundwater quality data collected during the fall of 2018 met quality assurance criteria established by the General Order and described in the submitted QAPrP. While laboratory QA/QC completeness reached 100%, issues preventing the measurement of depth to water resulted in 98.28% parameter completeness. Qualified laboratory results were reported on rare occasions (0.87%). All other results appear accurate and were reported to the proper level of precision. Many of the contracted lab's equipment can analyze constituents to a lower level than the minimum detection and reporting levels, which allows the CWDC to have confidence that adequate precision is achieved.

3.7.2 Results Not Meeting QAPrP Criteria, Data Validity and Corrections

Most groundwater quality results collected in fall of 2018 met QAPrP criteria. Less than one percent of laboratory result were qualified, but the results are considered acceptable based on other criteria. Qualified results are tabulated in **Appendix B**. Results from one field blank were higher than the RLs for several constituents. The KRWC is working with the analytical laboratory to determine potential causes for the reported results and any potential corrective action.

3.7.3 Completeness

Groundwater quality results collected in fall of 2018 reached 100% QA/QC completeness and 0.87% of the results involved qualified results. The 100% completeness exceeds the minimum completeness requirement of 90% specified in the General Order. While unsampled network wells resulted in 87.91% sampling completeness, parameter completeness reached 98.28%. Tables showing completeness are provided in **Appendix B**.

3.8 Actions to Address Water Quality Exceedances

The General Order requires the development of a Comprehensive Groundwater Quality Management Plan (**CGQMP**) to address exceedances of water quality objectives. The KRWQC submitted a Revised CGQMP to the RWQCB on October 17, 2016 and received conditional approval of the Revised CGQMP on November 1, 2017. The KRWQC will submit an annual CGQMP status update to the RWQCB as required by the General Order.

3.9 Management Practice Evaluation Program

The MPEP is required by the General Order to evaluate different conditions which may affect the discharge of waste from irrigated lands to groundwater (e.g., soil type, depth to groundwater, irrigation practice, crop type, nutrient management practices). The KRWQC has elected to meet requirements of the MPEP by participating in the Southern San Joaquin Valley MPEP (**SSJV MPEP**).

4 Nitrogen Management Plan Summary Report Analysis

The data provided in Section 4 "Nitrogen Management Plan Summary Report Analysis" was summarized, tabulated and analyzed by 4 Creeks Inc..

4.1 Introduction and Background

The NMP Worksheet was approved by the EO of the Central Valley Regional Water Quality Control Board (CVRWQCB) on December 23, 2014, for 12 water quality coalitions in the Central Valley, excluding the California Rice Commission and the Grassland Drainage Area. It is intended to assist growers with nitrogen management. The NMP Worksheet must be kept on farm and be available for inspection by the CVRWQCB. The NMP Crop/Harvest Year is determined by the year in which harvest was *completed*. For example, navel oranges harvested from October 2017 through April 2018 would be considered the 2018 Crop/Harvest Year.

The NMP Worksheet has two main sections: crop nitrogen planning and post-production actuals. The planning phase should generally be completed in advance of the irrigation and fertilization season. The general process of the planning phase involves determination of a projected yield to develop a nitrogen requirement, and an accounting of any nitrogen credits from soil and irrigation water. The difference between the calculated nitrogen requirement and nitrogen credits is the amount of additional nitrogen that is required from fertilizers. The planning phase of the NMP Worksheet is a projection of the upcoming season, but actual yields and fertilizer rates may vary. Certification by a qualified professional (such as a Certified Crop Adviser [**CCA**] with the California Department of Food and Agriculture Nitrogen Certification) or a self-certified grower is required for certain coalition members depending on the farm size and groundwater quality vulnerability designation. After harvest is completed, the post-production information of the NMP Worksheet is completed, but certification of this information is not required.

The NMP Summary Report was approved by the EO of the CVRWQCB on December 23, 2015. Some of the information from the NMP Worksheet is required for the NMP Summary Report: site location information, crop, total acres, total available nitrogen applied (**A**), the ratio of applied nitrogen and actual yield (**Y**) [known as the **A/Y ratio**], and the crop harvest production units.

The NMP Summary Report does not require certification, but it is a required submittal to coalitions for farms in HVAs. See **Figure 1-3** for the KRWQC GAR designated HVAs. KRWQC members have been informed of their vulnerability designation, farm size classification, and the required reporting schedules.

4.1.1 Timeline

In the Tulare Lake Basin, NMP Worksheets were first required in 2015 for large farms (≥ 60 acres) in HVAs, but certification was not required. By March 1, 2017, the NMP Worksheet for large farms in HVAs was to be completed and certified. The first NMP Summary Report was due to the coalitions by March 1, 2017, for large farms in HVAs for the 2017 Crop/Harvest Year. Small farms (≤ 60 acres) in HVAs were required to complete and certify an NMP Worksheet by March 1, 2017, and subsequently submit an NMP Summary Report by March 1, 2018. As of March 1, 2018, all farms in HVAs are required to complete NMP Worksheets and NMP Summary Reports annually. Farms of all sizes in areas of low groundwater quality vulnerability were required to complete an NMP Worksheet by March 1, 2017, and annually thereafter, but certification and NMP Summary Reports are not required.

4.1.2 Nitrogen Management Plan Summary Report Analysis

The NMP Worksheet stays on farm and is *not* submitted to the coalitions or the CVRWQCB. The NMP Summary Report that members submit to coalitions provides *some* information on nitrogen management. Per the General Order, coalitions must summarize these data in their AMRs. The CVRWQCB can use this information to evaluate the reported nitrogen management trends and any possible impacts to water quality. Data are aggregated on a township (36 square miles) and crop basis within the KRWQC.

This is the third NMP Summary Report analysis for the KRWQC. The analysis covers the 2018 Crop/Harvest Year for large *and* small farms in HVAs. The surface water monitoring sections of this AMR are strictly based on the 2018 Calendar Year (01 January to 31 December). The NMP Summary Report data summarized in this section come from crops in which harvest was completed from January 2018 through December 2018.

In general, this report describes the analysis of nitrogen applications, A/Y ratios, and applied nitrogen over nitrogen removal (**A/R**) ratios, where possible, by crop, soil characteristics, and irrigation systems on a township basis. Some of the data are also summarized by crop on a coalition-wide basis. The KRWQC believes that summarizing these data by crop on a coalition-wide basis is the best way to evaluate the information. For many crops, the sample sizes are too small to provide meaningful summary statistics or box and whisker plots on a township basis. Moreover, statistical outliers by crop are not consistent between townships. Depending on the spread of the population data, an outlier in one township may not be an outlier in another township, and an outlier in a township may not be an outlier on a coalition basis for a given crop. This could create confusion and frustration among growers and make the information less impactful. Overall, township analysis has little value and the KRWQC would prefer to omit this analysis in future reporting and focus on coalition-wide crop statistics instead.

Although the reported NMP Summary Report data do provide some insight into estimated nitrogen application rates, crop yields, and metrics of nitrogen efficiency, the data are general and aggregated, and do *not* define mass loading of nitrogen to groundwater. The data should only be used to evaluate general trends by crop across multiple years, as recommended by the Agricultural Expert Panel (Burt et al., 2014). The most effective use of this information will be for a grower and adviser outreach and education and as inputs for the SSJV MPEP analyses and modeling. Regulatory metrics or thresholds of A/Y, A/R, or other metrics should not be developed from these data.

Nitrogen management is highly complex and depends on many factors such as location, weather, irrigation infrastructure and management, soils, crop type and cultivar, rootstocks, pest management, cultural practices, nitrogen consumption rates vs. nitrogen removal rates, and other factors. The complex interactions of these factors cannot be appropriately interpreted by simple metrics. In addition, simple metrics fail to adequately address the unique nitrogen removal rates due to inter-cropping patterns of minority group growers within the KRWQC. Moreover, averaged singular value nitrogen removal coefficients based on relatively limited data do not account for the substantial variability in nitrogen demand and removal rates, nitrogen required to grow permanent tissues, etc. Undoubtedly, many sophisticated growers in Kings County will outperform average yields and nitrogen removal rates in the Central Valley, and therefore the summary of nitrogen removal in this report may not be accurate for many growers in the KRWQC. An ongoing process of education and outreach via individual grower NMP Summary Feedback letters, coalition meetings, the MPEP, and other outlets is the best use of this information.

4.2 Data Quality Assessment, Rationale, and Methods

4.2.1 Submitted Data

Growers with enrolled parcels located within an HVA from January 1 to December 31, 2018, were required to submit an NMP Summary Report to the KRWQC. Within the KRWQC, 4,200 Current Members were required to submit the NMP Summary Report. Of these members, 3,599 members submitted the NMP Summary Report, or 85.6% (as of this writing). Of the 2,246 NMP Summary Reports submitted, a total of 416,378 irrigated acres were included, although only 389,092 irrigated acres of this total were used in this report due to various issues outlined.

The Coalition utilizes this NMP Summary data to calculate the Nitrogen Removed from the field at harvest. After the analysis of this data is complete, the Coalition provides outreach to each member their nitrogen removal estimates on a per acre basis and provides a statistical summary of their fields' nitrogen use and removal in congruence with Coalition members with similar management practices and crops.

4.2.2 Data Quality and Assumptions

As this is the third grower submission of NMP Templates to the KRWQC, the data was carefully evaluated for quality and outliers prior to analysis. Potentially erroneous data was flagged and filtered out of all the figures (Box-Plots) to improve readability for this year's summary report. For example, some of the reported A/Y ratios resulted in calculated yields that were impossibly high for a given crop as well as inconsistencies in reported production units, and nitrogen applications. Examples of uncertainties are listed:

- Reporting yields as A/Y ratio
- Reporting applied nitrogen for total acreage instead of a per acre basis
- Crops that do not have an assigned Geisseler N Removed coefficient
- Data pertaining to the Growth Stages of certain crops was not collected
- Zero (0) was used to represent Non-Bearing (**NB**) crops for the Total Available N Applied per field, these had to be excluded from the report to not skew the data
- Zero (0) was used to represent No Yield (**NY**) crops for A/Y Total Available N / Actual Yield/ field, these had to be excluded from the report to not skew the data
- Crops that represent less than 1% of the coalitions total irrigated acreage

A series of filters consisting of minimum and maximum values by crop was used to exclude erroneous data for the following variables:

- Data reported as NB, NY, A/Y values of zero, or N-Applied values of zero
- All charts had values of 3 times the 90th percentile removed to the enhance viewability of each chart. The underlying data is still present in the tables accompanying the box and whisker plots

Significant improvement in quality of reported member data for the 2018 reporting year compared to the 2017 reporting year can be attributed to member outreach and limiting members reporting production units and commodity groups so normalization of production units and commodity groups could be done with a higher level of certainty. As a result, of the 13,781 data points available, 10,723 are included in this report.

4.2.3 Crop Yields and Moisture Content

The A/Y ratio represents the total nitrogen applied [**A**] divided by the total yield [**Y**] from the NMP worksheet, as shown in the equation below:

$$\frac{A}{Y} = \frac{total\ nitrogen\ applied\ per\ acre\ [A]}{total\ yield\ per\ acre\ [Y]}$$

This equation was algebraically solved for total yield [Y] as shown in the following equation:

$$Yield\ per\ acre\ [Y] = \frac{Total\ nitrogen\ applied\ per\ acre\ [A]}{\frac{A}{Y}}$$

To standardize all reported information, the KRWQC converted all yield units (e.g., bins, cartons, boxes, tons, cwt, bales, lugs, sacks) to pounds per acre. Therefore, the units for the A/Y ratios summarized in this report are as follows:

$$\frac{A}{Y} = \frac{pounds\ of\ nitrogen\ applied\ per\ acre}{pounds\ of\ yield\ per\ acre}$$

4.2.4 Nitrogen Removal Coefficients

4.2.4.1 Background and Evaluation of Nitrogen Removal Values

The Central Valley Water Quality Coalitions submitted a literature review on crop nitrogen removal values from Dr. Daniel Geisseler of UC Davis to the CVRWQCB on January 13, 2017 (Geisseler, 2016). A summary of the information from Geisseler (2016) that was used to develop this report is tabulated in **Table 4-1**.

To calculate nitrogen removal, the KRWQC used the *average* nitrogen removal values listed in **Table 4-1**. It is critical to note that the ranges of nitrogen removal values vary substantially, even for crops with excellent supporting datasets from the Central Valley. For example, the average nitrogen removal value for almonds is 136 pounds of nitrogen removed per ton of harvest kernels (lbs N/ton kernels). The minimum and maximum nitrogen removal values are 102 and 174 lbs N/ton kernels, respectively. Actual nitrogen removal values from grower fields will span the range provided by Geisseler (2016) and beyond. The calculations of nitrogen removal and A/R ratios using average nitrogen removal rates only provide a very general estimation of nitrogen removal on a landscape level, such as all almonds reported to the KRWQC. Assessing nitrogen removal on individual fields using these values is problematic as they likely do not reflect actual field conditions.

The KRWQC also evaluated the status of the nitrogen removal values to determine their validity (see the "N Removal Coefficient Status" column of **Table 4-1**). One of three qualitative categories were assigned to each crop: 1) Good, 2) Sufficient, and 3) Needs Improvement. "Good" represents nitrogen removal numbers that are reliable estimates supported by robust datasets from California. "Sufficient" represents reasonable estimates of nitrogen removal that could be improved with more data from the Central Valley. "Needs Improvement" represents rough estimates of nitrogen removal values. More data are needed from the Central Valley of California to refine those numbers.

Geisseler (2016) provided nitrogen removal values for 68 crops. Of those, the KRWQC defined 17 (25%) as "Good", 12 (18%) as "Sufficient", and 39 (57%) as "Needs Improvement." This information indicates that

the nitrogen removal values for 51 of 68 crops (75%) could or should be improved. Moreover, even crops defined as having "good" estimates of nitrogen removal values could use larger datasets consisting of more locations, years, soil types, varieties, etc. For permanent crops, there are also other potential pathways of nitrogen removal from the soil, such as nitrogen required for permanent tissue growth, abscised leaves, prunings, etc., that are not considered in the estimates provided by Geisseler (2016).

4.2.4.2 Future Work to Improve Nitrogen Removal Values

To address some of the deficiencies of the current level of knowledge of crop nitrogen removal, the Southern SSJV MPEP committee applied for and received a California Department of Food and Agriculture Fertilizer Research and Education Program (CDFA FREP) grant in 2018 titled, "Assessment of harvested and sequestered nitrogen content to improve nitrogen management in crops." This grant will provide approximately $223,000 over three years (2018-2020) to work with Dr. Daniel Geisseler on the following items:

- Sampling and analysis of additional crops to determine nitrogen removal rates
- Incorporation of additional datasets into the existing nitrogen removal database
- Establishment of nitrogen sequestration values for some permanent crops
- Comprehensive update of Geisseler (2016), as appropriate

The SSJV MPEP Committee has also allocated an additional $45,000 from the NRCS Conservation Innovation Grant (**CIG**) to support this work in addition to $15,000 for program and grant administration from the general SSJV MPEP budget. The KRWQC will utilize this updated information when it becomes available. Although this project will substantially improve current nitrogen removal values, many of the same caveats will remain and additional work on other crops will be needed after this project is complete. Understanding crop nitrogen removal is a perpetual process.

Table 4-1. Summary of Nitrogen Removal Information from Geisseler (2016)

Commodity	Nitrogen Removed with Harvested Parts			Units and Moisture	Number of Observations	Standard Deviation	Coefficient of Variation	Average Nitrogen in Harvested Parts	N Removal Coefficient Status
	Average	Low	High		n	SD	CV %	lbs N / lb yield	
Alfalfa - Hay	**62.3**	49.3	82.5	lbs N/ton at 12% moisture	49	7.8	12.5	**0.0312**	Good
Alfalfa - Silage	**24**	18.5	27.6	lbs N/ton at 65% moisture	6	4.2	17.5	**0.0120**	Good
Barley - Grain	**33.6**	19.6	48.7	lbs N/ton at 12% moisture	61	4.9	14.6	**0.0168**	Needs Improvement
Barley - Straw	**15.4**	6.8	16.9	lbs N/ton at 12% moisture	970	4.83	31.3	**0.0077**	Needs Improvement
Beans, dry - Blackeye	**73**	56.3	80.6	lbs N/ton at 12% moisture	164	7.6	10.4	**0.0365**	Needs Improvement
Beans, dry - Garbanzo	**67.2**	46.8	95.7	lbs N/ton at 12% moisture	108	7.6	11.3	**0.0336**	Needs Improvement
Beans, dry - Lima	**72.3**	63.3	90	lbs N/ton at 12% moisture	75	3.9	5.4	**0.0362**	Sufficient
Corn - Grain	**24**	6	53.6	lbs N/ton at 15.5% moisture	1775	5	20.8	**0.0120**	Needs Improvement
Corn - Silage	**7.56**	5	10.4	lbs N/ton at 70% moisture	72	0.8	10.5	**0.0038**	Good
Cotton	**43.7**	23.3	63.2	lbs N/ton lint & seed	80	12.9	29.5	**0.0219**	Good
Fescue, Tall - Hay	**50.8**	33.7	70.1	lbs N/ton at 12% moisture	260	8.24	16.2	**0.0254**	Needs Improvement
Oat - Grain	**37.7**	26.5	50.7	lbs N/ton at 12% moisture	134	3.61	9.6	**0.0189**	Needs Improvement
Oat - Straw	**14.8**	6.1	23.1	lbs N/ton at 12% moisture	526	5.2	34.7	**0.0074**	Needs Improvement
Oat - Hay	**21.7**	14.6	29.3	lbs N/ton at 12% moisture	49	4	18.2	**0.0109**	Good
Orchard Grass - Hay	**54.5**	38	76.3	lbs N/ton at 12% moisture	60	10.88	20	**0.0273**	Needs Improvement
Ryegrass, Perennial - Hay	**54.9**	36.2	75.8	lbs N/ton at 12% moisture	60	9.21	16.8	**0.0275**	Needs Improvement
Safflower	**56.8**	33.8	109.3	lbs N/ton at 8% moisture	149	11.4	20	**0.0284**	Needs Improvement
Sorghum - Grain	**33**	10.4	74	lbs N/ton at 13.5% moisture	256	9.8	29.7	**0.0165**	Needs Improvement
Sorghum - Silage	**7.34**	3.9	11.9	lbs N/ton at 65% moisture	260	1.55	21	**0.0037**	Good
Sunflower	**54.1**	32.8	69.9	lbs N/ton at 8% moisture	208	7.76	14.3	**0.0271**	Needs Improvement
Triticale - Grain	**40.4**	29.5	50.9	lbs N/ton at 12% moisture	51	5.25	13	**0.0202**	Good
Triticale - Straw	**11.5**	5.5	29	lbs N/ton at 12% moisture	102	4.42	38.3	**0.0058**	Needs Improvement
Triticale - Silage	**9.03**	7.4	11.5	lbs N/ton at 70% moisture	19	1.24	13.7	**0.0045**	Good
Wheat, common - Grain	**43**	32.1	52.7	lbs N/ton at 12% moisture	113	4.45	10.3	**0.0215**	Good
Wheat - Straw	**13.8**	6.1	29.3	lbs N/ton at 12% moisture	494	4.56	33	**0.0069**	Needs Improvement
Wheat - Silage	**10.5**	6.7	14.5	lbs N/ton at 70% moisture	39	1.96	18.6	**0.0053**	Good
Wheat, durum - Grain	**42.1**	33.7	54	lbs N/ton at 12% moisture	41	1.56	3.7	**0.0211**	Good
Asparagus	**5.85**	3.92	8.88	lbs N/ton of fresh spears	19	0.82	14	**0.0029**	Needs Improvement
Beans, green (snap beans)	**5.78**	4.45	7.2	lbs/ton of fresh weight	122	1.49	25.7	**0.0029**	Needs Improvement
Broccoli	**11.2**	7.48	19.01	lbs N/ton of fresh weight	46	2.28	20.4	**0.0056**	Needs Improvement
Carrots	**3.29**	1.71	7.35	lbs/ton of fresh weight	167	0.74	22.4	**0.0016**	Needs Improvement
Corn, sweet	**7.17**	4.83	10.6	lbs/ton of fresh ears	50	0.94	13.1	**0.0036**	Needs Improvement
Cucumbers	**2.16**	1.6	2.84	lbs/ton of fresh weight	10	0.38	17.4	**0.0011**	Needs Improvement
Garlic	**15.1**	9.41	20.48	lbs/ton of fresh weight	12	2.94	19.5	**0.0076**	Needs Improvement
Lettuce, Iceberg	**2.63**	1.75	4.74	lbs/ton of fresh weight	68	0.44	16.7	**0.0013**	Good
Lettuce, Romaine	**3.62**	2.27	5.12	lbs/ton of fresh weight	26	0.49	13.7	**0.0018**	Good
Melons, Cantaloupe	**4.87**	1.97	7.02	lbs/ton of melons	31	0.76	15.5	**0.0024**	Sufficient
Melons, Honeydew	**2.95**	1.98	4.25	lbs/ton of melons	12	0.65	22.1	**0.0015**	Needs Improvement
Melons, Watermelons	**1.39**	0.95	2.04	lbs/ton of melons	6	0.33	23.9	**0.0007**	Needs Improvement
Onions	**3.94**	1.6	6.29	lbs/ton of fresh weight	45	0.78	19.7	**0.0020**	Needs Improvement
Pepper, Bell	**3.31**	2.18	6.13	lbs/ton of fresh weight	40	0.26	7.9	**0.0017**	Needs Improvement
Potatoes	**6.24**	4.08	9.22	lbs/ton of fresh weight	64	0.85	13.6	**0.0031**	Needs Improvement
Pumpkin	**7.36**	4.27	9.06	lbs/ton of fresh weight	13	0.74	10.1	**0.0037**	Needs Improvement
Squash	**3.67**	0.64	6.4	lbs/ton of fresh weight	74	0.82	22.4	**0.0018**	Needs Improvement
Sweet potatoes	**4.74**	3.43	6.37	lbs/ton of fresh weight	23	0.8	16.8	**0.0024**	Good
Tomatoes, fresh market	**2.61**	1.89	3.39	lbs/ton of fresh weight	34	0.43	16.5	**0.0013**	Needs Improvement
Tomatoes, processing	**2.73**	1.9	3.6	lbs/ton of fresh weight	24	0.3	11.1	**0.0014**	Good
Almonds	**136**	102	174	lbs/ton of kernels	31	5.6	4.1	**0.0680**	Good
Apples	**1.08**	0.6	3.23	lbs/ton of fruits	132	0.38	35.1	**0.0005**	Needs Improvement
Apricots	**5.56**	4.48	5.64	lbs/ton of fruits	22	6.35	114	**0.0028**	Needs Improvement
Cherries	**4.42**	2.7	6.67	lbs/ton of fruits	24	0.87	19.8	**0.0022**	Needs Improvement

Commodity	Nitrogen Removed with Harvested Parts			Units and Moisture	Number of Observations	Standard Deviation	Coefficient of Variation	Average Nitrogen in Harvested Parts	N Removal Coefficient Status
	Average	Low	High		n	SD	CV %	lbs N / lb yield	
Figs	**2.54**	2.4	4.21	lbs/ton of fruits	19	0.46	18.1	**0.0013**	Needs Improvement
Grapefruit	**2.96**	1.6	3.24	lbs/ton of fruits	27	0.23	7.8	**0.0015**	Sufficient
Grapes - Raisins	**10.1**	7.88	12.5	lbs/ton at 15% moisture	19	0.58	5.8	**0.0051**	Sufficient
Grapes - Table	**2.26**	1.78	2.81	lbs/ton of grapes	19	0.13	5.8	**0.0011**	Sufficient
Grapes - Wine	**3.6**	1.96	5.2	lbs/ton of grapes	38	0.47	13	**0.0018**	Needs Improvement
Lemons	**2.58**	2.3	3.87	lbs/ton of fruits	22	0.26	10	**0.0013**	Sufficient
Nectarines	**3.64**	1.65	5.55	lbs/ton of fruits	41	0.99	27.1	**0.0018**	Sufficient
Olives	**6.28**	4	11.1	lbs/ton of olives	29	1.43	22.8	**0.0031**	Sufficient
Oranges	**2.96**	2.35	4.86	lbs/ton of fruits	82	0.32	10.9	**0.0015**	Sufficient
Peaches	**2.26**	1.38	3.69	lbs/ton of fruits	25	0.47	20.7	**0.0011**	Sufficient
Pears	**1.29**	0.7	2.1	lbs/ton of fruits	64	0.23	17.9	**0.0006**	Needs Improvement
Pistachios	**56.1**	54	58	lbs N/ton dry yield (CPC)	11	1.94	3.5	**0.0281**	Good
Plums	**2.83**	2.4	3.3	lbs/ton of fruits	11	0.32	11.2	**0.0014**	Needs Improvement
Pomegranate	**15.2**	12.1	18.7	lbs/ton of fruits	7	2.28	15	**0.0076**	Needs Improvement
Prunes	**11.2**	8.9	18	lbs/ton of dried fruits	18	1.83	16.3	**0.0056**	Sufficient
Tangerines	**2.54**	2.02	3.06	lbs/ton of fruits	2	0.74	29.2	**0.0013**	Needs Improvement
Walnuts	**31.9**	24	46	lbs N/ton with shells	18	3.56	11.2	**0.0160**	Sufficient

4.2.5 Data Analysis Methods

As the NMP Summary Report template does not require members to submit yield directly, the Coalition calculates the yield to utilize data evaluation and quality control. If yield was reported in a production unit other than pounds, the coalition used conversion factors from USDA Agricultural Handbook, "Weights, Measures, and Conversion Factors for Agricultural Commodities and Their Products", to normalize all productions units to pounds.

Interquartile Range (**IQR**) summary statistical analysis was used to determine outliers for calculated Applied Nitrogen over Removed Nitrogen (A/R) values for each commodity group with respects to township and range, soil classification and irrigation practice. Quartiles are defined by taking the data sets, ranking the values, then defining the lower quartile (Q1) as the middle value for the first half of data points, the middle quartile (Q2) as the median of the data set, and the upper quartile (Q3) as the middle data point of the second half of the data set. The IQR is the fifty percent of the entire data set within Q1 and Q3, or Q3 minus Q1. What does this meanData points are determined as outliers if they were greater than one and half times the upper IQR (or Q3), or one and half times less the lower quartile or Q1 (MIT, 2007).

For the purposes of the KRWQC NMP Summary, data points less than one and half times the Q1 were not identified as outliers, but similar to outliers, will be included in member outreach to determine if possible incorrect summary data was submitted to the coalition. This form of statistical analysis was selected based on its insensitivity to extreme outliers, or erroneous data. **Figure 4-1** has been provided to describe the different components of the IQR statistical analysis.

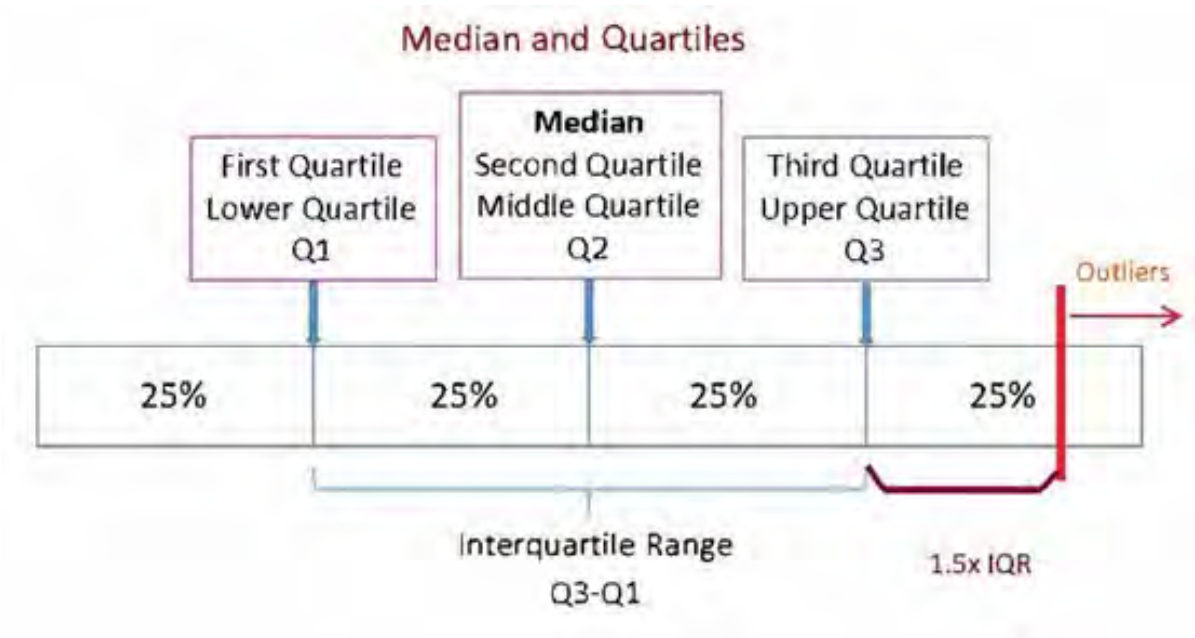

Figure 4-1. IQR Statistical Analysis Components

4.3 Results and Discussion

4.3.1 General Summary

Summary statistics and graphing of nitrogen removal was limited to commodities that were included in Geisseler N Removed Report, **Table 4-1**. Crops included in this report contribute at least 1% of all reported acreage and have a Geisseler N removed coefficient. Crops that meet these criteria include: almonds, raisin grapes, oranges, cotton, peaches, pistachios, wine grapes, table grapes, walnuts, tangerines, plums, nectarines, corn (silage), wheat (silage), tomatoes (processing). Reported crops that did not meet the 1% of KRWQC total acreage requirement and/or did not have a Geisseler nitrogen removal coefficient were excluded, these crops include: wheat (common grain), cherries, onions, lemons, sorghum (silage), pomegranates, corn (sweet), oats (hay), olives, corn (grain), pears, tomatoes (market), triticale (grain), bell peppers, squash, apricots, grapefruit, wheat (durum grain), wheat (straw), sorghum (grain), barley (grain), triticale (silage), beans (dry), garlic, beans (green), prunes, oats (grain), apples, broccoli, figs, safflower, melons (cantaloupe), melons (watermelon), Green Beans (snap), Cucumbers.

Graphical representations of the commodities contributing at least 1% of the reported acreage are identified in **Figure 4-2**.

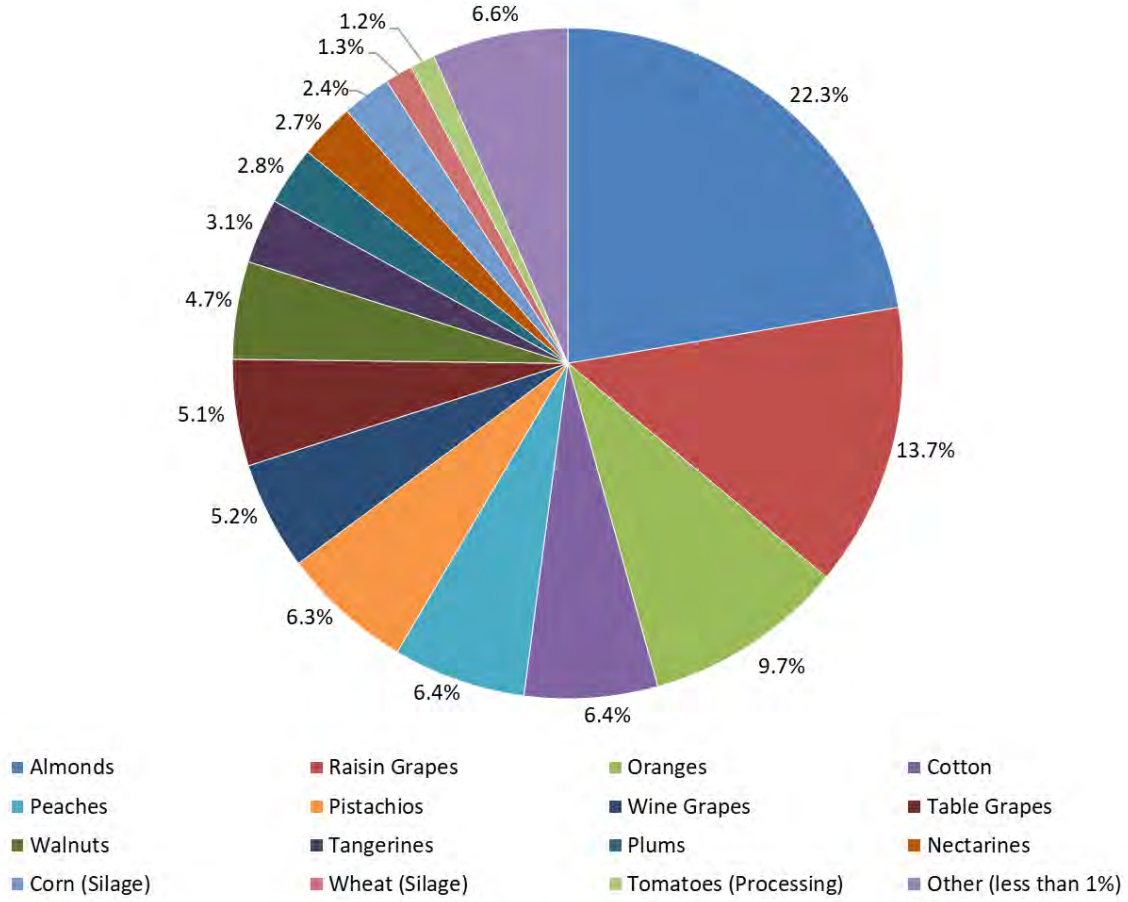

Figure 4-2. Commodities Contributing At Least 1% of Reported Acreage

Each commodity was analyzed with respect to its location (township and range), soil classification and irrigation practice. These analyses are shown in box and whisker plots and in tables for each commodity listed in this report. The box and whisker plots display green, blue and red lines representing the 10th, 50th, and 90th percentiles, respectively. All charts had abnormally high values above 3 times the 90th percentile, which were removed to enhance viewability. The underlying data is presented in the tables accompanying the box and whisker plots.

4.3.2 Almonds

Almonds represent the largest commodity reported in KRWQC, with 2,347 fields making up 92,980 acres (22.3%) of the coalition's total reported acreage. Of the total 2,347 fields, 2,114 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect, or incomplete data for reasons previously discussed in **Section 4.2.1**. **Figure 4-3Error! Reference source not found.** compares the calculated A/R values from the reported A/Y values for almonds corresponding to township and range. The aggregate A/R ratios from the data set ranged from a

minimum of 0.0001 to a maximum of 26,471 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-2**.

Ten percent of the filtered almonds A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-4** and **Table 4-3** as well as irrigation practices in **Figure 4-5**.

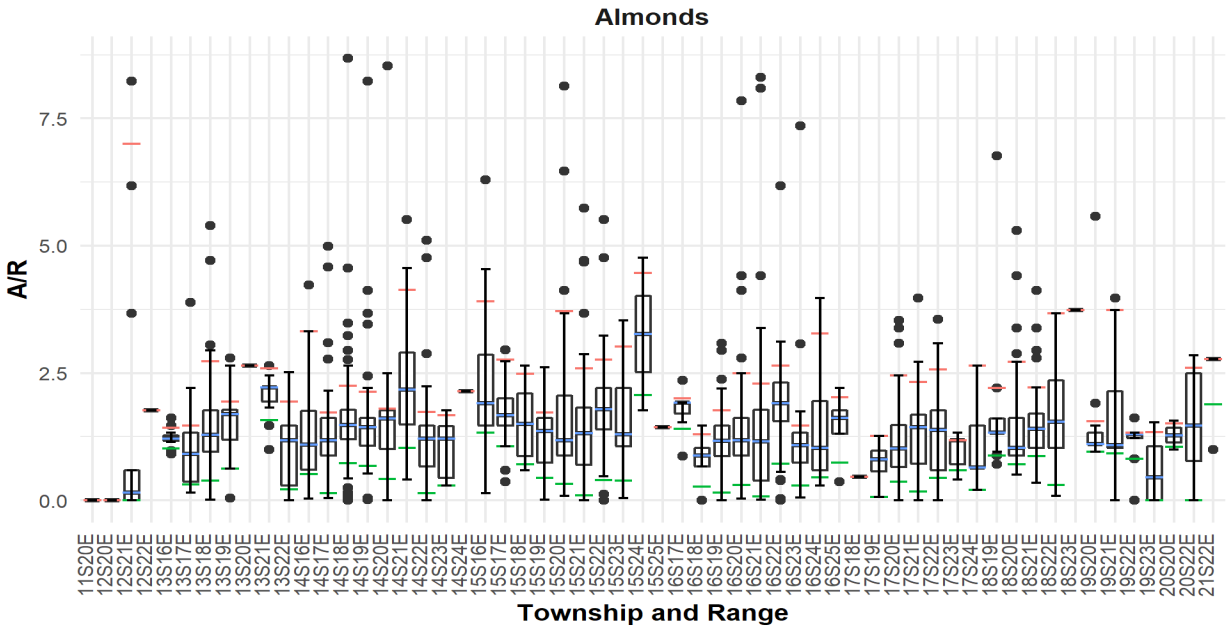

Figure 4-3. Box and Whisker Plots of A/R by Township and Range for Almonds

Table 4-2. A/R by Township and Range for Almonds

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1000	0.2500	0.5000	0.7500	0.9000				
11S20E	A/R	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	9	1	1	100%
12S20E	A/R	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	60	4	4	100%
12S21E	A/R	0.0004	8.2353	0.0015	0.0015	0.1471	0.5882	7.0000	652	17	4	24%
12S22E	A/R	1.7647	1.7647	1.7647	1.7647	1.7647	1.7647	1.7647	51	2	2	100%
13S16E	A/R	0.9118	1.6176	1.0235	1.1654	1.2059	1.2702	1.4265	982	14	2	14%
13S17E	A/R	0.1471	3.8824	0.3087	0.3676	0.9154	1.3235	1.4706	1,706	50	1	2%
13S18E	A/R	0.0132	735.2941	0.4399	0.9779	1.4309	1.9847	3.0418	3,312	112	11	10%
13S19E	A/R	0.0459	20,016.0128	0.6204	1.1956	1.7647	1.7823	2.1912	1,946	71	2	3%
13S20E	A/R	2.6471	2.6471	2.6471	2.6471	2.6471	2.6471	2.6471	36	1	1	100%
13S21E	A/R	1.0000	2.6471	1.5765	1.9412	2.2206	2.2206	2.5879	703	24	3	13%
13S22E	A/R	0.0007	162.7938	0.2162	0.7353	1.2279	1.7059	79.4118	1,503	56	7	13%
14S16E	A/R	0.0324	3,852.9412	0.5279	0.6018	1.2647	3.1673	2,080.8824	4,094	46	7	15%
14S17E	A/R	0.0397	4.9863	0.1397	0.8824	1.1765	1.6160	1.7250	3,387	64	4	6%
14S18E	A/R	0.0011	1,470.5882	0.8235	1.2169	1.5000	1.9838	2.7621	7,046	196	12	6%
14S19E	A/R	0.0132	1,500.0000	0.6765	1.1176	1.4412	1.8235	3.6765	4,302	113	14	12%
14S20E	A/R	0.0047	1,470.5882	0.5176	1.0662	1.6176	1.7717	1.8062	1,830	94	3	3%
14S21E	A/R	0.4118	116.4706	1.0294	1.4853	2.1765	3.0588	4.9408	991	37	4	11%
14S22E	A/R	0.0006	154.1177	0.1733	0.7941	1.2868	1.5250	9.8441	2,103	93	13	14%
14S23E	A/R	0.2941	138.5294	0.2941	0.5147	1.2493	1.6544	42.7941	370	8	1	13%
14S24E	A/R	2.1471	2.1471	2.1471	2.1471	2.1471	2.1471	2.1471	173	7	7	100%
15S16E	A/R	0.1379	3,852.9412	1.3235	1.4706	2.0588	3.0147	4.4382	3,126	39	3	8%
15S17E	A/R	0.3676	2.9588	1.0588	1.4706	1.6676	2.0066	2.7576	1,853	30	3	10%
15S18E	A/R	0.5882	168.0809	0.7088	0.8750	1.6765	2.1029	2.6471	2,106	15	1	7%
15S19E	A/R	0.0103	2,676.4703	0.4412	0.9191	1.3971	1.6994	2.4622	5,194	110	9	8%
15S20E	A/R	0.0882	2,560.0182	0.4338	0.8824	1.4706	2.2059	8.1324	2,162	77	12	16%
15S21E	A/R	0.0003	588.2353	0.1029	0.7353	1.3235	1.8529	2.8241	1,457	69	5	7%
15S22E	A/R	0.0049	16.1765	0.6000	1.4706	2.0300	3.6176	15.0735	1,010	36	7	19%
15S23E	A/R	0.0436	3.5294	0.3820	1.0621	1.3007	2.2059	3.0206	815	24	0	0%
15S24E	A/R	1.7647	367.6471	2.6655	4.0168	186.2073	367.6471	367.6471	251	4	0	0%
15S25E	A/R	1.4362	1.4362	1.4362	1.4362	1.4362	1.4362	1.4362	20	1	1	100%
16S17E	A/R	0.8706	2.3529	1.4000	1.7044	1.9205	1.9205	2.0070	1,359	9	1	11%
16S18E	A/R	0.0029	1.4706	0.2668	0.6625	0.8824	1.0294	1.2941	993	4	0	0%
16S19E	A/R	0.0029	2,676.4703	0.1471	0.8723	1.1728	1.4706	1.7941	5,241	80	5	6%
16S20E	A/R	0.0353	2,676.4703	0.4235	0.9658	1.2931	2.3000	16.3324	3,207	87	17	20%
16S21E	A/R	0.0140	217.6470	0.0856	0.5294	1.3750	2.2059	8.1765	3,456	97	11	11%
16S22E	A/R	0.0003	6.1765	0.7163	1.5577	1.9118	2.3143	2.6471	1,880	68	1	1%
16S23E	A/R	0.0506	26,471.5042	0.3559	0.9504	1.1378	1.4706	6.0682	1,485	74	9	12%
16S24E	A/R	0.2926	3.9706	0.4489	0.5882	1.0340	1.9485	3.2765	605	24	0	0%
16S25E	A/R	0.3676	2.2059	0.7426	1.3051	1.6176	1.7647	2.0294	59	4	0	0%
17S18E	A/R	0.4603	0.4603	0.4603	0.4603	0.4603	0.4603	0.4603	47	2	2	100%
17S19E	A/R	0.0647	1.2647	0.0709	0.5699	0.8088	0.9779	1.2647	301	8	0	0%
17S20E	A/R	0.0071	2,676.4703	0.4397	0.6702	1.0294	2.3899	3.3824	2,375	56	4	7%
17S21E	A/R	0.0003	294.1176	0.1881	0.7353	1.4412	1.7500	2.7206	3,321	65	6	9%
17S22E	A/R	0.0003	12.9412	0.4412	0.5882	1.3779	1.7647	2.6123	1,622	57	3	5%
17S23E	A/R	0.4044	1.3235	0.5882	0.7132	1.1765	1.1765	1.1765	831	16	0	0%
17S24E	A/R	0.2059	2.6471	0.2059	0.6471	0.6471	1.4706	2.6471	378	9	0	0%
18S19E	A/R	0.7078	14.2647	0.8824	1.3235	1.3235	1.6029	2.2059	1,661	36	7	19%
18S20E	A/R	0.4996	5.2941	0.7078	0.8824	1.0294	1.6176	2.7147	3,016	81	8	10%
18S21E	A/R	0.3490	4.1176	0.8706	1.0306	1.4026	1.7056	2.2119	1,324	50	4	8%
18S22E	A/R	0.0882	241.1757	0.3471	1.0317	1.7647	3.0882	3.6765	886	23	1	4%
18S23E	A/R	3.7353	3.7353	3.7353	3.7353	3.7353	3.7353	3.7353	40	1	1	100%
19S20E	A/R	0.9559	5.5735	0.9559	1.1029	1.1029	1.3235	1.5588	616	19	2	11%
19S21E	A/R	0.0003	162.6471	0.9471	1.0294	1.1324	2.5000	3.7353	1,169	29	1	3%
19S22E	A/R	0.0001	1.6176	0.8132	1.2206	1.3003	1.3235	1.3235	674	13	1	8%
19S23E	A/R	0.0001	1.5294	0.0001	0.0001	0.4559	1.0662	1.3441	462	4	0	0%
20S20E	A/R	0.9926	1.5676	1.0501	1.1364	1.2801	1.4239	1.5101	451	2	0	0%
20S22E	A/R	0.0001	2.8529	0.0001	0.7721	1.4706	2.5000	2.6059	303	8	0	0%
21S22E	A/R	1.0000	2.7765	1.8882	2.7765	2.7765	2.7765	2.7765	1,972	6	5	83%
Almonds Coalition-Wide:	**A/R**	**0.0001**	**26,471.5042**	**0.7459**	**1.1125**	**4.5830**	**8.1535**	**47.4112**	**92,980**	**2,347**	**233**	**10%**

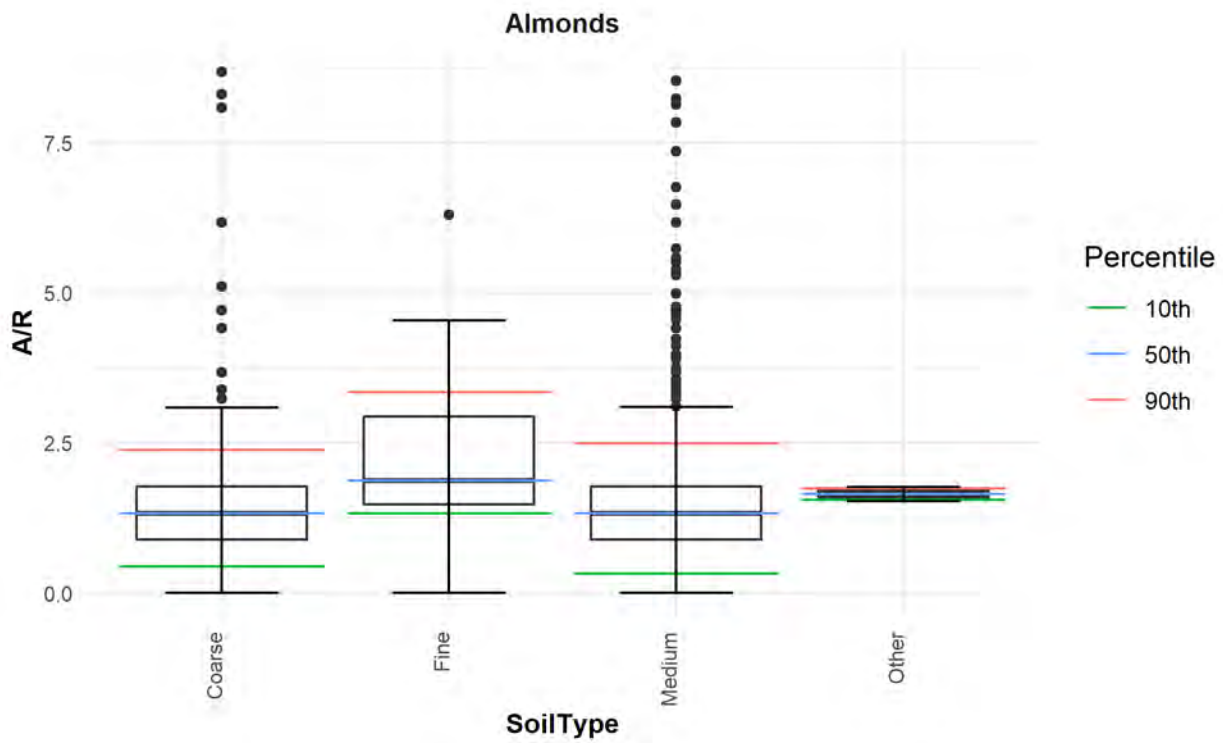

Figure 4-4. Box and Whisker Plots of A/R by Soil Type for Almonds

Table 4-3. A/R by Soil Type for Almonds

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.0007	3852.9412	1.3235	1.4706	1.9118	2.9588	4.4382	3,048	49	4	8%
Medium	A/R	0.0001	26471.5042	0.3490	0.8824	1.3779	1.8485	3.0553	72,198	1827	174	10%
Coarse	A/R	0.0013	2676.4703	0.4853	0.8897	1.3544	1.9118	2.9412	17,704	469	42	9%
Other	A/R	1.529	1.764706	1.5529	1.588	1.647	1.706	1.741	30	2	0	0%

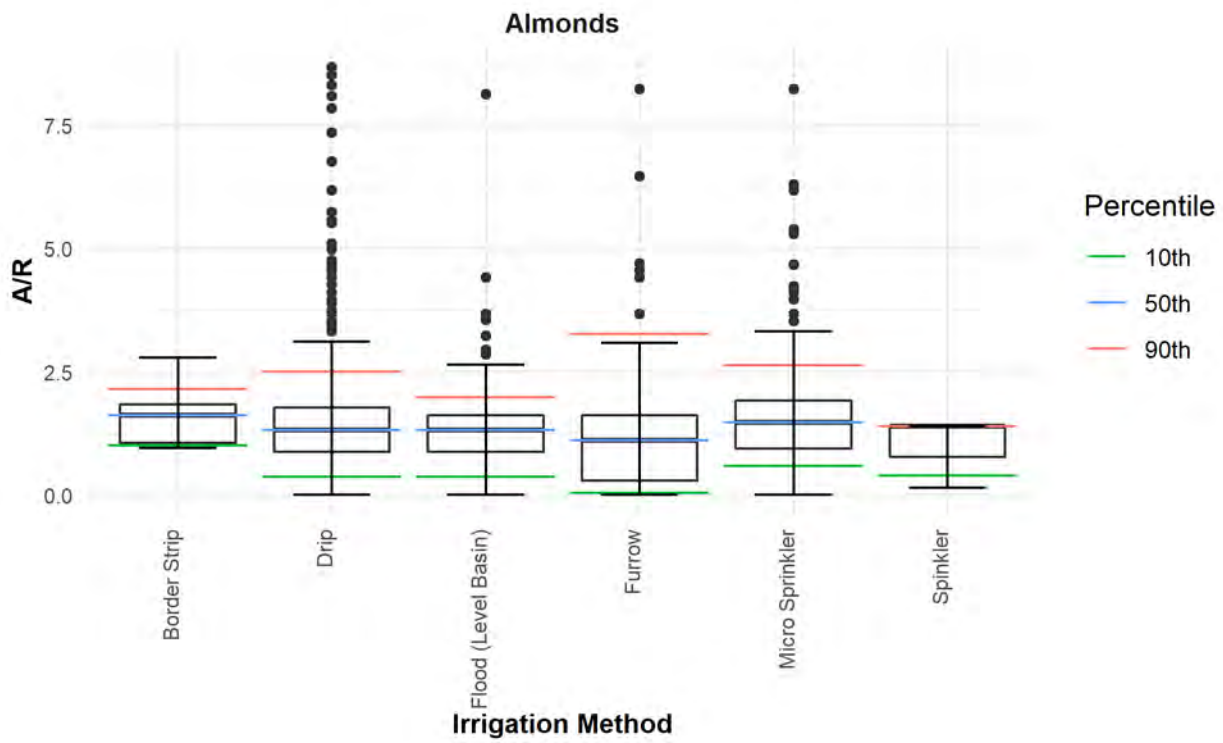

Figure 4-5. Box and Whisker Plots of A/R by Irrigation Practices for Almonds

Table 4-4. A/R by Irrigation Practices for Almonds

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	0.9538	1500.0000	1.0162	1.0849	1.6912	1.9706	2.4493	504	18	1	6%
Drip	A/R	0.0001	26471.5042	0.4015	0.8897	1.3603	1.9118	3.0553	58,553	1,407	124	9%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.0003	2560.0182	0.3713	0.8824	1.3235	1.6765	2.6324	13,175	412	36	9%
Furrow	A/R	0.0003	3852.9412	0.0397	0.2941	1.1471	1.7941	3.6765	4,187	132	11	8%
Micro Sprinkler	A/R	0.0004	3852.9412	0.5882	1.0074	1.4706	2.0297	3.3157	16,362	375	36	10%
Spinkler	A/R	0.1471	1.3971	0.3971	0.7721	1.3971	1.3971	1.3971	198	3	0	0%

Medium soil type was the most commonly reported texture while drip irrigation was the primary reported irrigation practice for almonds in 2018.

4.3.3 Raisin Grapes

Raisin grapes represent the second largest commodity reported in KRWQC, with 1,878 fields making up 56,858 acres (13.7%) of the coalitions total reported acreage. Of the total 1,878 fields, 1,770 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-6. Box and Whisker Plots of A/R **by** Township and Range for Raisin Grapes compares the calculated A/R values from the reported A/Y values for raisin grapes corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0001 to a maximum of 39,408 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-5**. Six percent of the filtered raisin grapes A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-7** and **Table 4-6** as well as irrigation practices in **Figure 4-8** and **Table 4-7**. Medium soil type was most commonly reported texture while drip irrigation was the primary reported irrigation practice for raisin grapes.

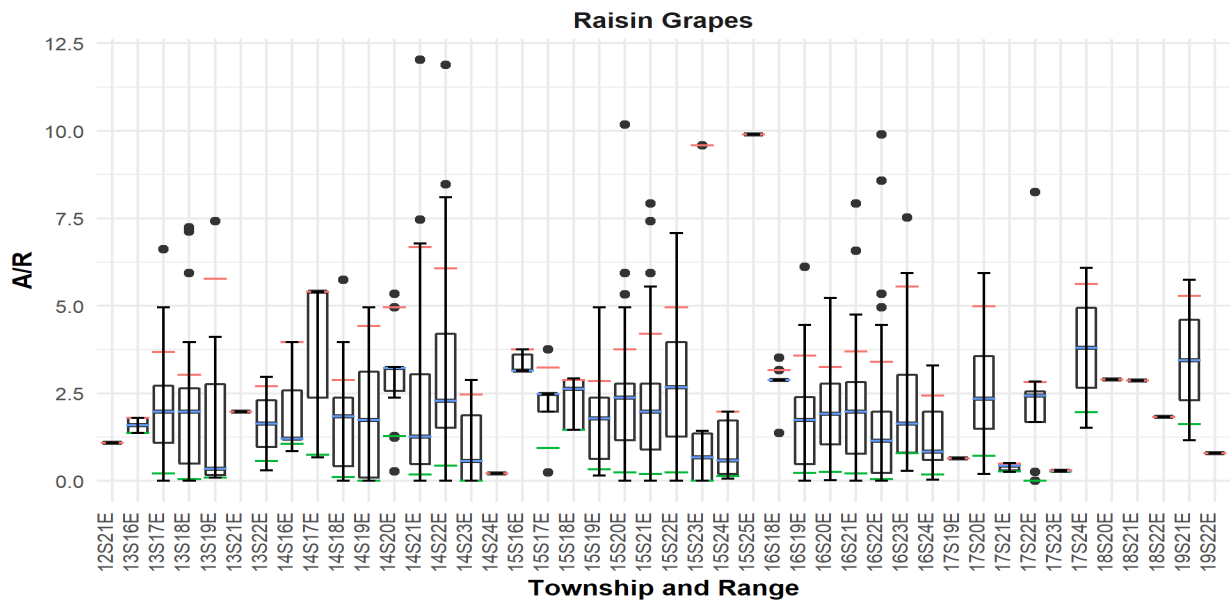

Figure 4-6. Box and Whisker Plots of A/R by Township and Range for Raisin Grapes

Table 4-5. A/R by Township and Range for Raisin Grapes

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1000	0.2500	0.5000	0.7500	0.9000				
12S21E	A/R	1.0792	1.0792	1.0792	1.0792	1.0792	1.0792	1.0792	2	1	1	100%
13S16E	A/R	1.3713	1.7980	1.3713	1.3713	1.5847	1.7980	1.7980	1,026	4	0	0%
13S17E	A/R	0.0001	6.6119	0.2069	1.0842	1.9802	2.7228	3.6762	2,261	92	4	4%
13S18E	A/R	0.0003	8,033.4917	0.0450	0.4995	1.9802	2.7228	3.0580	4,796	198	10	5%
13S19E	A/R	0.0971	7.4257	0.0981	0.1602	0.3369	2.7653	5.7698	765	26	3	12%
13S21E	A/R	1.9802	1.9802	1.9802	1.9802	1.9802	1.9802	1.9802	8	1	1	100%
13S22E	A/R	0.3051	2.9703	0.5717	0.9714	1.6377	2.3040	2.7038	29	2	0	0%
14S16E	A/R	0.8515	3.9604	1.0523	1.1861	1.2077	2.5841	3.9604	480	7	0	0%
14S17E	A/R	0.6733	5.4010	0.7498	2.3762	5.4010	5.4010	5.4010	1,006	29	0	0%
14S18E	A/R	0.0002	39,408.8670	0.1036	0.4515	1.9079	2.3762	3.3020	3,000	98	7	7%
14S19E	A/R	0.0005	3,712.8713	0.0033	0.1094	1.9802	3.1188	4.4257	695	31	1	3%
14S20E	A/R	0.2713	5.3465	1.2723	2.5743	3.2178	3.2178	4.9505	678	31	4	13%
14S21E	A/R	0.0030	346.5344	0.1889	0.4703	1.4396	3.2871	6.7822	886	33	2	6%
14S22E	A/R	0.0037	11.8812	0.4295	1.5149	2.2891	4.2010	6.0729	907	45	2	4%
14S23E	A/R	0.0040	2.8752	0.0040	0.0040	0.5614	1.8673	2.4721	84	5	0	0%
14S24E	A/R	0.2062	0.2062	0.2062	0.2062	0.2062	0.2062	0.2062	71	1	1	100%
15S16E	A/R	3.1545	3.7490	3.1545	3.1545	3.1545	3.6004	3.7490	463	6	0	0%
15S17E	A/R	0.2327	3.7490	0.9317	1.9802	2.4752	2.4752	3.2395	524	5	1	20%
15S18E	A/R	1.4505	2.9208	1.4505	1.4505	2.6238	2.8782	2.8782	1,370	13	0	0%
15S19E	A/R	0.1436	2,744.6029	0.3267	0.6295	1.7822	2.3762	2.8877	3,864	94	2	2%
15S20E	A/R	0.0012	1,684.0030	0.2414	1.1762	2.3762	2.7723	3.9604	6,853	260	11	4%
15S21E	A/R	0.0001	7,722.7723	0.1980	0.9037	1.9859	2.7833	4.9505	5,368	212	14	7%
15S22E	A/R	0.0010	7.0825	0.2366	1.2658	2.6752	3.9594	4.9505	1,536	67	0	0%
15S23E	A/R	0.0040	9.5812	0.0040	0.0040	0.6685	1.3470	9.5812	225	10	2	20%
15S24E	A/R	0.0648	1.9802	0.1314	0.2001	0.5790	1.7231	1.9802	62	6	0	0%
15S25E	A/R	9.9010	9.9010	9.9010	9.9010	9.9010	9.9010	9.9010	19	1	1	100%
16S18E	A/R	1.3723	3.5248	2.8782	2.8782	2.8782	2.8782	3.1683	1,522	11	10	91%
16S19E	A/R	0.0016	6.1188	0.2277	0.4713	1.7327	2.3871	3.5832	4,415	104	1	1%
16S20E	A/R	0.0198	5,663.6654	0.2574	1.1613	1.9802	2.7723	4.0376	4,916	135	5	4%
16S21E	A/R	0.0099	9,307.1956	0.2059	0.7750	1.9802	2.8715	3.6980	4,496	146	3	2%
16S22E	A/R	0.0016	3,736.0831	0.0510	0.2322	1.2673	2.0545	4.4554	2,353	114	11	10%
16S23E	A/R	0.2832	754.9505	0.7921	0.8297	2.2941	3.9505	381.2376	468	26	3	12%
16S24E	A/R	0.0257	3.3000	0.1782	0.5941	0.8267	1.9802	2.4317	335	20	0	0%
16S25E	A/R	13.8614	13.8614	13.8614	13.8614	13.8614	13.8614	13.8614	37	2	2	100%
17S19E	A/R	0.6449	32.6733	3.8477	8.6520	16.6591	24.6662	29.4704	194	2	0	0%
17S20E	A/R	0.1881	5.9406	0.7087	1.4896	2.3478	3.5644	4.9901	242	4	0	0%
17S21E	A/R	0.2574	0.5014	0.2763	0.3047	0.4271	0.4951	0.4989	176	5	0	0%
17S22E	A/R	0.0035	3,736.0831	0.0035	2.1604	2.4921	2.6812	2.8317	367	21	2	10%
17S23E	A/R	0.2723	0.2970	0.2748	0.2785	0.2847	0.2908	0.2946	71	2	0	0%
17S24E	A/R	1.5089	6.0812	1.9661	2.6520	3.7950	4.9381	5.6240	140	2	0	0%
18S20E	A/R	2.9010	2.9010	2.9010	2.9010	2.9010	2.9010	2.9010	40	1	1	100%
18S21E	A/R	2.8713	2.8713	2.8713	2.8713	2.8713	2.8713	2.8713	20	1	1	100%
18S22E	A/R	1.8218	1.8218	1.8218	1.8218	1.8218	1.8218	1.8218	34	1	1	100%
19S21E	A/R	1.1554	5.7426	1.6142	2.3022	3.4490	4.5958	5.2839	37	2	0	0%
19S22E	A/R	0.7921	0.7921	0.7921	0.7921	0.7921	0.7921	0.7921	17	1	1	100%
Raisin Grapes Coalition-Wide:	**A/R**	**0.0001**	**39,408.8670**	**1.3659**	**1.8607**	**2.7039**	**3.5071**	**12.8793**	**56,858**	**1,878**	**108**	**6%**

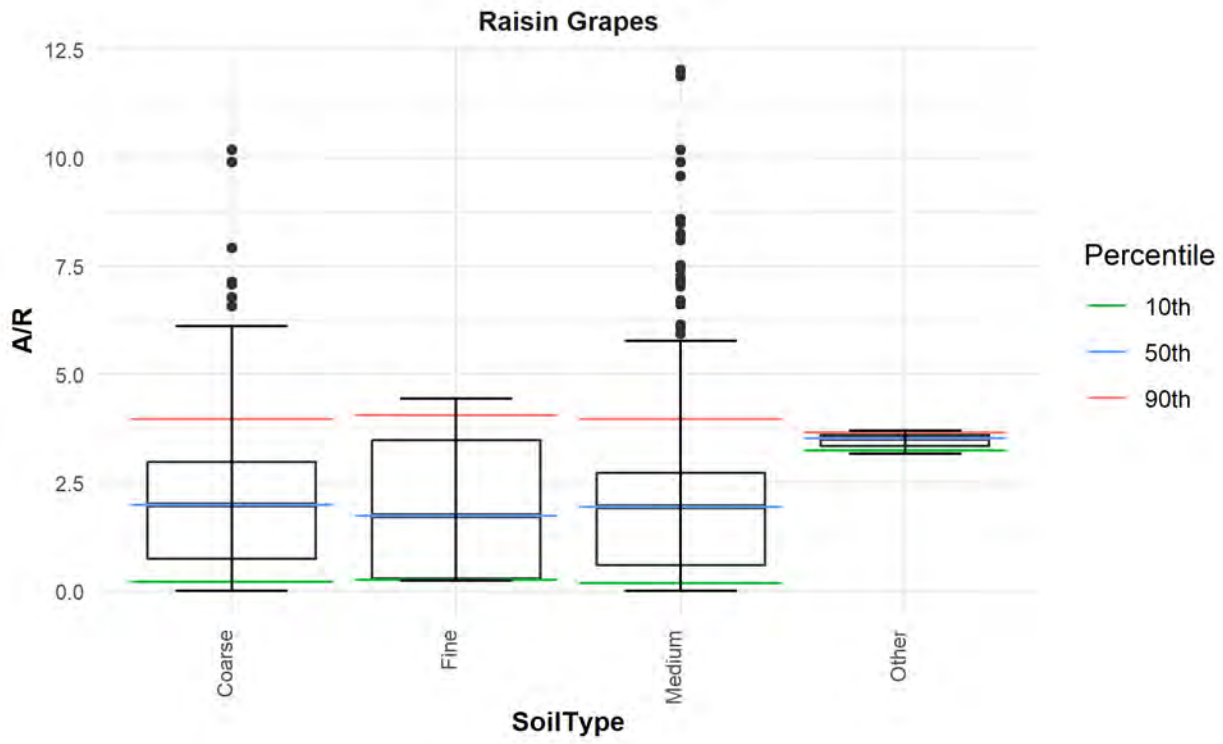

Figure 4-7. Box and Whisker Plots of A/Y by Soil Type for Raisin Grapes

Table 4-6. A/R by Soil Types for Raisin Grapes

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.2327	4.4356	0.2544	0.2870	1.7298	3.4748	4.0513	39	4	0	0%
Medium	A/R	0.0001	39408.8670	0.1782	0.6270	1.9802	2.7723	4.4554	36,223	1238	60	5%
Coarse	A/R	0.0001	5663.6654	0.2130	0.7921	1.9802	2.9970	4.0891	20,321	633	18	3%
Other	A/R	3.1683	3.6970	3.2396	3.3465	3.5248	3.6109	3.6626	275	3	0	0%

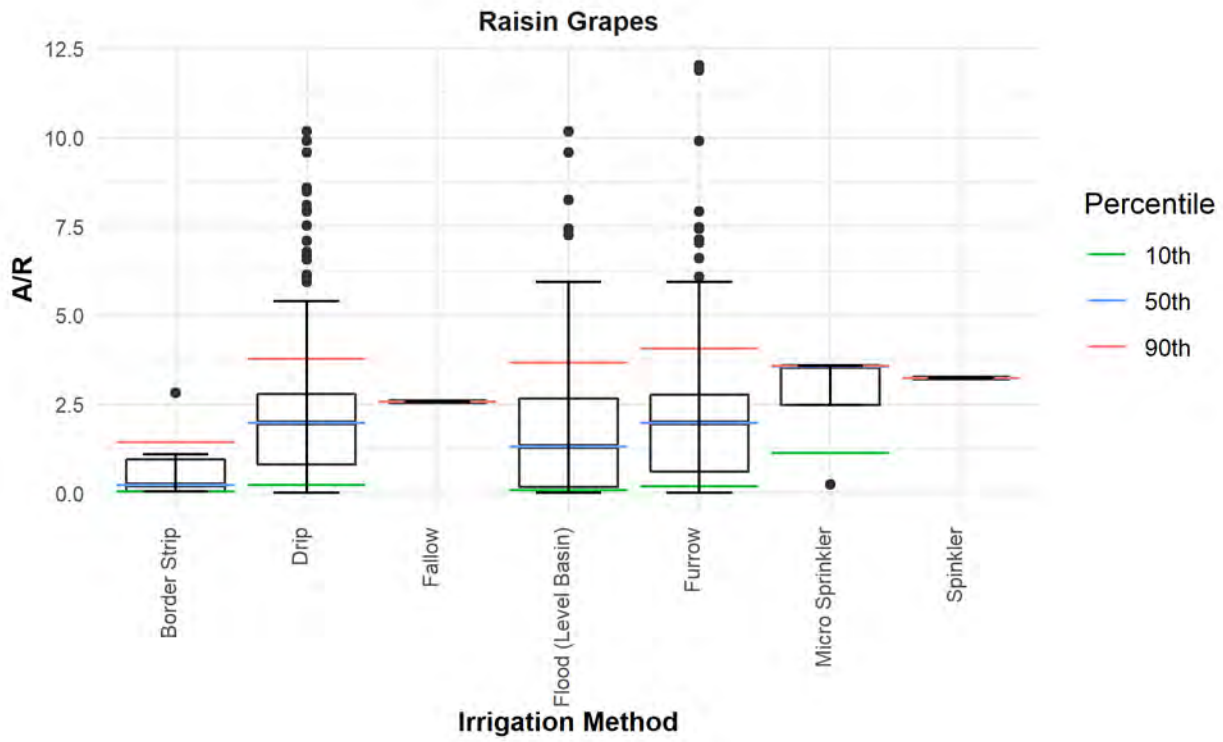

Figure 4-8. Box and Whisker Plots of A/R by Irrigation Practice for Raisin Grapes

Table 4-7. A/R by Irrigation Practices for Raisin Grapes

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	-	-	-	-	-	-	-	-	-	-	-
Drip	A/R	0.0012	9307.1956	0.2328	0.8467	2.0891	2.8782	4.1966	33,871	952	50	5%
Dry Farming	A/R	2.5594	2.5594	2.5594	2.5594	2.5594	2.5594	2.5594	3	1	1	100%
Flood (Level Basin)	A/R	0.0002	8033.4917	0.0806	0.1807	1.9802	2.9703	5.7426	4,244	163	15	9%
Furrow	A/R	0.0001	39408.8670	0.1946	0.5941	1.9802	2.7723	4.3782	18,130	746	23	3%
Micro Sprinkler	A/R	0.2366	5940.5941	1.3559	2.7458	3.5688	3.5802	#####	94	6	1	17%
Spinkler	A/R	3.2337	3.2337	3.2337	3.2337	3.2337	3.2337	3.2337	30	1	1	100%

4.3.4 Oranges

Oranges represent the third largest commodity reported in KRWQC, with 1,547 fields making up 62,391 acres (9.7%) of the coalitions total reported acreage. Of the total 1,547 fields, 1,360 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-9. Box and Whisker Plots of A/R **by** Township and Range for Oranges compares the calculated A/R values from the reported A/Y values for oranges corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0001 to a maximum of 2,702 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-8.** 12% of the filtered oranges A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-10** and **Table 4-9** as well as irrigation practices in **Figure 4-11** and **Table 4-10.** Medium soil type was most commonly reported texture while Micro Sprinkler irrigation was the primary reported irrigation practice for oranges.

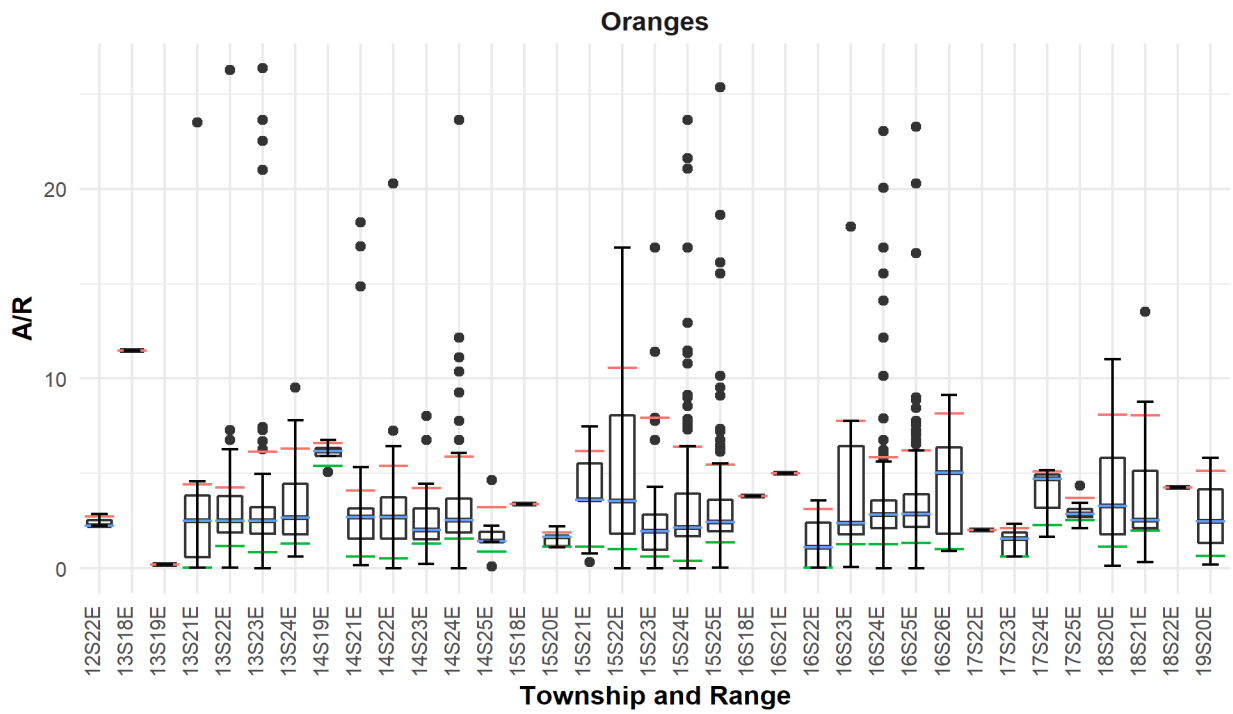

Figure 4-9. Box and Whisker Plots of A/R by Township and Range for Oranges

Table 4-8. A/R by Township and Range for Oranges

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S22E	A/R	2.2523	2.8568	2.2523	2.2523	2.2523	2.5545	2.7359	33	3	0	0%
13S18E	A/R	11.4865	11.4865	11.4865	11.4865	11.4865	11.4865	11.4865	19	1	1	100%
13S19E	A/R	0.1930	0.1930	0.1930	0.1930	0.1930	0.1930	0.1930	38	1	1	100%
13S21E	A/R	0.0432	23.5018	0.0486	0.6014	2.5097	3.8480	4.4372	189	13	1	8%
13S22E	A/R	0.0304	357.2268	1.1873	1.8839	2.5150	3.8243	6.3707	1,992	89	9	10%
13S23E	A/R	0.0008	2,702.7027	0.9689	1.8968	2.8378	4.5380	941.0829	3,199	118	23	19%
13S24E	A/R	0.6284	9.5133	1.3069	1.8090	2.6840	4.4733	6.3011	978	46	1	2%
14S17E	A/R	60.0000	60.0000	60.0000	60.0000	60.0000	60.0000	60.0000	4	1	1	100%
14S19E	A/R	5.0676	6.7568	5.4054	5.9122	6.1937	6.3345	6.5878	60	4	0	0%
14S21E	A/R	0.1596	202.7030	0.6453	1.6106	2.7027	3.2497	4.7104	1,297	48	4	8%
14S22E	A/R	0.0012	1,621.6216	1.2196	1.6892	3.1182	4.4402	45.0450	1,701	101	14	14%
14S23E	A/R	0.2230	1,756.7488	1.3287	1.6117	2.3649	3.7584	26.6743	1,330	45	6	13%
14S24E	A/R	0.0030	27.0270	1.5759	1.8994	2.5526	3.6854	6.4865	3,862	95	10	11%
14S25E	A/R	0.1067	4.6586	0.8748	1.3869	1.4403	1.9381	3.2183	449	7	1	14%
15S18E	A/R	3.3784	3.3784	3.3784	3.3784	3.3784	3.3784	3.3784	19	1	1	100%
15S20E	A/R	1.1011	2.2022	1.1377	1.1723	1.6516	1.6542	1.8749	119	7	0	0%
15S21E	A/R	0.3294	7.4966	1.1583	3.6036	3.6036	5.5341	6.1879	211	13	0	0%
15S22E	A/R	0.0115	1,013.5135	1.1730	2.1811	5.7271	9.6005	106.0811	625	23	3	13%
15S23E	A/R	0.0169	385.1338	0.6081	0.9865	1.9745	3.0245	10.7243	759	33	7	21%
15S24E	A/R	0.0030	2,432.4444	0.6417	1.7656	2.2280	4.0315	8.0856	5,940	208	24	12%
15S25E	A/R	0.0405	450.4505	1.4484	1.9635	2.5357	3.6855	6.2649	5,330	198	20	10%
16S18E	A/R	3.8243	3.8243	3.8243	3.8243	3.8243	3.8243	3.8243	18	1	1	100%
16S21E	A/R	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	5.0000	36	1	1	100%
16S22E	A/R	0.0338	2,576.0135	0.0338	0.0338	2.0045	3.5811	2,576.0135	123	9	2	22%
16S23E	A/R	0.0751	270.2703	1.3690	1.8549	2.7943	7.7863	22.5220	419	36	5	14%
16S24E	A/R	0.0001	676.2240	1.3068	2.2297	2.9338	4.3369	17.5270	3,712	139	21	15%
16S25E	A/R	0.0068	405.4049	1.4132	2.1959	2.9516	4.1742	7.2233	5,848	245	25	10%
16S26E	A/R	0.9246	9.1248	1.0100	1.8301	5.0541	6.3739	8.1557	288	7	0	0%
17S22E	A/R	2.0270	2.0270	2.0270	2.0270	2.0270	2.0270	2.0270	13	1	1	100%
17S23E	A/R	0.6081	2.3447	0.6081	0.6081	1.5652	1.8760	2.1239	656	7	0	0%
17S24E	A/R	1.6731	5.1872	2.2844	3.2014	4.7297	4.9584	5.0957	144	3	0	0%
17S25E	A/R	2.1047	4.3758	2.5328	2.7162	2.8784	3.1419	3.7249	250	8	1	13%
18S20E	A/R	0.1351	11.0242	1.1514	1.7781	3.2819	5.8243	8.1080	307	17	0	0%
18S21E	A/R	0.3378	13.5135	1.9784	2.1021	2.5375	5.1329	8.0536	238	13	1	8%
18S22E	A/R	4.2736	4.2736	4.2736	4.2736	4.2736	4.2736	4.2736	38	1	1	100%
19S20E	A/R	0.2145	5.8108	0.6695	1.3519	2.4893	4.1501	5.1465	110	3	0	0%
19S21E	A/R	50.6757	50.6757	50.6757	50.6757	50.6757	50.6757	50.6757	8	1	1	100%
Oranges Coalition-Wide:	**A/R**	**0.0001**	**2,702.7027**	**4.8161**	**5.2699**	**6.0262**	**7.0911**	**108.0384**	**40,362**	**1,547**	**187**	**12%**

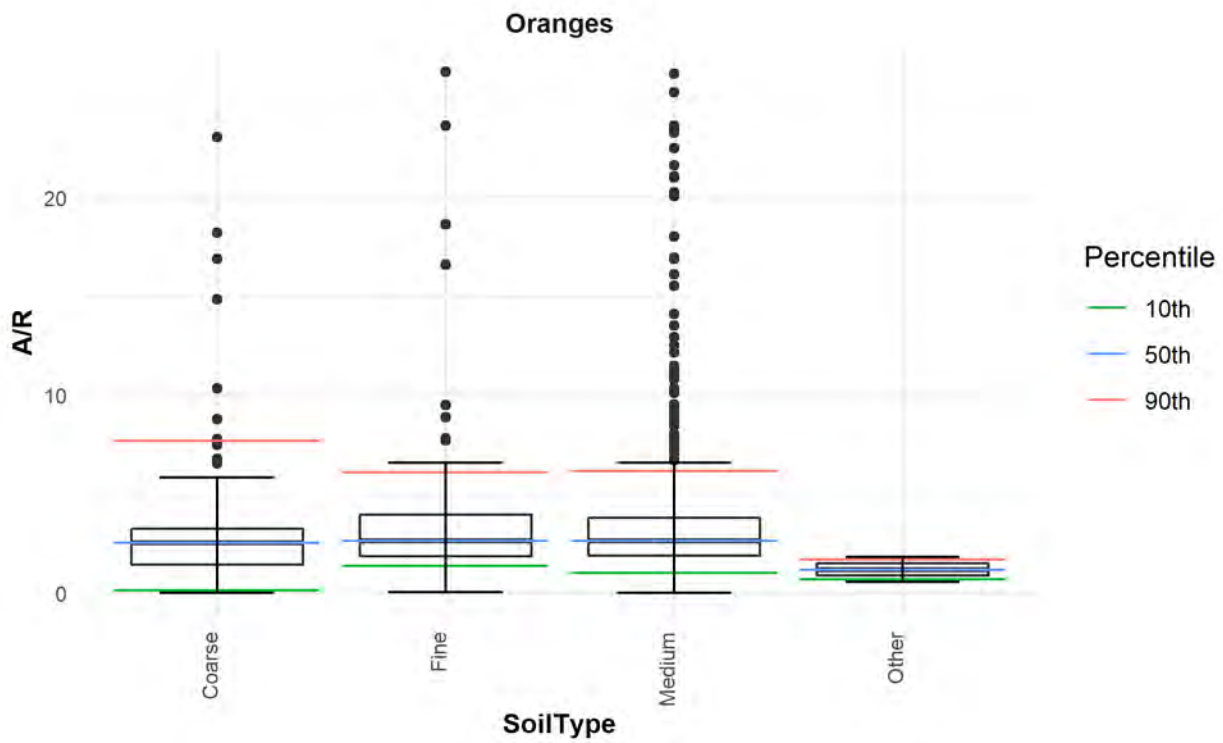

Figure 4-10. Box and Whisker Plots of A/R by Soil Type for Oranges

Table 4-9. A/R by Soil Types for Oranges

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.0225	2702.7027	1.4270	1.8994	2.9250	4.7149	20.1381	4,558	168	20	12%
Medium	A/R	0.0001	2576.0135	1.0615	1.9534	2.7932	4.0628	8.1644	32,803	1268	154	12%
Coarse	A/R	0.0008	676.3499	0.1619	1.4742	2.6351	3.5628	11.2508	2,973	109	19	17%
Other	A/R	0.5473	1.8200	0.6746	0.8655	1.1836	1.5018	1.6927	27	2	0	0%

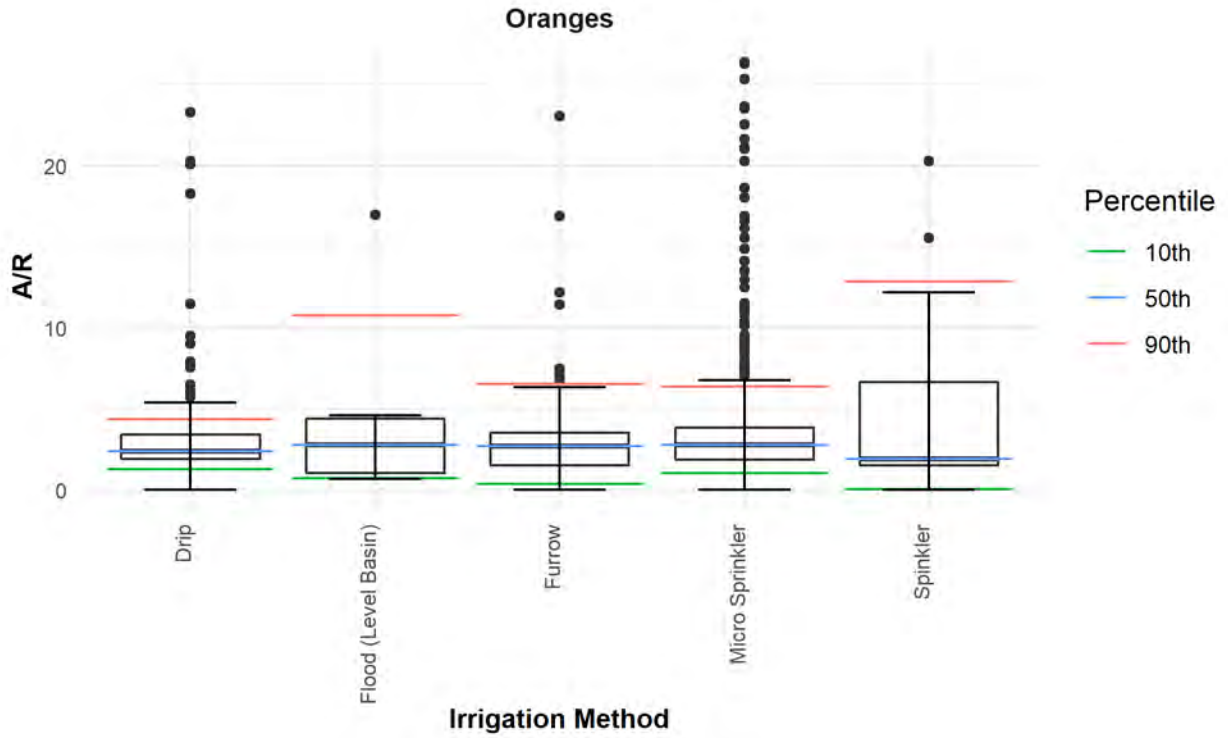

Figure 4-11. Box and Whisker Plots of A/R by Irrigation Practice for Oranges

Table 4-10. A/R by Irrigation Practices for Oranges

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	50.6757	50.6757	50.6757	50.6757	50.6757	50.6757	50.6757	8	1	1	100%
Drip	A/R	0.0001	2576.0135	1.3385	1.8994	2.4169	3.5796	7.6070	6,503	259	30	12%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.6757	270.2703	0.7703	1.4747	4.2044	27.7196	123.0811	61	8	1	13%
Furrow	A/R	0.0012	385.1338	0.3820	1.5228	2.7095	4.0137	7.1124	1,940	110	9	8%
Micro Sprinkler	A/R	0.0008	2702.7027	1.0615	1.9512	2.8664	4.2916	8.8047	31,336	1,148	124	11%
Spinkler	A/R	0.0068	676.2240	0.0826	1.7365	2.7027	9.0090	20.2703	513	21	3	14%

4.3.5 Cotton

Cotton represents the fourth largest commodity reported in KRWQC, with 365 fields making up 26,711 acres (7%) of the coalitions total reported acreage. Of the total 365 fields, 297 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-12Error! Reference source not found. compares the calculated A/R values from the reported A/Y values for cotton corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0023 to a maximum of 75,528 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-11** 19% of the filtered cotton A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-13** and **Table 4-12** as well as irrigation practices in **Figure 4-14** and **Table 4-13**. Medium soil type was most commonly reported texture while flood irrigation was the primary reported irrigation practice for cotton.

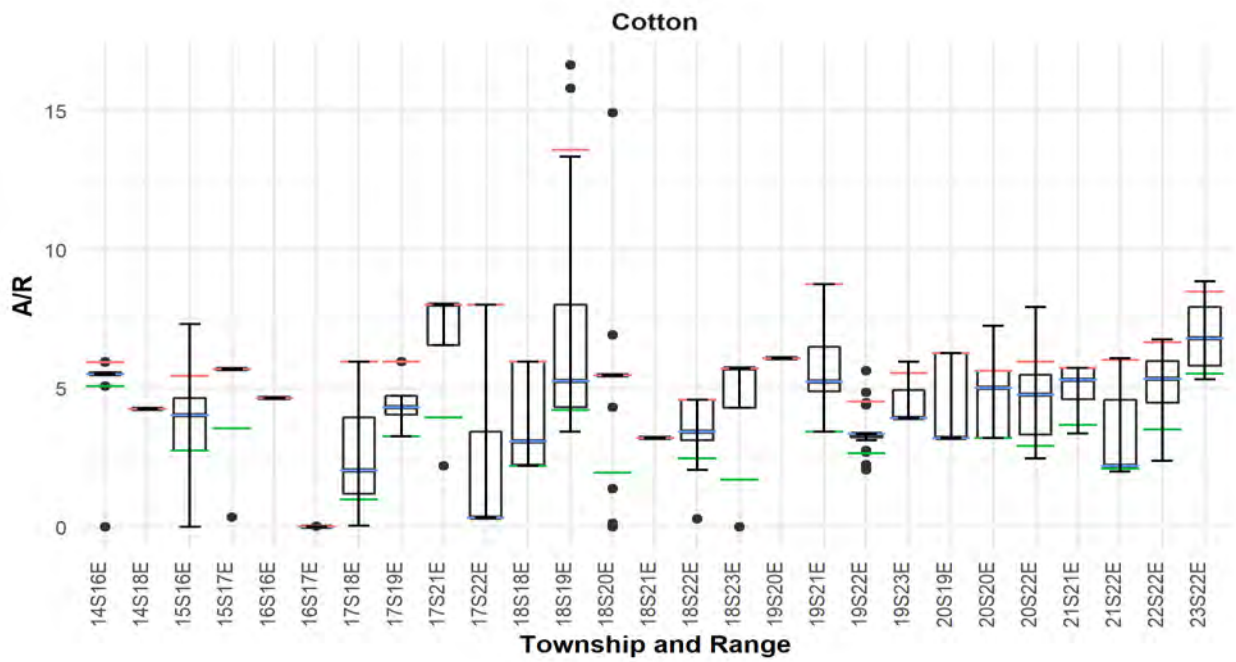

Figure 4-12. Box and Whisker Plots of A/R by Township and Range for Cotton

Table 4-11. A/R by Township and Range for Cotton

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
14S16E	A/R	0.0124	11,441.6476	5.0737	5.5103	5.5103	5.5661	5.9497	946	21	5	24%
14S18E	A/R	4.2563	4.2563	4.2563	4.2563	4.2563	4.2563	4.2563	60	3	3	100%
15S16E	A/R	0.0084	75,528.7009	2.7460	2.7460	4.3135	6.1785	74,373.1407	1,980	30	6	20%
15S17E	A/R	0.3558	5.6888	3.5474	5.6751	5.6888	5.6888	5.6888	178	7	0	0%
16S16E	A/R	4.6453	4.6490	4.6457	4.6462	4.6471	4.6481	4.6486	162	2	0	0%
16S17E	A/R	0.0110	0.0275	0.0110	0.0110	0.0110	0.0151	0.0225	267	4	1	25%
17S18E	A/R	0.0522	5.9497	1.0007	1.1873	2.0302	3.9474	5.9497	894	10	0	0%
17S19E	A/R	3.2677	5.9497	3.2677	4.0533	4.3151	4.7238	5.9497	350	12	3	25%
17S21E	A/R	2.2023	8.0092	3.9443	6.5574	8.0092	8.0092	8.0092	258	4	0	0%
17S22E	A/R	0.3432	8.0092	0.3432	0.3432	0.3432	3.4325	8.0092	502	9	0	0%
18S18E	A/R	2.2023	5.9497	2.2023	2.2394	3.0920	5.9497	5.9497	1,075	8	0	0%
18S19E	A/R	3.4325	16.6430	4.2151	4.3119	5.2632	8.0092	13.5941	1,289	20	2	10%
18S20E	A/R	0.0092	14.9268	1.9614	5.4728	5.4728	5.4728	5.4728	1,608	43	35	81%
18S21E	A/R	3.2037	3.2037	3.2037	3.2037	3.2037	3.2037	3.2037	84	2	2	100%
18S22E	A/R	0.3021	4.5767	2.4721	3.1275	3.4325	4.5767	4.5767	1,466	27	0	0%
18S23E	A/R	0.0023	5.7208	1.7178	4.2912	5.7208	5.7208	5.7208	145	4	0	0%
19S20E	A/R	6.0809	6.0809	6.0809	6.0809	6.0809	6.0809	6.0809	185	6	6	100%
19S21E	A/R	3.4325	8.7553	3.4325	4.8817	5.2302	6.5014	8.7553	363	11	0	0%
19S22E	A/R	2.0668	5.6328	2.6538	3.2188	3.3562	3.3562	4.5217	852	20	4	20%
19S23E	A/R	3.9176	1,803.6650	3.9176	3.9176	4.9406	455.3889	1,264.3546	366	4	1	25%
20S19E	A/R	3.2037	6.2558	3.2037	3.2037	3.2037	6.2558	6.2558	1,002	12	0	0%
20S20E	A/R	3.2037	7.2464	3.2037	3.2037	5.0050	5.6330	5.6330	1,193	21	0	0%
20S22E	A/R	2.4771	7.9359	2.9106	3.3303	4.7597	5.4920	5.9497	2,517	34	0	0%
21S21E	A/R	3.3772	5.7379	3.6810	4.6096	5.3099	5.7379	5.7379	2,815	13	0	0%
21S22E	A/R	1.9911	6.0740	2.0984	2.1790	2.2037	4.5767	6.0118	2,152	16	0	0%
22S22E	A/R	2.3936	6.7683	3.5168	4.4838	5.3494	5.9755	6.6581	3,083	18	0	0%
23S22E	A/R	5.3247	8.8580	5.5181	5.8083	6.7986	7.9353	8.4889	918	4	0	0%
Cotton Coalition-Wide:	**A/R**	**0.0023**	**75,528.7009**	**3.1417**	**3.7981**	**4.3536**	**21.9382**	**2,806.9848**	**26,711**	**365**	**68**	**19%**

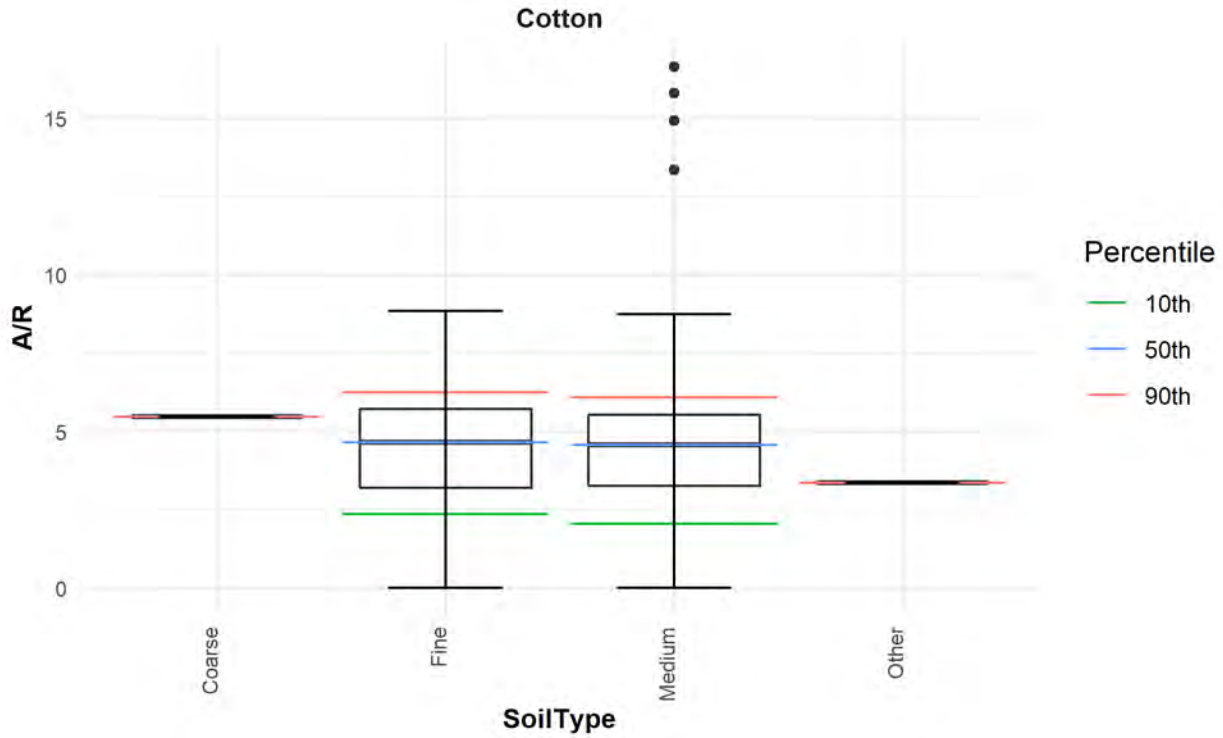

Figure 4-13. Box and Whisker Plots of A/R by Soil Type for Cotton

Table 4-12. A/R by Soil Types for Cotton

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.8241	1.5076	0.8241	0.8942	0.8942	0.8942	1.5076	520	9	7	78%
Medium	A/R	0.0185	2603.1746	0.5741	0.7554	0.9815	1.3188	1.5542	9,131	244	10	4%
Coarse	A/R	0.0156	1.7464	0.3305	0.8029	0.8373	1.3095	1.5717	171	5	0	0%
Other	A/R	0.5741	0.5741	0.5741	0.5741	0.5741	0.5741	0.5741	47	1	1	100%

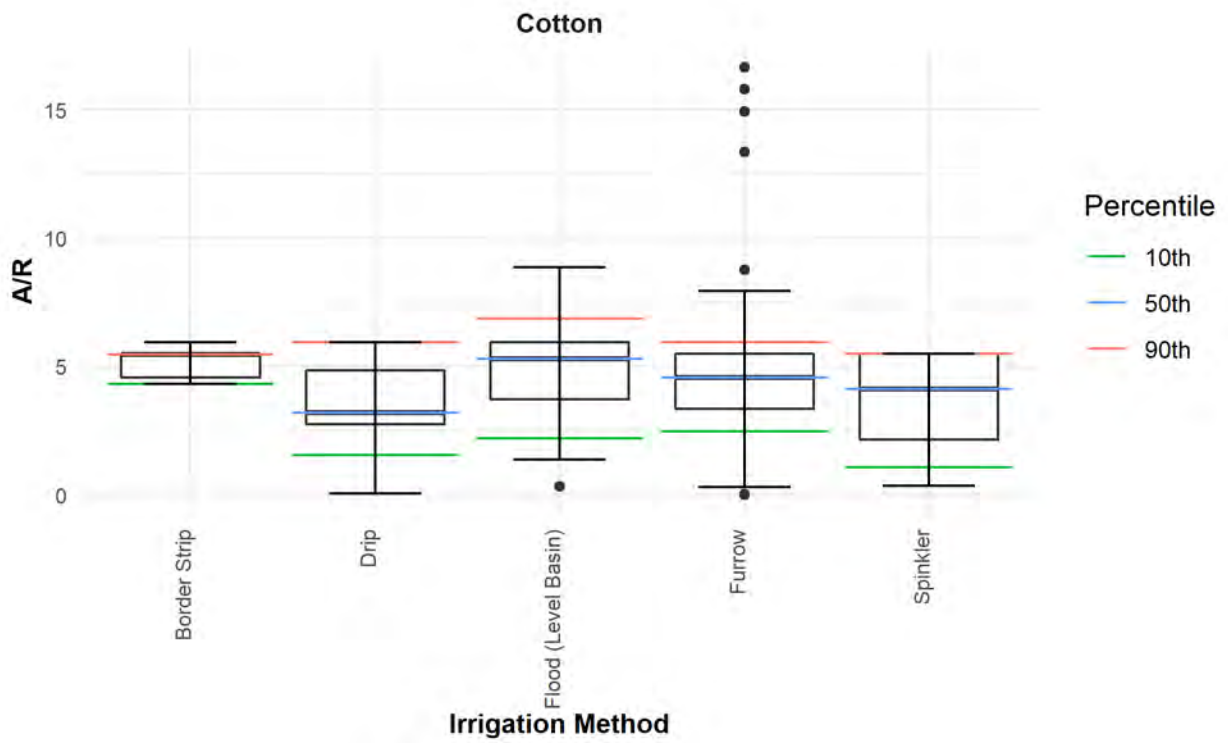

Figure 4-14. Box and Whisker Plots of A/R by Irrigation Practice for Cotton

Table 4-13. A/R by Irrigation Practices for Cotton

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	4.3151	5.9497	4.3151	4.5767	5.4728	5.4728	5.4728	663	19	0	0%
Drip	A/R	0.0522	11441.6476	1.6705	2.7460	3.2037	5.0737	5.9497	4,798	65	2	3%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.3432	8.8580	2.2037	3.7161	5.3099	5.9497	6.8639	13,610	129	0	0%
Furrow	A/R	0.0023	75528.7009	2.4771	3.3562	4.5767	5.6330	6.9840	7,492	148	10	7%
Micro Sprinkler	A/R	-	-	-	-	-	-	-	-	-	-	-
Spinkler	A/R	0.3558	5.5103	1.0729	2.1485	4.1281	5.5103	5.5103	149	4	0	0%

4.3.6 Peaches

Peaches represent the fifth largest commodity reported in KRWQC, with 1,200 fields making up 26,362 acres (6%) of the coalitions total reported acreage. Of the total 1,200 fields, 1,077 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-15. Box and Whisker Plots of A/R **by** Township and Range for Peaches compares the calculated A/R values from the reported A/Y values for peaches corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0010 to a maximum of 651 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-14** 10% of the filtered peaches A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-16** and **Table 4-15** as well as irrigation practices in **Figure 4-17** and **Table 4-16** Medium soil type was most commonly reported while furrow irrigation was the primary reported irrigation practice for peaches.

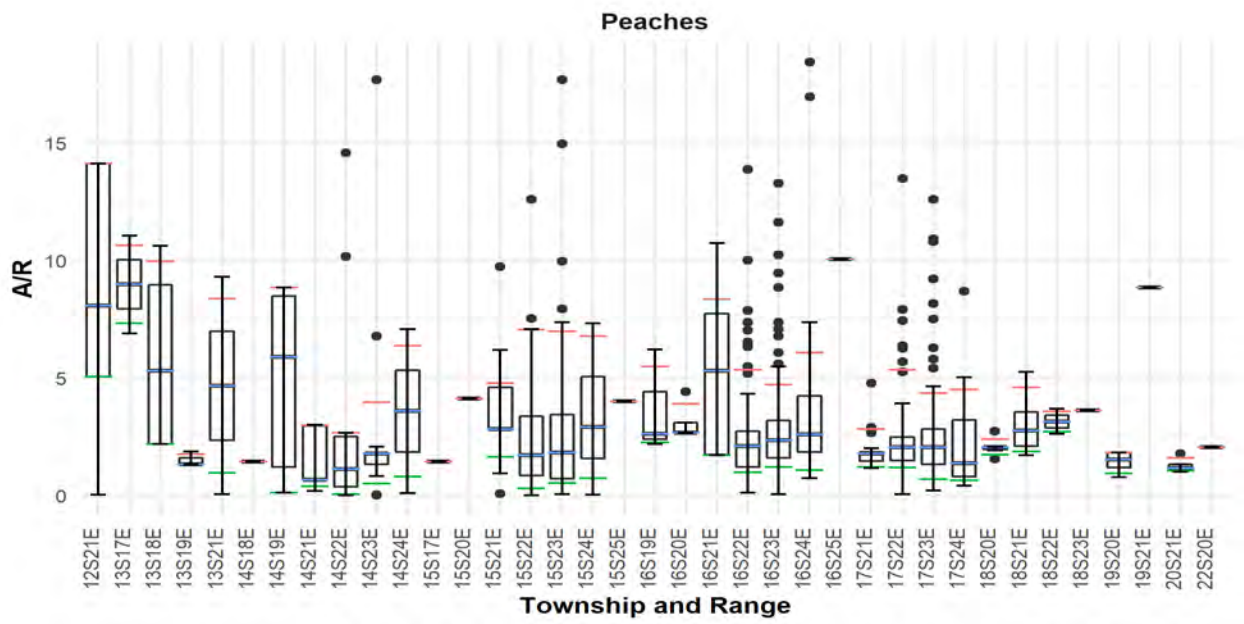

Figure 4-15. Box and Whisker Plots of A/R by Township and Range for Peaches

Table 4-14. A/R by Township and Range for Peaches

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S21E	A/R	0.0310	55.4380	5.0575	5.7257	8.8296	14.1150	21.1119	266	14	1	7%
13S17E	A/R	6.9027	11.0619	7.3186	7.9425	8.9823	10.0221	10.6460	20	2	0	0%
13S18E	A/R	2.1858	10.6195	2.1858	2.1858	5.2965	8.9602	9.9558	47	4	0	0%
13S19E	A/R	1.3230	1.8673	1.3230	1.3230	1.3230	1.5951	1.7584	37	3	0	0%
13S21E	A/R	0.0402	176.9912	1.8924	4.6706	9.3009	93.1460	143.4531	15	3	0	0%
14S18E	A/R	1.4469	1.4469	1.4469	1.4469	1.4469	1.4469	1.4469	74	2	2	100%
14S19E	A/R	0.1278	8.8496	0.1278	1.2021	5.8997	8.4808	8.8496	23	6	0	0%
14S21E	A/R	0.1770	3.0044	0.3974	0.6637	0.6637	2.9513	2.9938	89	9	0	0%
14S22E	A/R	0.0089	651.7912	0.0814	0.4425	1.4027	2.6361	14.1394	712	42	7	17%
14S23E	A/R	0.0010	17.6991	0.5027	1.3274	1.7699	1.7699	3.9558	570	17	2	12%
14S24E	A/R	0.0951	7.0796	0.7936	1.8413	3.5874	5.3335	6.3812	36	2	0	0%
15S17E	A/R	1.4469	1.4469	1.4469	1.4469	1.4469	1.4469	1.4469	80	1	1	100%
15S20E	A/R	4.1150	4.1150	4.1150	4.1150	4.1150	4.1150	4.1150	51	1	1	100%
15S21E	A/R	0.0632	42.4779	1.7522	2.8319	2.8319	4.6018	6.9049	340	29	3	10%
15S22E	A/R	0.0083	119.4691	0.2947	0.9112	1.8496	4.1560	7.0619	713	52	3	6%
15S23E	A/R	0.0531	126.5486	0.5310	0.7261	2.0000	3.5398	7.1239	2,418	141	13	9%
15S24E	A/R	0.0354	7.3212	0.7257	1.5697	2.9061	5.0622	6.7699	481	26	0	0%
15S25E	A/R	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	9	1	1	100%
16S19E	A/R	2.1770	6.2159	2.2641	2.3947	2.6124	4.4142	5.4952	322	3	0	0%
16S20E	A/R	2.6549	4.4248	2.6549	2.6549	2.6549	3.0973	3.8938	106	4	1	25%
16S21E	A/R	1.7067	21.8584	1.7130	2.2124	7.7434	21.8584	21.8584	382	13	0	0%
16S22E	A/R	0.1150	159.2920	0.9996	1.2168	2.1372	2.8009	5.8258	1,269	77	10	13%
16S23E	A/R	0.0442	194.6905	1.2168	1.5929	2.3894	3.4336	6.8319	5,293	319	33	10%
16S24E	A/R	0.7434	70.5168	1.0926	1.9381	2.6301	5.0221	7.1793	1,261	82	7	9%
16S25E	A/R	10.0496	22.3575	11.2804	13.1265	16.2035	19.2805	21.1267	30	2	0	0%
17S21E	A/R	1.1726	101.7699	1.2080	1.4723	1.7699	1.8540	2.8876	2,820	32	6	19%
17S22E	A/R	0.0606	13.4956	1.1814	1.4735	2.0531	2.4823	5.3388	2,524	79	9	11%
17S23E	A/R	0.2205	83.0514	0.6923	1.3670	2.0747	2.8451	4.6442	5,447	185	16	9%
17S24E	A/R	0.4182	8.6929	0.6352	0.8005	1.3735	3.2035	4.4991	460	21	1	5%
18S20E	A/R	1.5487	2.7301	1.7301	1.9491	2.0619	2.0639	2.3973	51	6	1	17%
18S21E	A/R	1.7080	35.3982	1.8938	2.1460	2.8549	4.4325	14.3053	93	8	1	13%
18S22E	A/R	2.6106	3.6850	2.7181	2.8792	3.1478	3.4164	3.5775	265	2	0	0%
18S23E	A/R	3.6283	3.6283	3.6283	3.6283	3.6283	3.6283	3.6283	75	1	1	100%
19S20E	A/R	0.7752	1.8301	0.9409	1.1894	1.5363	1.8301	1.8301	47	5	0	0%
19S21E	A/R	8.8496	8.8496	8.8496	8.8496	8.8496	8.8496	8.8496	20	1	1	100%
20S21E	A/R	1.0044	1.7876	1.0514	1.1219	1.1611	1.3177	1.5996	82	4	1	25%
22S20E	A/R	2.0544	2.0544	2.0544	2.0544	2.0544	2.0544	2.0544	160	1	1	100%
Peaches Coalition-Wide:	**A/R**	**0.0010**	**651.7912**	**2.2107**	**2.6605**	**3.6916**	**7.4396**	**10.5388**	**26,686**	**1,200**	**123**	**10%**

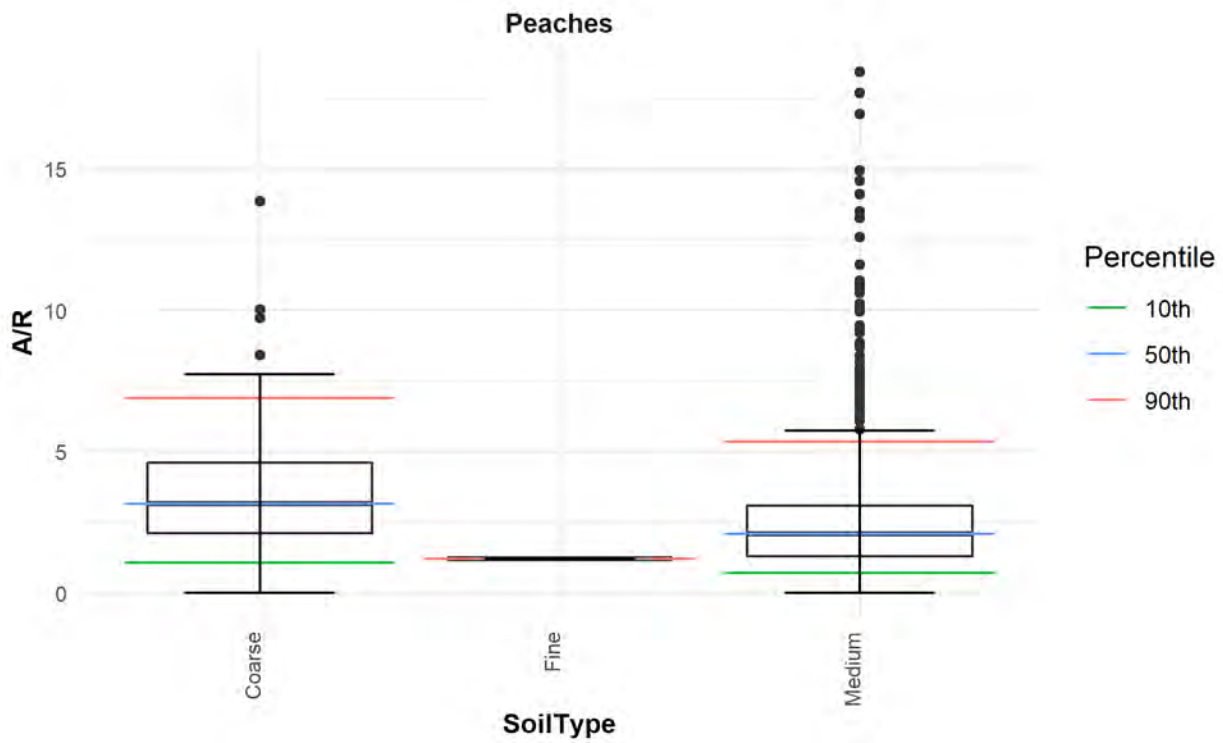

Figure 4-16. Box and Whisker Plots of A/R by Soil Type for Peaches

Table 4-15. A/R by Soil Types for Peaches

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	1.1947	1.1947	1.1947	1.1947	1.1947	1.1947	1.1947	39	1	1	100%
Medium	A/R	0.0010	651.7912	0.7080	1.3251	2.1549	3.2928	7.1504	23,894	1105	140	13%
Coarse	A/R	0.0083	26.5487	1.1228	2.1239	3.1606	4.6018	7.0637	2,754	94	6	6%

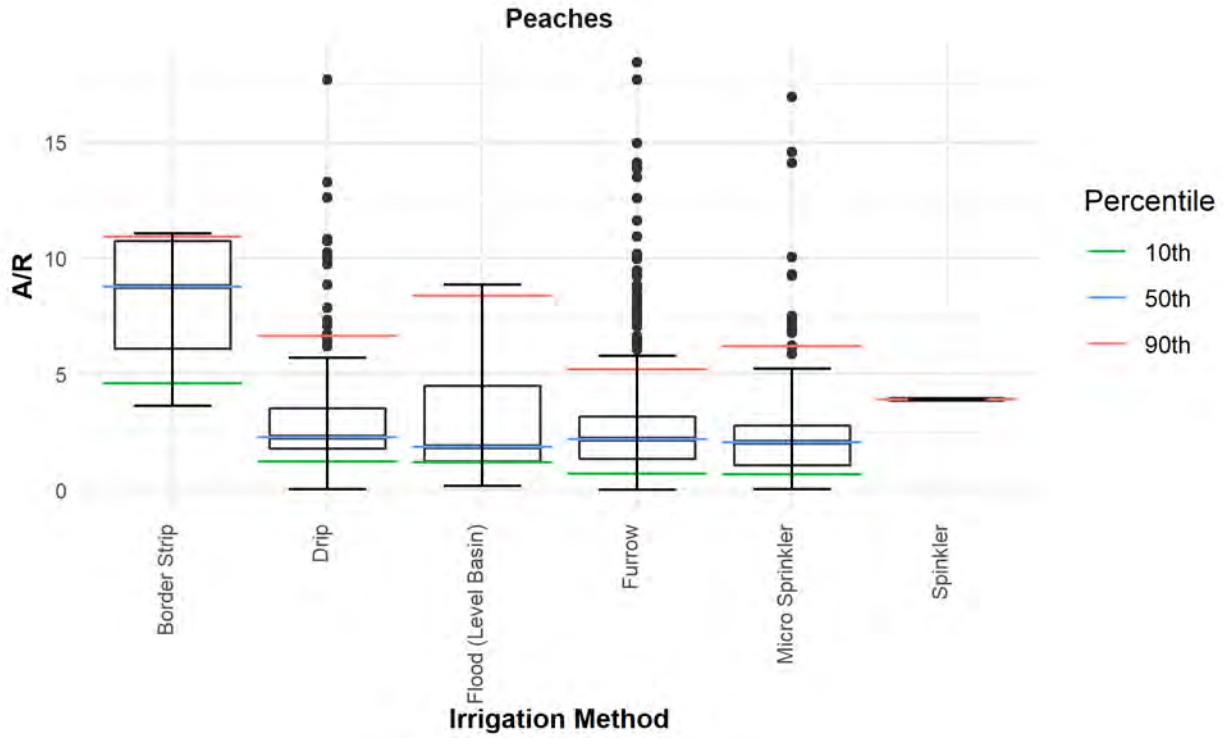

Figure 4-17. Box and Whisker Plots of A/R by Irrigation Practice for Peaches

Table 4-16. A/R by Irrigation Practices for Peaches

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	3.6283	11.0619	4.6106	6.0841	8.7611	10.7301	10.9292	107	4	0	0%
Drip	A/R	0.0402	651.7912	1.2168	1.7699	2.3761	4.4248	8.8496	6,702	193	21	11%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.1770	39.1151	1.2080	1.2168	2.1549	7.5885	8.8496	863	39	3	8%
Furrow	A/R	0.0010	176.9912	0.7080	1.3717	2.2566	3.2850	6.3844	15,133	739	79	11%
Micro Sprinkler	A/R	0.0310	56.6264	0.6687	1.0977	2.0544	3.5937	7.0111	3,854	224	20	9%
Spinkler	A/R	3.9084	3.9084	3.9084	3.9084	3.9084	3.9084	3.9084	27	1	1	100%

4.3.7 Pistachios

Pistachios represent the sixth largest commodity reported in KRWQC, with 344 fields making up 26,362 acres (6%) of the coalitions total reported acreage. Of the total 344 fields, 275 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-18 compares the calculated A/R values from the reported A/Y values for pistachios corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0010 to a maximum of 3,208 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-17** 20% of the filtered pistachios A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-19** and **Table 4-18** as well as irrigation practices in **Figure 4-20** and **Table 4-19** Medium soil type was most commonly reported texture while drip irrigation was the primary reported irrigation practice for pistachios.

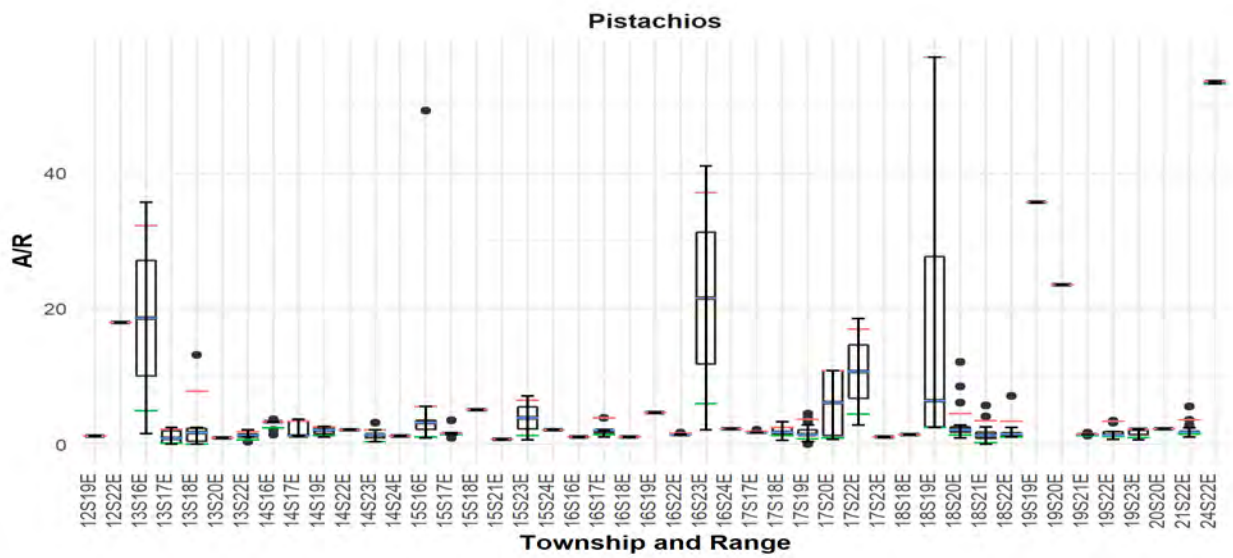

Figure 4-18. Box and Whisker Plots of A/R by Township and Range for Pistachios

Table 4-17. A/R by Township and Range for Pistachios

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S19E	A/R	1.1883	1.1883	1.1883	1.1883	1.1883	1.1883	1.1883	58	2	2	100%
12S22E	A/R	17.9287	17.9287	17.9287	17.9287	17.9287	17.9287	17.9287	18	1	1	100%
13S16E	A/R	1.5330	35.6506	4.9447	10.0624	18.5918	27.1212	32.2389	150	2	0	0%
13S17E	A/R	0.0011	2.4955	0.1251	0.1783	0.8699	1.9964	2.2210	212	8	0	0%
13S18E	A/R	0.0010	13.1907	0.0010	0.4019	1.7112	2.3262	7.8431	513	6	1	17%
13S20E	A/R	0.9394	0.9394	0.9394	0.9394	0.9394	0.9394	0.9394	25	1	1	100%
13S22E	A/R	0.3529	2.1390	0.6257	1.0348	1.2620	1.4813	1.8759	33	4	0	0%
14S16E	A/R	1.4260	3.6720	2.3815	3.3512	3.3512	3.3512	3.3512	4,052	13	11	85%
14S17E	A/R	1.2121	3.6778	1.2121	1.2121	1.2121	3.3850	3.4189	211	11	0	0%
14S19E	A/R	1.0481	2.6381	1.2663	1.5936	2.1390	2.3886	2.5383	23	3	0	0%
14S22E	A/R	2.1390	2.1390	2.1390	2.1390	2.1390	2.1390	2.1390	24	2	2	100%
14S23E	A/R	0.3565	3.2086	0.3565	0.9055	1.4260	1.5544	2.1390	462	11	1	9%
14S24E	A/R	1.1765	1.1765	1.1765	1.1765	1.1765	1.1765	1.1765	40	2	2	100%
15S16E	A/R	0.9127	49.1979	1.0339	2.2228	3.2086	3.5651	5.5615	698	11	1	9%
15S17E	A/R	0.9127	3.5651	1.4439	1.4617	1.5365	1.5740	1.6221	2,090	16	1	6%
15S18E	A/R	5.0980	5.0980	5.0980	5.0980	5.0980	5.0980	5.0980	76	1	1	100%
15S21E	A/R	0.7130	0.7130	0.7130	0.7130	0.7130	0.7130	0.7130	20	1	1	100%
15S23E	A/R	0.6661	7.1301	1.3125	2.2821	3.8981	5.5141	6.4837	14	2	0	0%
15S24E	A/R	2.0963	2.0963	2.0963	2.0963	2.0963	2.0963	2.0963	14	1	1	100%
16S16E	A/R	1.0410	1.0410	1.0410	1.0410	1.0410	1.0410	1.0410	526	4	4	100%
16S17E	A/R	1.0410	3.8859	1.4260	1.6043	2.0677	2.0677	3.8859	883	11	2	18%
16S18E	A/R	1.0695	1.0695	1.0695	1.0695	1.0695	1.0695	1.0695	105	1	1	100%
16S19E	A/R	4.6346	4.6346	4.6346	4.6346	4.6346	4.6346	4.6346	20	1	1	100%
16S22E	A/R	1.4216	1.6806	1.4216	1.4216	1.4216	1.4863	1.6029	239	4	1	25%
16S23E	A/R	2.1390	40.9982	6.0250	11.8538	21.5686	31.2834	37.1123	13	2	0	0%
16S24E	A/R	2.2318	2.2318	2.2318	2.2318	2.2318	2.2318	2.2318	65	1	1	100%
17S17E	A/R	1.7825	2.1390	1.7825	1.7825	1.7825	1.7825	1.9251	1,870	7	7	100%
17S18E	A/R	0.5704	3.3155	1.2563	1.4260	1.7825	2.4599	2.4599	4,116	29	0	0%
17S19E	A/R	0.0357	4.4920	0.7909	1.4260	1.4260	2.1332	3.6578	917	15	3	20%
17S20E	A/R	0.7109	10.8378	0.9254	1.2472	6.1319	10.8378	10.8378	169	4	0	0%
17S22E	A/R	2.8521	18.5383	4.4207	6.7736	10.6952	14.6168	16.9697	65	2	0	0%
17S23E	A/R	1.0695	1.0695	1.0695	1.0695	1.0695	1.0695	1.0695	80	1	1	100%
17S25E	A/R	3,208.5562	3,208.5562	3,208.5562	########	3,208.5562	3,208.5562	3,208.5562	51	1	1	100%
18S18E	A/R	1.4260	1.4260	1.4260	1.4260	1.4260	1.4260	1.4260	47	1	1	100%
18S19E	A/R	2.4955	57.0410	2.4955	2.5312	6.4171	27.6292	57.0410	1,076	19	0	0%
18S20E	A/R	0.9305	12.1212	1.3761	1.7825	2.1390	2.5241	4.4813	981	26	3	12%
18S21E	A/R	0.0053	5.7041	0.2363	0.8734	1.2478	1.7871	3.4744	425	15	2	13%
18S22E	A/R	1.0339	7.1301	1.0661	1.0742	1.4884	1.7005	3.4225	263	9	1	11%
19S19E	A/R	35.6506	35.6506	35.6506	35.6506	35.6506	35.6506	35.6506	130	1	1	100%
19S20E	A/R	23.5294	891.2656	23.5294	23.5294	88.5917	706.8627	891.2656	230	6	0	0%
19S21E	A/R	1.2977	1.6806	1.2977	1.3906	1.4216	1.4216	1.4993	378	8	1	13%
19S22E	A/R	0.7130	3.4688	1.1376	1.1646	1.2684	1.8717	3.4239	1,037	23	5	22%
19S23E	A/R	0.6774	2.1747	0.9768	1.4260	2.1747	2.1747	2.1747	188	3	0	0%
20S20E	A/R	2.2567	2.2567	2.2567	2.2567	2.2567	2.2567	2.2567	56	1	1	100%
21S22E	A/R	1.0695	5.5971	1.4973	1.4973	1.7825	1.9062	3.6007	1,588	31	6	19%
24S22E	A/R	53.1194	53.4759	53.1194	53.1194	53.4759	53.4759	53.4759	2,110	20	0	0%
Pistachios Coalition-Wide:	**A/R**	**0.0010**	**3,208.5562**	**74.1022**	**74.5619**	**76.8545**	**91.5542**	**96.9743**	**26,362**	**344**	**69**	**20%**

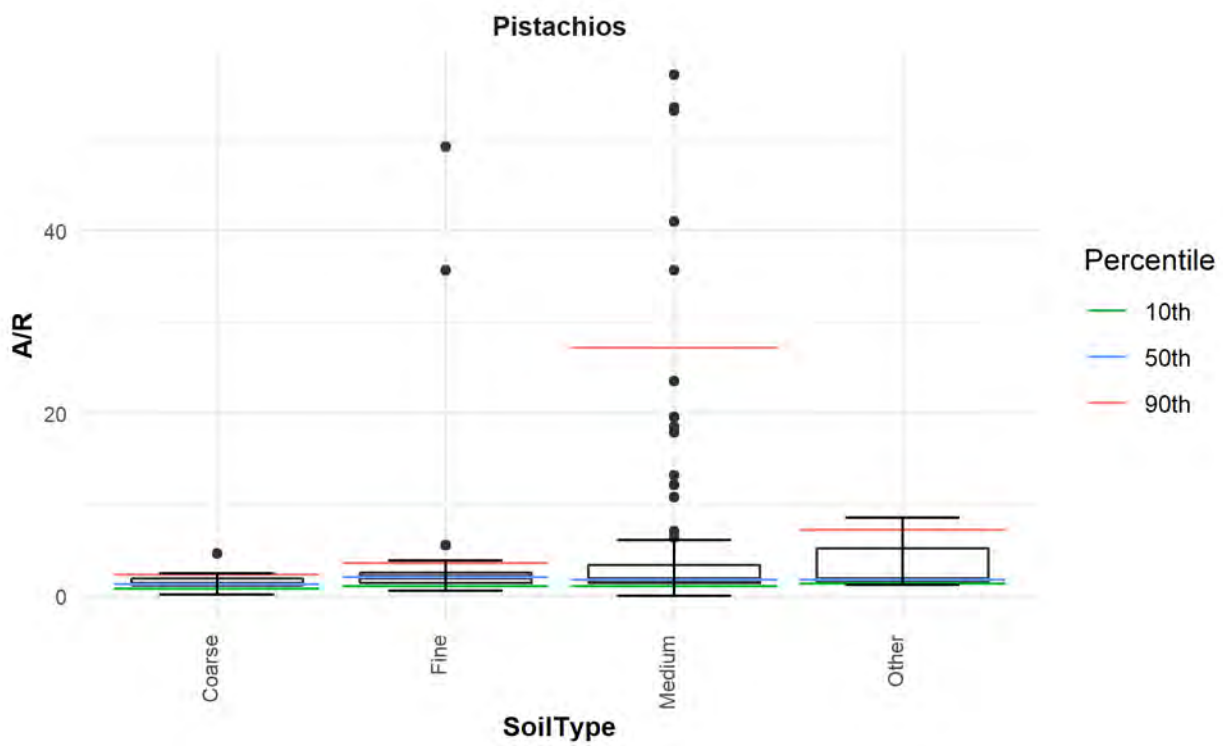

Figure 4-19. Box and Whisker Plots of A/R by Soil Type for Pistachios

Table 4-18. A/R by Soil Types for Pistachios

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.5704	3208.5562	1.0410	1.4260	2.0677	2.5668	3.8004	4,930	54	4	7%
Medium	A/R	0.0010	891.2656	1.0481	1.4260	1.7825	3.3512	40.9982	21,003	271	47	17%
Coarse	A/R	0.1783	4.6346	0.7867	1.2062	1.2620	1.8984	2.3173	328	16	1	6%
Other	A/R	1.2121	8.5562	1.3262	1.4973	1.7825	5.1693	7.2014	101	3	0	0%

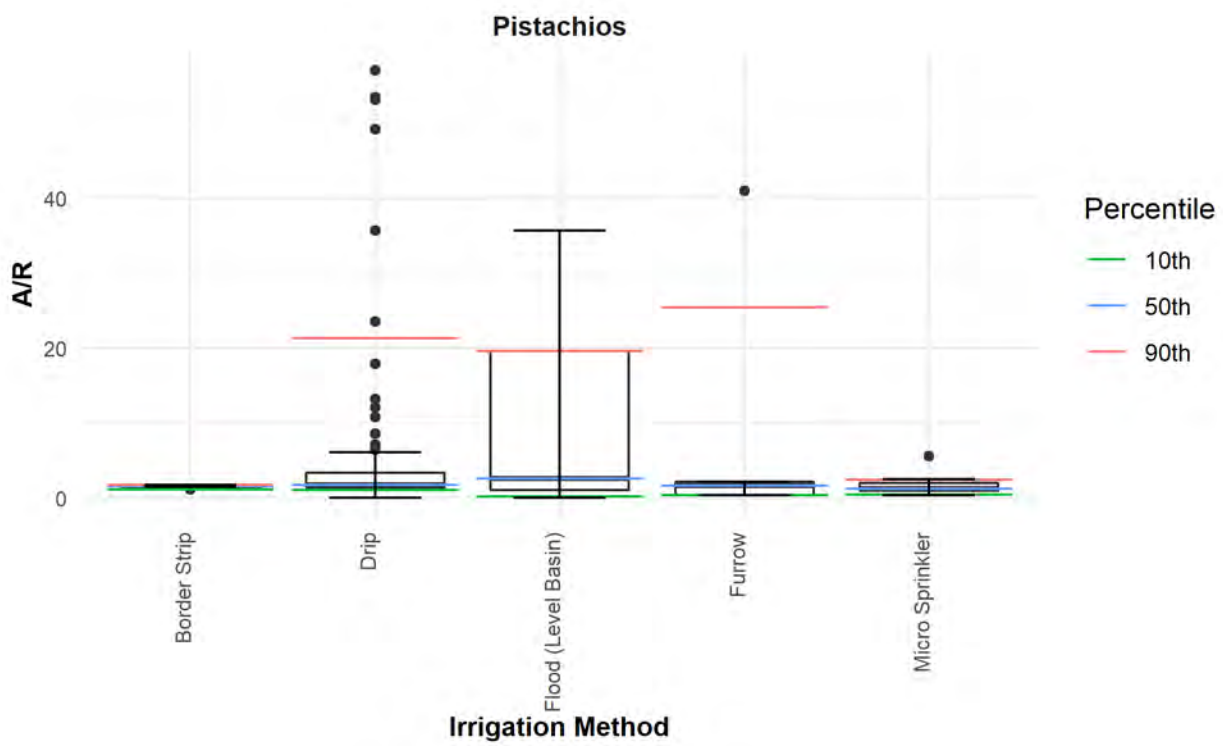

Figure 4-20. Box and Whisker Plots of A/R by Irrigation Practice for Pistachios

Table 4-19. A/R by Irrigation Practices for Pistachios

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	1.1376	1.7005	1.1376	1.4603	1.5679	1.6011	1.7005	250	8	0	0%
Drip	A/R	0.0010	3208.5562	1.0652	1.4260	1.8257	3.3512	35.6506	25,002	299	44	15%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.0357	35.6506	0.1783	1.0695	2.5668	19.6078	19.6078	530	17	0	0%
Furrow	A/R	0.3529	40.9982	0.3658	0.3850	1.6827	2.1390	25.4545	79	5	1	20%
Micro Sprinkler	A/R	0.3565	5.5971	0.4804	0.9447	1.1883	1.9786	2.3900	500	15	1	7%
Spinkler	A/R	-	-	-	-	-	-	-	-	-	-	-

4.3.8 Wine Grapes

Wine grapes represent the seventh largest commodity reported in KRWQC, with 378 fields making up 21,774 acres (5%) of the coalitions total reported acreage. Of the total 378 fields, 321were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-21 compares the calculated A/R values from the reported A/Y values for wine grapes corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0004 to a maximum of 31,998 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-20** 15% of the filtered wine grapes A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-23** and **Table 4-21** as well as irrigation practices in **Figure 4-24** and **Table 4-22**. Medium soil type was most commonly reported texture while drip irrigation was the primary reported irrigation practice for wine grapes.

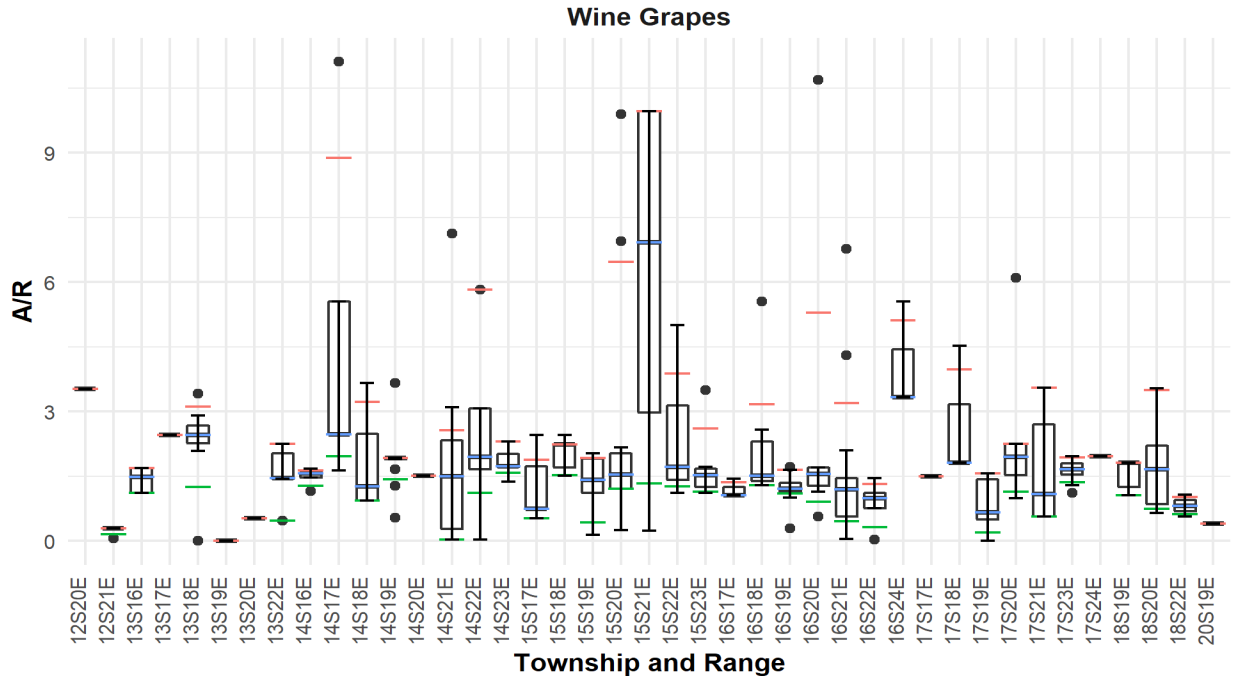

Figure 4-21. Box and Whisker Plots of A/R by Township and Range for Wine Grapes

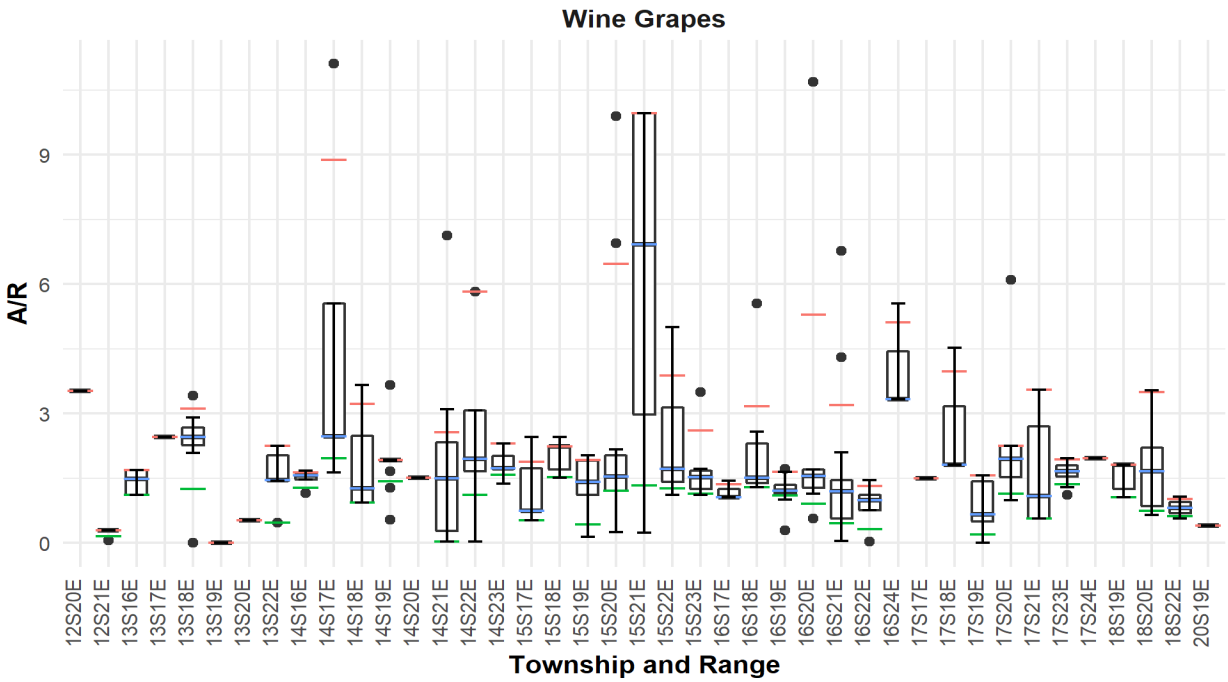

Figure 4-22. A/R by Irrigation Practices for Wine Grapes

Table 4-20. A/R by Township and Range for Wine Grapes

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S20E	A/R	3.5194	3.5194	3.5194	3.5194	3.5194	3.5194	3.5194	77	5	5	100%
12S21E	A/R	0.0556	0.2861	0.1478	0.2861	0.2861	0.2861	0.2861	101	5	4	80%
13S16E	A/R	1.1111	1.6861	1.1111	1.1111	1.4806	1.6861	1.6861	640	7	0	0%
13S17E	A/R	2.4500	2.4500	2.4500	2.4500	2.4500	2.4500	2.4500	175	17	17	100%
13S18E	A/R	0.0083	3.4136	1.2533	2.2667	2.4500	2.6778	3.1088	150	7	1	14%
13S19E	A/R	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	20	1	1	100%
13S20E	A/R	0.5222	0.5222	0.5222	0.5222	0.5222	0.5222	0.5222	64	2	2	100%
13S22E	A/R	0.4722	2.2472	0.4722	1.4444	1.4583	2.0278	2.2450	151	9	0	0%
14S16E	A/R	1.1572	1.6694	1.2801	1.4644	1.5668	1.5924	1.6386	432	4	0	0%
14S17E	A/R	1.6308	11.1111	1.9636	2.4627	2.4627	5.5556	8.8889	658	5	1	20%
14S18E	A/R	0.9306	3.6556	0.9306	0.9306	1.2653	2.4833	3.2167	298	6	0	0%
14S19E	A/R	0.5331	3.6556	1.4333	1.9000	1.9194	1.9194	1.9194	2,100	15	1	7%
14S20E	A/R	1.5056	1.5056	1.5056	1.5056	1.5056	1.5056	1.5056	48	2	2	100%
14S21E	A/R	0.0239	7.1222	0.0239	0.2778	1.5000	2.3333	2.5642	389	18	1	6%
14S22E	A/R	0.0332	3,888.8889	1.1317	1.7083	2.0635	5.8333	16.2028	543	20	3	15%
14S23E	A/R	1.3778	22.2222	1.6189	1.7222	1.7361	2.3006	8.2771	408	8	1	13%
15S17E	A/R	0.5278	2.4500	0.5278	0.7417	0.7417	1.7361	1.8789	534	9	0	0%
15S18E	A/R	1.5044	2.4500	1.5181	1.6999	2.2389	2.2389	2.2389	1,551	12	0	0%
15S19E	A/R	0.1435	31,998.0459	0.4569	1.1111	1.4198	1.9173	1.9194	1,916	30	1	3%
15S20E	A/R	0.2556	9.9000	1.2139	1.2139	1.5319	2.0347	6.4672	400	12	2	17%
15S21E	A/R	0.2306	9.9667	1.3281	2.9743	6.9278	9.9667	9.9667	89	4	0	0%
15S22E	A/R	1.1111	5.0000	1.2644	1.4194	1.7222	3.1389	3.8833	263	7	0	0%
15S23E	A/R	1.1139	3.4944	1.1347	1.2486	1.5278	1.6736	2.6083	210	6	1	17%
16S17E	A/R	1.0526	1.4417	1.0526	1.0526	1.0526	1.2471	1.3639	318	3	0	0%
16S18E	A/R	1.2894	22.2222	1.2894	1.3889	1.5044	4.0667	22.2222	1,226	11	2	18%
16S19E	A/R	0.2944	1.7194	1.1028	1.1285	1.2036	1.3392	1.6414	1,801	19	1	5%
16S20E	A/R	0.5667	36.6667	1.2750	1.6618	36.1111	36.6666	36.6666	783	16	0	0%
16S21E	A/R	0.0472	6.7750	0.4569	0.5667	1.1944	1.4583	3.2000	557	16	2	13%
16S22E	A/R	0.0256	1.4583	0.3154	0.7501	0.9917	1.1083	1.3183	53	4	0	0%
16S24E	A/R	3.3333	5.5556	3.3333	3.3333	3.3333	4.4444	5.1111	23	3	0	0%
17S17E	A/R	1.5000	1.5000	1.5000	1.5000	1.5000	1.5000	1.5000	508	2	2	100%
17S18E	A/R	1.8111	4.5250	1.8111	1.8111	1.8111	3.1681	3.9822	463	3	0	0%
17S19E	A/R	0.0004	1.5639	0.1918	0.4917	0.6639	1.4306	1.5639	675	7	0	0%
17S20E	A/R	0.9919	19.5333	1.1513	1.5260	2.0167	2.2500	4.1775	517	16	2	13%
17S21E	A/R	0.5667	1,133.3300	0.5667	0.6958	2.7042	117.5556	253.3331	657	10	1	10%
17S23E	A/R	1.1111	1.9639	1.3581	1.5319	1.6667	1.7986	1.9306	1,221	14	0	0%
17S24E	A/R	1.9639	1.9639	1.9639	1.9639	1.9639	1.9639	1.9639	76	2	2	100%
18S19E	A/R	1.0590	1.8056	1.0590	1.2457	1.8056	1.8056	1.8056	154	6	0	0%
18S20E	A/R	0.6441	3.5389	0.7368	0.8497	1.6667	2.2083	3.5000	1,294	31	0	0%
18S22E	A/R	0.5667	1.0684	0.6168	0.6921	0.8175	0.9430	1.0182	95	2	0	0%
20S19E	A/R	0.3972	0.3972	0.3972	0.3972	0.3972	0.3972	0.3972	137	2	2	100%
Wine Grapes Coalition-Wide:	**A/R**	**0.0004**	**31,998.0459**	**1.1462**	**1.3799**	**2.5539**	**5.9697**	**10.5780**	**21,774**	**378**	**57**	**15%**

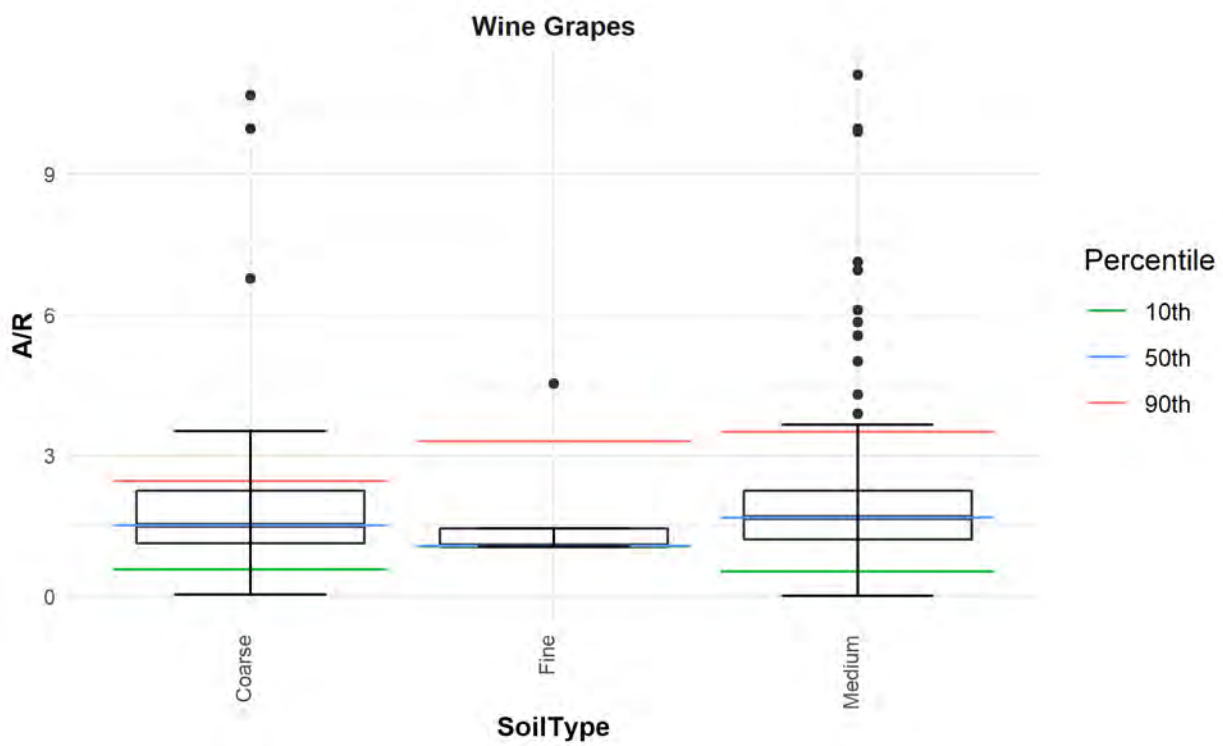

Figure 4-23. Box and Whisker Plots of A/R by Soil Type for Wine Grapes

Table 4-21. A/R by Soil Types for Wine Grapes

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	1.0526	4.5250	1.0526	1.0526	1.0667	1.4417	3.2917	457	5	1	20%
Medium	A/R	0.0004	31998.0459	0.5272	1.2113	1.6861	2.2500	3.5656	16,403	280	26	9%
Coarse	A/R	0.0239	36.6667	0.6007	1.1285	1.5694	2.4500	19.9150	4,914	93	13	14%

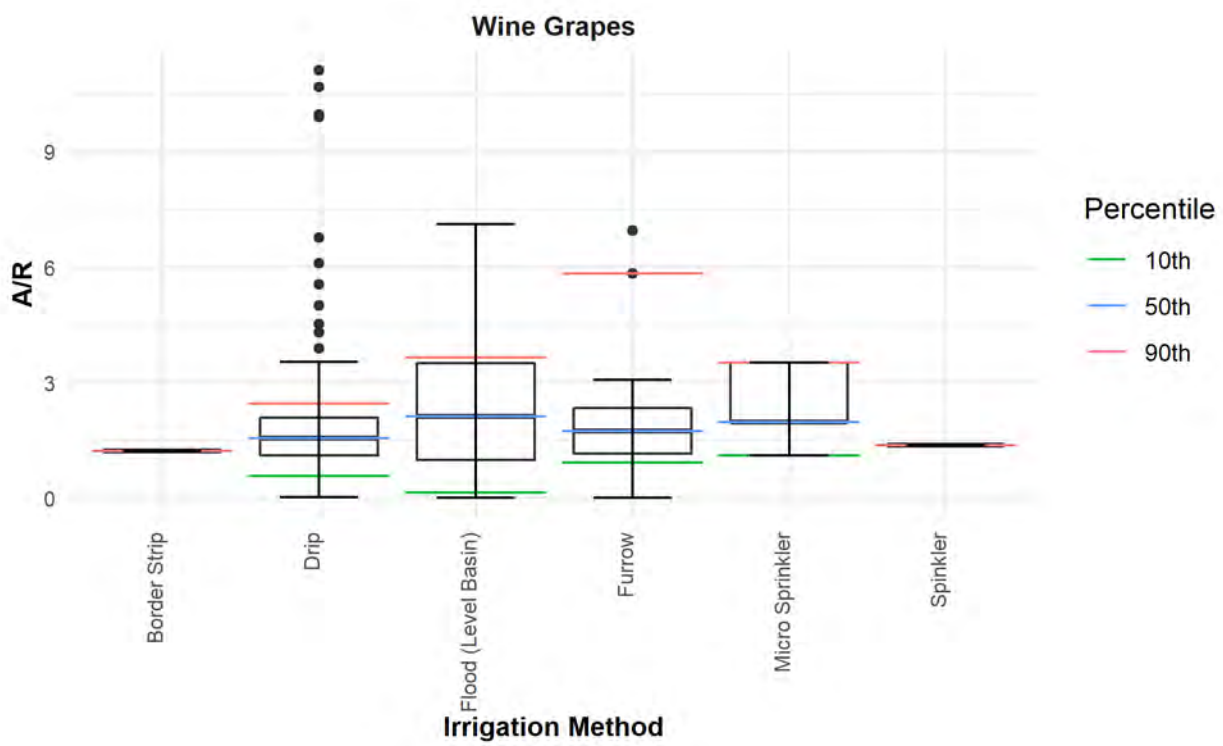

Figure 4-24. Box and Whisker Plots of A/R by Irrigation Practice for Wine Grapes

Table 4-22. A/R by Irrigation Practices for Wine Grapes

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	1.2139	1.2139	1.2139	1.2139	1.2139	1.2139	1.2139	120.5	4	4	100%
Drip	A/R	0.0239	31998.0459	0.5667	1.1285	1.6222	2.2472	4.0533	18,880	297	30	10%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.0004	7.1222	0.1435	0.9908	2.1278	3.5097	3.6556	645	24	0	0%
Furrow	A/R	0.0083	3888.8889	1.0667	1.2139	1.7361	2.3333	5.8333	1,658	41	7	17%
Micro Sprinkler	A/R	1.1111	3.5194	1.1111	1.9639	1.9639	3.5194	3.5194	435	11	0	0%
Spinkler	A/R	1.3778	1.3778	1.3778	1.3778	1.3778	1.3778	1.3778	36	1	1	100%

4.3.9 Table Grapes

Table Grapes represent the eighth largest commodity reported in KRWQC, with 687 fields making up 21,367 acres (5%) of the coalitions total reported acreage. Of the total 687 fields, 633 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-25 compares the calculated A/R values from the reported A/Y values for table grapes corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0004 to a maximum of 53,976 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-23** 8% of the filtered table grapes A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-26** and **Table 4-24** as well as irrigation practices in **Figure 4-27** and **Table 4-25** Medium soil type was most commonly reported texture while drip irrigation was the primary reported irrigation practice for table grapes.

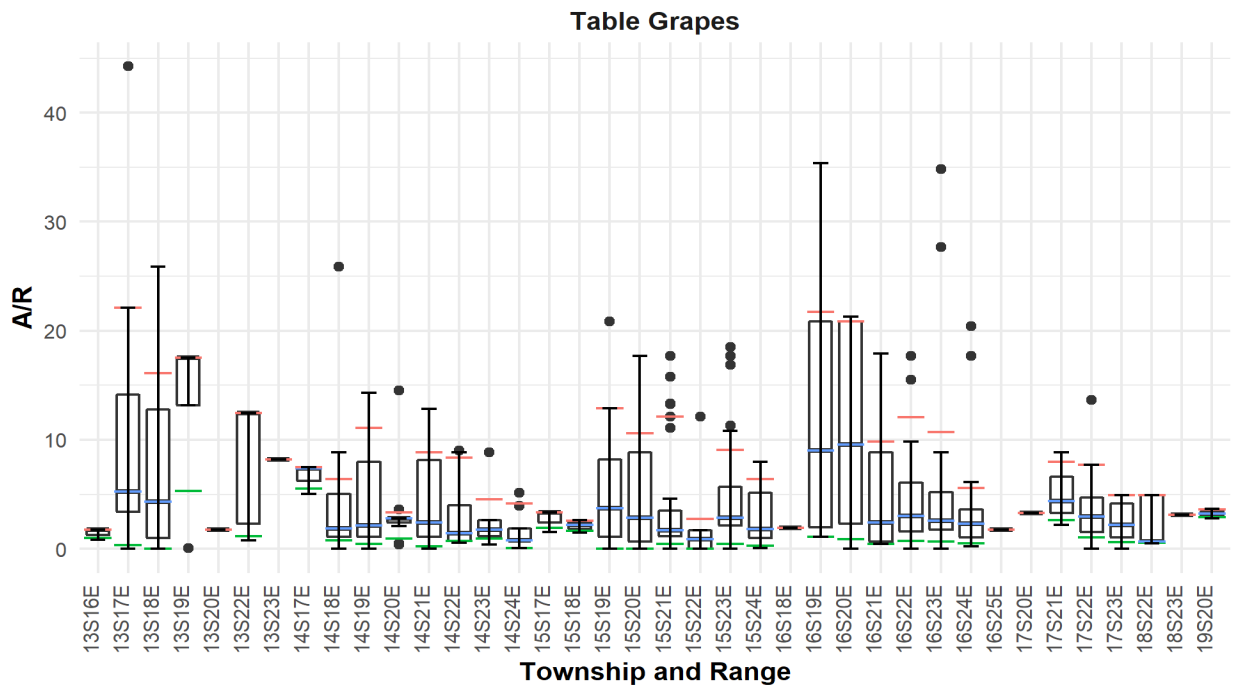

Figure 4-25. Box and Whisker Plots of A/R by Township and Range for Table Grapes

Table 4-23. A/R by Township and Range for Table Grapes

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
13S16E	A/R	0.8296	1.7699	0.9679	1.2721	1.7699	1.7699	1.7699	229	6	0	0%
13S17E	A/R	0.0053	44,247.7876	0.6890	3.4204	5.3097	22.1239	39.8230	324	13	1	8%
13S18E	A/R	0.0035	25.8850	0.0147	1.0177	4.3363	12.7533	16.1031	1,105	46	0	0%
13S19E	A/R	0.0628	17.5398	5.3059	13.1706	17.5398	17.5398	17.5398	226	4	0	0%
13S20E	A/R	1.7301	1.7301	1.7301	1.7301	1.7301	1.7301	1.7301	51	2	2	100%
13S21E	A/R	294.6906	294.6906	294.6906	294.6906	294.6906	294.6906	294.6906	1	1	1	100%
13S22E	A/R	0.8009	12.4526	1.1385	2.3119	12.4526	12.4526	12.4526	69	8	0	0%
13S23E	A/R	8.2174	8.2174	8.2174	8.2174	8.2174	8.2174	8.2174	19	1	1	100%
14S17E	A/R	5.0442	7.4898	5.5103	6.2094	7.3746	7.4322	7.4668	282	3	0	0%
14S18E	A/R	0.0133	25.8850	0.7743	1.1062	1.8584	5.0159	6.4159	1,230	41	1	2%
14S19E	A/R	0.0066	14.3230	0.4549	1.1062	2.1239	7.9646	11.0619	356	13	0	0%
14S20E	A/R	0.3717	14.5221	0.9549	2.3982	2.7946	2.7946	3.3534	240	14	2	14%
14S21E	A/R	0.0004	12.8319	0.2177	1.0867	2.4336	8.1637	8.8496	417	25	0	0%
14S22E	A/R	0.5752	1,769.9115	0.7319	0.7345	1.4712	6.1892	162.9593	318	20	2	10%
14S23E	A/R	0.3687	8.8496	0.9159	1.1504	1.7301	2.6549	4.5133	243	8	1	13%
14S24E	A/R	0.0411	5.1327	0.0411	0.7699	0.7699	1.8682	4.1731	282	9	2	22%
15S17E	A/R	1.5398	3.3186	1.8956	2.4292	3.3186	3.3186	3.3186	275	3	0	0%
15S18E	A/R	1.5089	2.6549	1.6403	1.8374	2.1814	2.4757	2.5832	568	4	0	0%
15S19E	A/R	0.0066	20.8319	0.0066	1.1062	3.7168	8.1903	12.8761	1,188	29	2	7%
15S20E	A/R	0.0013	17.6991	0.0153	0.6648	2.8363	8.8496	10.5973	1,535	46	0	0%
15S21E	A/R	0.0084	17.6991	0.4319	1.1504	1.6991	3.5288	12.1195	1,274	43	7	16%
15S22E	A/R	0.0102	12.1195	0.0148	0.0214	0.8721	1.6814	2.7252	329	10	1	10%
15S23E	A/R	0.0044	18.5018	0.4425	2.1361	2.8609	5.6748	9.0487	1,685	70	6	9%
15S24E	A/R	0.0411	98.3284	0.2655	0.9993	1.9690	5.3097	6.3913	731	31	1	3%
16S18E	A/R	1.9469	1.9469	1.9469	1.9469	1.9469	1.9469	1.9469	80	1	1	100%
16S19E	A/R	1.1062	35.3982	1.1062	1.9900	9.0044	20.8319	21.7389	842	26	0	0%
16S20E	A/R	0.0084	7,548.4765	0.9115	2.6106	9.5870	20.8319	20.8319	1,059	33	1	3%
16S21E	A/R	0.4425	53,976.2505	0.4425	0.7042	2.5221	8.8496	10.1628	1,598	40	1	3%
16S22E	A/R	0.0102	75.2212	0.7965	1.6239	3.5973	7.0796	17.6991	729	29	5	17%
16S23E	A/R	0.0075	5,539.8397	0.7375	1.7699	2.7788	5.5310	27.6549	471	31	4	13%
16S24E	A/R	0.2212	141.5927	0.5385	1.1303	2.8540	4.8456	79.6461	621	28	6	21%
16S25E	A/R	1.7699	1.7699	1.7699	1.7699	1.7699	1.7699	1.7699	91	3	3	100%
17S20E	A/R	3.2743	3.2743	3.2743	3.2743	3.2743	3.2743	3.2743	33	1	1	100%
17S21E	A/R	2.1681	8.8496	2.6115	3.2765	4.3850	6.6173	7.9566	512	3	0	0%
17S22E	A/R	0.0296	13.6283	1.0619	1.5295	2.9500	4.6829	7.6903	539	11	1	9%
17S23E	A/R	0.0296	4.9410	0.6261	1.0619	2.1681	4.1482	4.9410	1,171	23	0	0%
18S22E	A/R	0.5177	4.9410	0.5761	0.6637	0.6637	4.9410	4.9410	268	5	0	0%
18S23E	A/R	3.0973	3.0973	3.0973	3.0973	3.0973	3.0973	3.0973	287	1	1	100%
19S20E	A/R	2.7965	3.6858	2.8854	3.0188	3.2412	3.4635	3.5969	90	2	0	0%
Table Grapes Coalition-Wide:	**A/R**	**0.0004**	**53,976.2505**	**8.9602**	**9.7489**	**11.2794**	**14.2128**	**22.5058**	**21,367**	**687**	**54**	**8%**

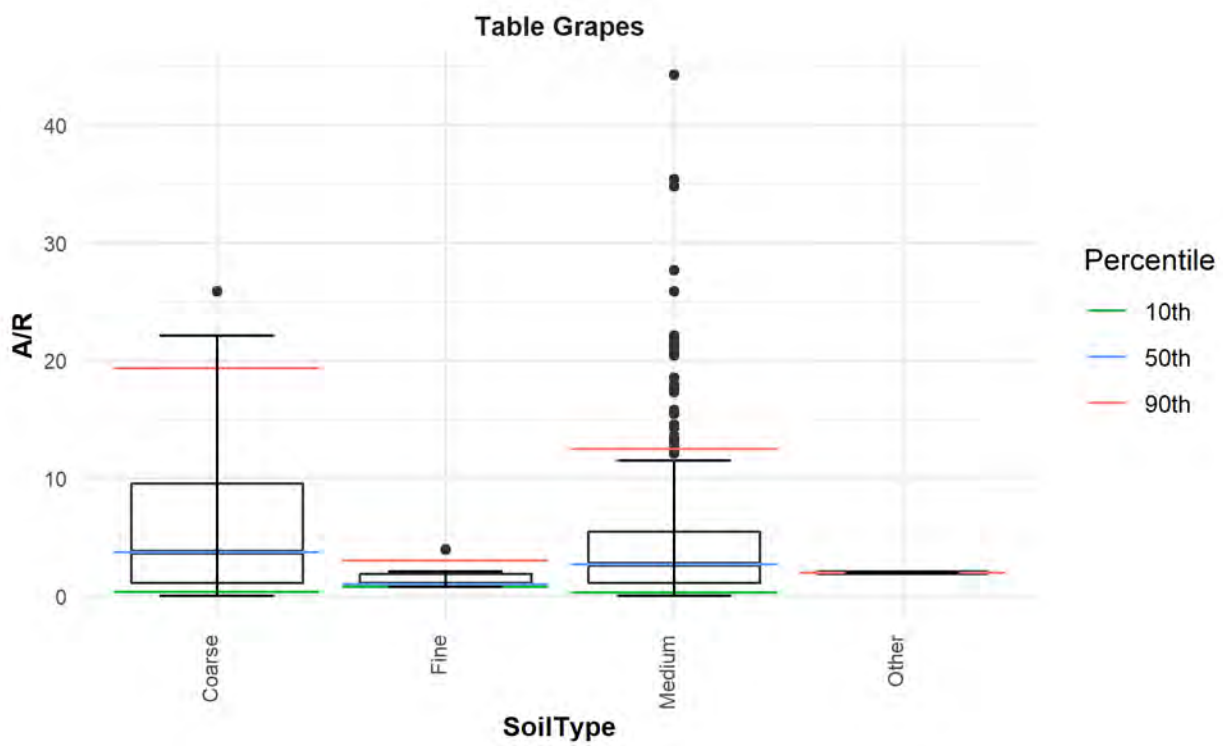

Figure 4-26. Box and Whisker Plots of A/R by Soil Type for Table Grapes

Table 4-24. A/R by Soil Types for Table Grapes

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.7699	3.9331	0.7699	0.7699	0.9602	1.8540	3.0108	161	6	1	17%
Medium	A/R	0.0004	53976.2505	0.3027	1.1416	2.7655	6.0960	13.7673	17,461	539	55	10%
Coarse	A/R	0.0027	1769.9115	0.3687	1.1062	3.8496	9.5870	20.8319	3,665	141	3	2%
Other	A/R	1.9469	1.9469	1.9469	1.9469	1.9469	1.9469	1.9469	80	1	1	100%

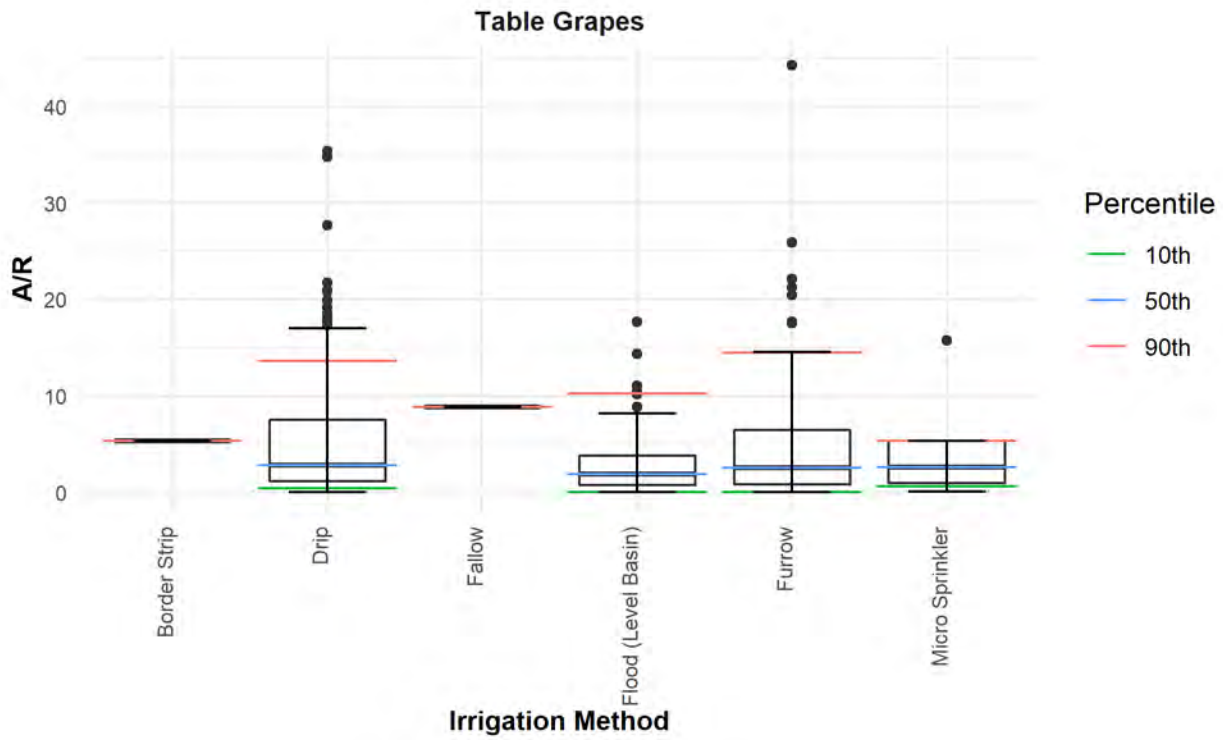

Figure 4-27. Box and Whisker Plots of A/R by Irrigation Practice for Table Grapes

Table 4-25. A/R by Irrigation Practices for Table Grapes

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	5.3097	5.3097	5.3097	5.3097	5.3097	5.3097	5.3097	8	1	1	100%
Drip	A/R	0.0027	53976.2505	0.4425	1.3274	2.8609	8.5841	17.6991	14,136	423	35	8%
Dry Farming	A/R	8.8496	8.8496	8.8496	8.8496	8.8496	8.8496	8.8496	68	1	1	100%
Flood (Level Basin)	A/R	0.0066	70.7965	0.0066	0.7345	1.8584	5.2434	10.5780	1,677	48	3	6%
Furrow	A/R	0.0004	44247.7876	0.0582	0.9420	2.6549	6.8451	14.5050	4,968	199	18	9%
Micro Sprinkler	A/R	0.0885	15.7743	0.6056	0.9775	2.6106	5.3097	5.3097	511	15	1	7%
Spinkler	A/R	-	-	-	-	-	-	-	-	-	-	-

4.3.10 Walnuts

Walnuts represent the ninth largest commodity reported in KRWQC, with 684 fields making up 19,594 acres (4%) of the coalitions total reported acreage. Of the total 684 fields, 613 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-28 compares the calculated A/R values from the reported A/Y values for walnuts corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0000 to a maximum of 191,044 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-26** 10% of the filtered walnuts A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-29** and **Table 4-27** as well as irrigation practices in **Figure 4-30** and **Table 4-28** Medium soil type was most commonly reported texture while flood irrigation was the primary reported irrigation practice for walnuts.

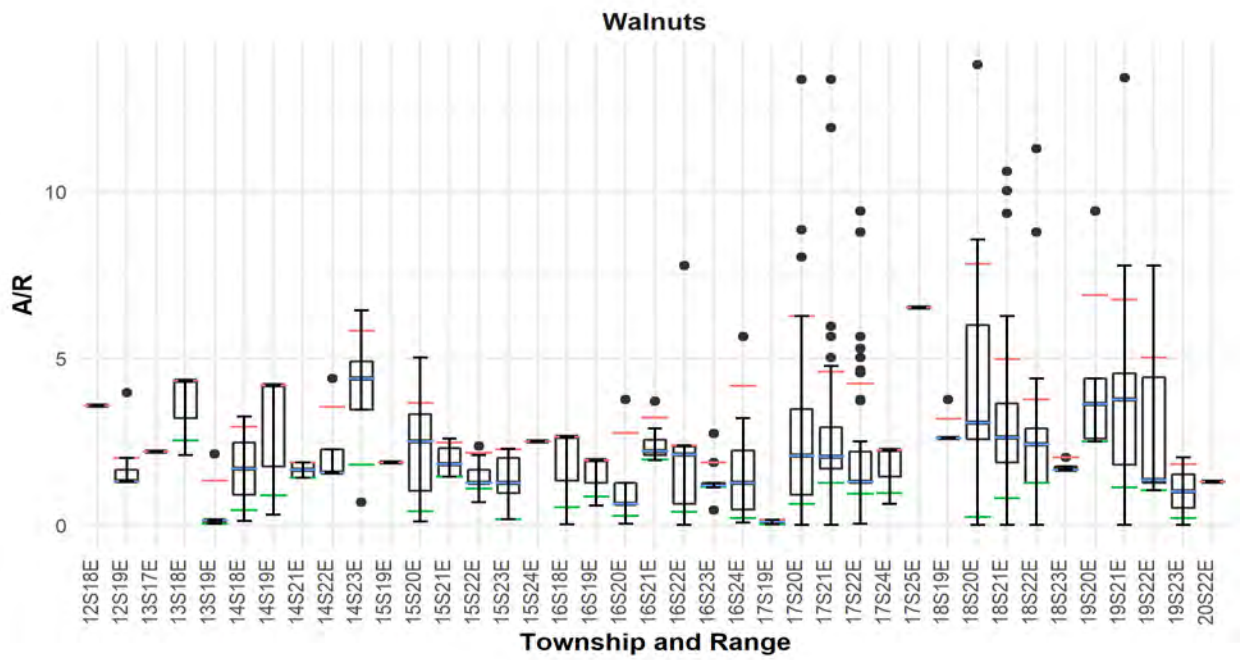

Figure 4-28. Box and Whisker Plots of A/R by Township and Range for Walnuts

Table 4-26. A/R by Township and Range for Walnuts

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S18E	A/R	3.5737	3.5737	3.5737	3.5737	3.5737	3.5737	3.5737	29	2	2	100%
12S19E	A/R	1.3166	3.9624	1.3166	1.3166	1.3166	1.6614	2.0063	55	11	1	9%
13S17E	A/R	2.2023	2.2023	2.2023	2.2023	2.2023	2.2023	2.2023	25	2	2	100%
13S18E	A/R	2.0878	4.3284	2.5359	3.2081	4.3284	4.3284	4.3284	114	3	0	0%
13S19E	A/R	0.0445	2.1317	0.0445	0.0445	0.1374	0.1374	1.3340	174	5	1	20%
14S18E	A/R	0.1254	3.2602	0.4389	0.9091	1.6928	2.4765	2.9467	177	2	0	0%
14S19E	A/R	0.3135	26.1191	1.0345	2.3632	4.1862	4.1862	15.1527	125	6	1	17%
14S21E	A/R	1.4107	1.8809	1.4107	1.4107	1.6458	1.8809	1.8809	56	4	0	0%
14S22E	A/R	1.5674	62.6959	1.5674	1.5674	2.9781	48.1191	62.6959	250	6	0	0%
14S23E	A/R	0.6897	20.3762	2.1693	4.3887	4.3887	6.4389	14.8013	270	5	1	20%
15S19E	A/R	1.8809	1.8809	1.8809	1.8809	1.8809	1.8809	1.8809	4	1	1	100%
15S20E	A/R	0.1091	5.0157	0.4080	1.0157	2.5078	3.3229	3.6614	138	9	0	0%
15S21E	A/R	1.4420	2.5906	1.4420	1.4420	1.8274	2.3073	2.4773	92	4	0	0%
15S22E	A/R	0.6897	2.3602	1.0846	1.2539	1.2539	1.6604	2.1710	105	8	1	13%
15S23E	A/R	0.1699	321.6296	0.1699	1.2182	1.2539	2.2571	66.1466	251	9	1	11%
15S24E	A/R	2.5078	2.5078	2.5078	2.5078	2.5078	2.5078	2.5078	19	1	1	100%
16S18E	A/R	0.0125	2.6332	0.5367	1.3229	2.6332	2.6332	2.6332	224	3	0	0%
16S19E	A/R	0.5861	1.9339	0.8556	1.2600	1.9339	1.9339	1.9339	112	3	0	0%
16S20E	A/R	0.0439	9,529.7857	0.4520	0.6270	2.5078	9,529.7857	9,529.7857	373	8	0	0%
16S21E	A/R	1.9404	37.6176	1.9645	2.2129	2.2129	3.7085	21.5674	304	9	2	22%
16S22E	A/R	0.0009	82.1319	0.4514	0.8294	2.2759	2.3806	58.5517	231	14	3	21%
16S23E	A/R	0.4389	2.7408	1.1379	1.1755	1.1755	1.2539	1.8809	219	13	3	23%
16S24E	A/R	0.0627	5.6426	0.2041	0.4627	1.2539	2.2257	4.1755	191	7	1	14%
17S19E	A/R	0.0188	0.1567	0.0219	0.0313	0.1034	0.1567	0.1567	177	6	0	0%
17S20E	A/R	0.0021	13.3542	0.6280	0.9094	2.0865	3.4796	6.2696	1,631	55	5	9%
17S21E	A/R	0.0010	3,009.4419	1.2539	1.8339	2.0497	3.1348	5.4545	3,077	104	11	11%
17S22E	A/R	0.0392	9.4044	0.9342	1.2539	1.3041	2.1944	4.2470	2,601	105	14	13%
17S24E	A/R	0.6270	2.2555	0.9527	1.4412	2.2555	2.2555	2.2555	186	3	0	0%
17S25E	A/R	6.5204	6.5204	6.5204	6.5204	6.5204	6.5204	6.5204	78	1	1	100%
18S19E	A/R	2.6019	3.7618	2.6019	2.6019	2.6019	2.6019	3.1818	121	6	6	100%
18S20E	A/R	0.0004	13.7931	0.2439	2.5784	3.0721	5.9969	7.8370	918	36	1	3%
18S21E	A/R	0.0000	2,507.8370	0.8944	1.8809	2.6238	3.8558	5.6426	2,714	106	6	6%
18S22E	A/R	0.0002	11.2853	1.2539	1.2539	2.4151	2.8997	3.7618	1,596	55	2	4%
18S23E	A/R	1.6614	191,044.7761	1.6614	1.6614	1.6614	2.0201	38,210.5713	345	9	1	11%
19S20E	A/R	2.5078	9.4044	2.5078	2.5972	3.6270	4.3887	6.8966	169	6	1	17%
19S21E	A/R	0.0000	13.4169	1.1203	1.8056	3.7618	4.5455	6.7649	1,020	28	1	4%
19S22E	A/R	1.0408	7.7743	1.0408	1.2602	1.3542	4.4326	5.0157	1,334	26	0	0%
19S23E	A/R	0.0002	2.0201	0.2022	0.5052	1.0101	1.5151	1.8181	49	2	0	0%
20S22E	A/R	1.2937	1.2937	1.2937	1.2937	1.2937	1.2937	1.2937	40	1	1	100%
Walnuts Coalition-Wide:	**A/R**	**0.0000**	**191,044.7761**	**1.3467**	**1.7339**	**2.2927**	**248.3116**	**1,233.0252**	**19,594**	**684**	**71**	**10%**

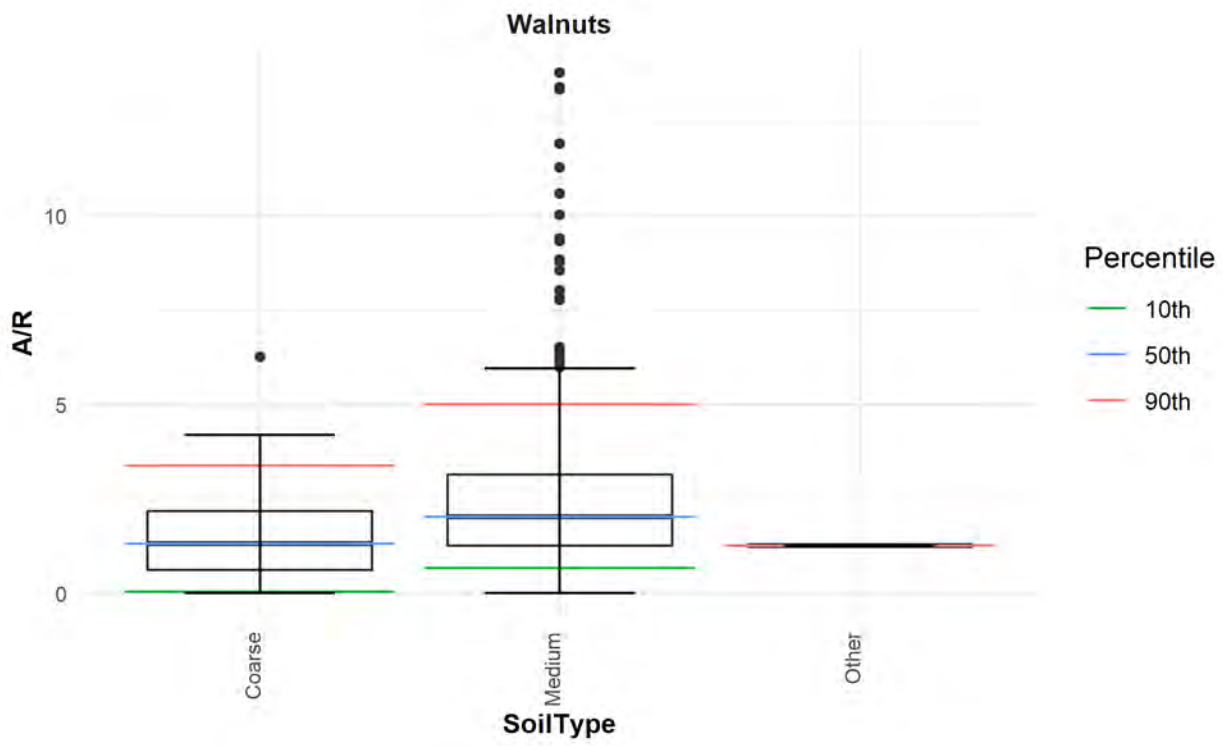

Figure 4-29. Box and Whisker Plots of A/R by Soil Type for Walnuts

Table 4-27. A/R by Soil Types for Walnuts

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Medium	A/R	0.0000	191044.7761	0.6897	1.2539	2.0878	3.3229	5.6426	18,608	651	46	7%
Coarse	A/R	0.0002	9529.7857	0.0561	0.6740	1.9107	3.3386	35.6113	936	32	5	16%
Other	A/R	1.2539	1.2539	1.2539	1.2539	1.2539	1.2539	1.2539	50	1	1	100%

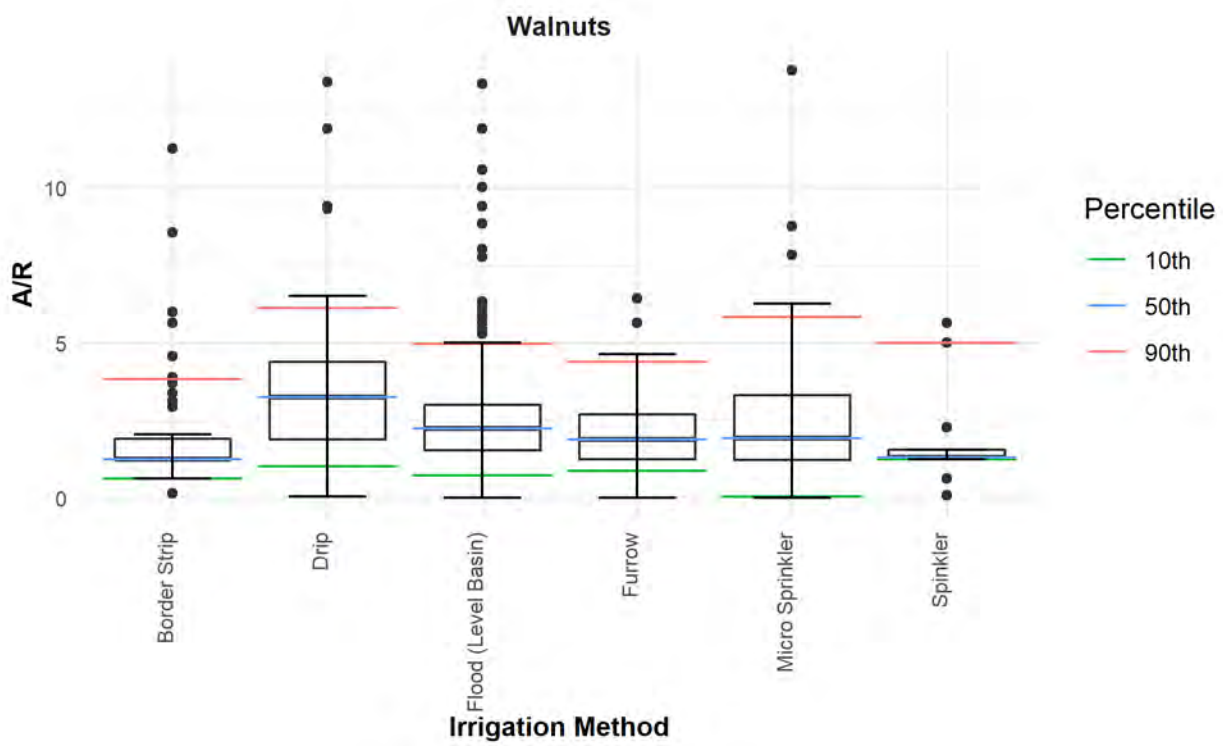

Figure 4-30. Box and Whisker Plots of A/R by Irrigation Practice for Walnuts

Table 4-28. A/R by Irrigation Practices for Walnuts

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	0.1567	2507.8370	0.6270	1.2539	1.2539	2.0497	4.5705	3,193	107	18	17%
Drip	A/R	0.0445	9529.7857	1.4420	1.8809	3.7618	5.0157	16.7273	2,592	73	11	15%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.0004	191044.7761	0.7214	1.5790	2.3166	3.0094	5.2900	7,698	300	32	11%
Furrow	A/R	0.0009	20.3762	0.9195	1.2458	1.8809	2.8997	4.3887	1,395	68	4	6%
Micro Sprinkler	A/R	0.0000	321.6296	0.0750	1.2476	1.9592	3.4690	7.6803	3,943	112	12	11%
Spinkler	A/R	0.0809	5.6426	1.2539	1.2539	1.3166	1.5564	5.0157	773	24	6	25%

4.3.11 Tangerines

Tangerines represent the tenth largest commodity reported in KRWQC, with 530 fields making up 13,052 acres (3%) of the coalitions total reported acreage. Of the total 530 fields, 464 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed. **Figure 4-31** compares the calculated A/R values from the reported A/Y values for tangerines corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0032 to a maximum of 6,267 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-29**. 12% of the filtered tangerines A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-32** and **Table 4-30** as well as irrigation practices in **Figure 4-33** and **Table 4-31**. Medium soil type was most commonly reported texture while Micro Sprinkler irrigation was the primary reported irrigation practice for tangerines.

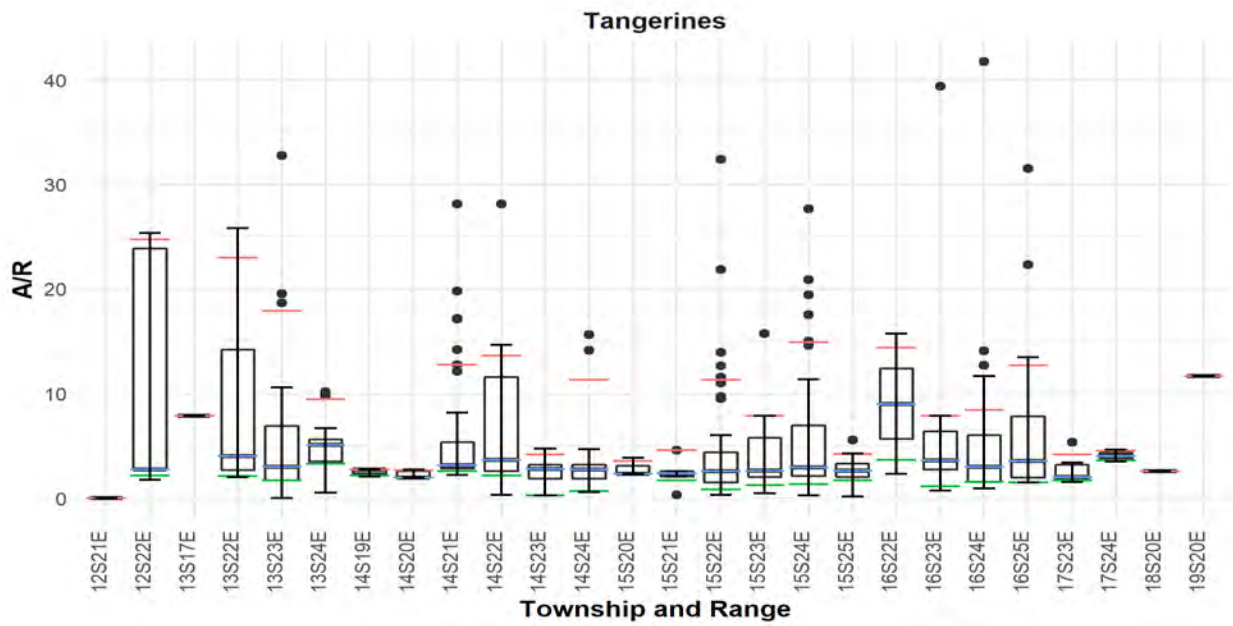

Figure 4-31. Box and Whisker Plots of A/R by Township and Range for Tangerines

Table 4-29. A/R by Township and Range for Tangerines

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S21E	A/R	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	5	1	1	100%
12S22E	A/R	1.7817	25.3177	2.1676	2.7465	2.7465	23.8253	24.7207	128	5	0	0%
13S17E	A/R	7.8740	7.8740	7.8740	7.8740	7.8740	7.8740	7.8740	30	1	1	100%
13S22E	A/R	2.0000	1,574.8032	2.1181	2.6905	8.0239	22.5079	180.7200	498	20	2	10%
13S23E	A/R	0.0032	32.7559	1.7165	1.7323	2.9921	6.9291	17.8578	852	32	4	13%
13S24E	A/R	0.5197	10.1908	3.2938	3.5238	5.1066	5.6098	9.4891	221	12	2	17%
14S19E	A/R	2.0551	2.7283	2.1898	2.3917	2.7283	2.7283	2.7283	187	3	0	0%
14S20E	A/R	1.9764	2.7323	1.9764	1.9764	1.9764	2.5787	2.6709	78	5	0	0%
14S21E	A/R	2.2008	52.4934	2.5984	2.8465	3.1496	5.7598	13.4961	1,272	56	9	16%
14S22E	A/R	0.3150	28.1215	2.1551	2.6093	3.6614	11.6142	13.6622	1,457	44	1	2%
14S23E	A/R	0.2533	787.4016	0.2533	2.4692	2.9264	4.5630	787.4016	240	10	2	20%
14S24E	A/R	0.5996	6,267.8689	0.7259	1.8898	2.7209	3.9606	15.0604	678	15	3	20%
15S20E	A/R	2.3346	3.8495	2.3346	2.3346	2.3346	3.0921	3.5465	64	3	0	0%
15S21E	A/R	0.3150	4.5827	1.7197	2.0709	2.3819	2.5748	4.5827	341	9	2	22%
15S22E	A/R	0.3150	125.9843	0.8577	1.5685	2.5986	4.7998	11.3386	2,131	72	15	21%
15S23E	A/R	0.4724	78.7402	1.3006	2.0020	2.7297	5.9201	7.8740	746	40	3	8%
15S24E	A/R	0.2913	792.3010	1.3981	2.4409	3.4306	9.8637	20.2937	1,389	65	6	9%
15S25E	A/R	0.1417	5.5468	1.7358	2.0146	2.6531	3.2957	4.2104	258	16	1	6%
16S22E	A/R	2.3237	15.7480	3.6661	5.6798	9.0359	12.3920	14.4056	21	2	0	0%
16S23E	A/R	0.7499	480.3148	1.1811	2.7244	3.6253	6.7535	7.8740	400	21	2	10%
16S24E	A/R	0.9141	72.5238	1.5630	1.5984	3.4359	6.0315	13.9806	928	52	7	13%
16S25E	A/R	1.4843	31.4961	1.5055	1.9827	3.5646	7.8150	12.7220	670	33	3	9%
17S23E	A/R	1.5488	5.3885	1.7165	1.8408	2.0194	3.1953	4.1960	307	7	1	14%
17S24E	A/R	3.5020	4.6494	3.6093	3.7704	4.0388	4.3441	4.5273	82	3	0	0%
18S20E	A/R	2.5874	45.6693	6.8956	13.3579	24.1284	34.8988	41.3611	51	2	0	0%
19S20E	A/R	11.6701	11.6701	11.6701	11.6701	11.6701	11.6701	11.6701	18	1	1	100%
Tangerines Coalition-Wide:	**A/R**	**0.0032**	**6,267.8689**	**2.6250**	**3.3782**	**4.6762**	**8.2548**	**47.6266**	**13,052**	**530**	**66**	**12%**

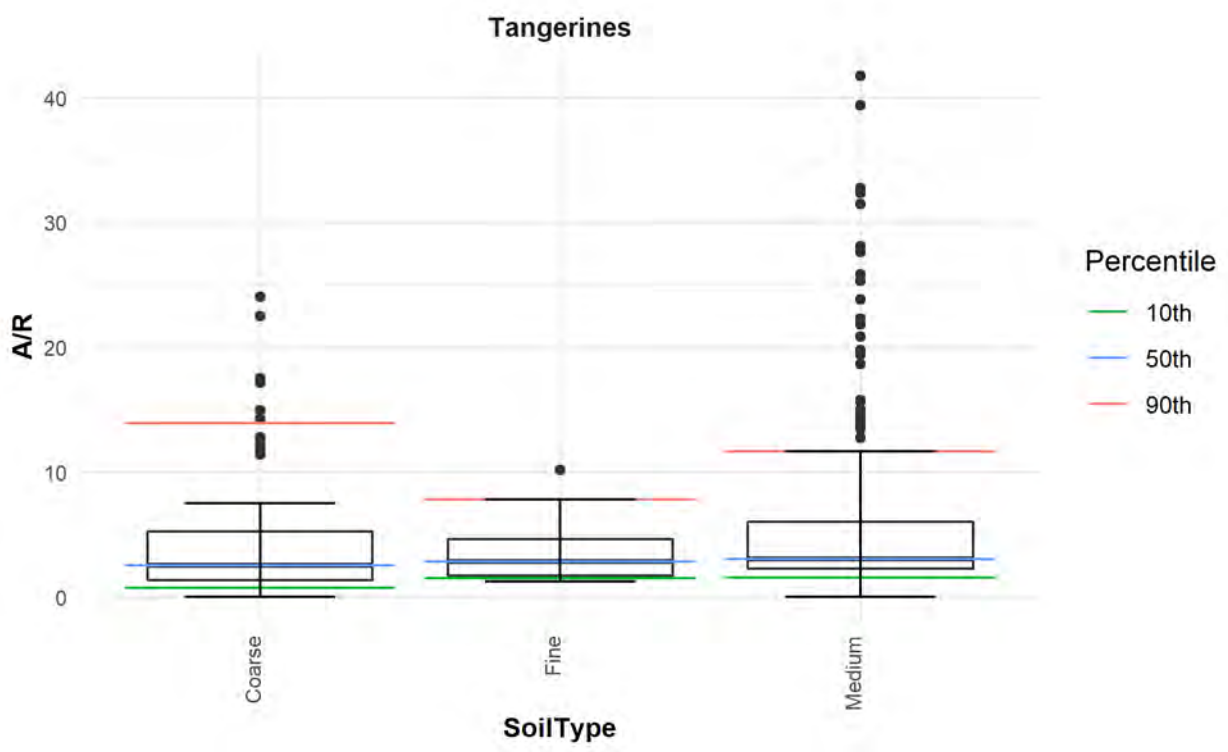

Figure 4-32. Box and Whisker Plots of A/R by Soil Type for Tangerines

Table 4-30. A/R by Soil Types for Tangerines

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	1.2370	10.1908	1.4961	1.7060	2.8236	4.6541	7.8150	184	12	1	8%
Medium	A/R	0.0276	6267.8689	1.5630	2.3292	3.1082	6.6614	14.6850	10,723	443	56	13%
Coarse	A/R	0.0032	1574.8032	0.7499	1.4821	2.5394	7.1470	14.9544	2,145	75	7	9%

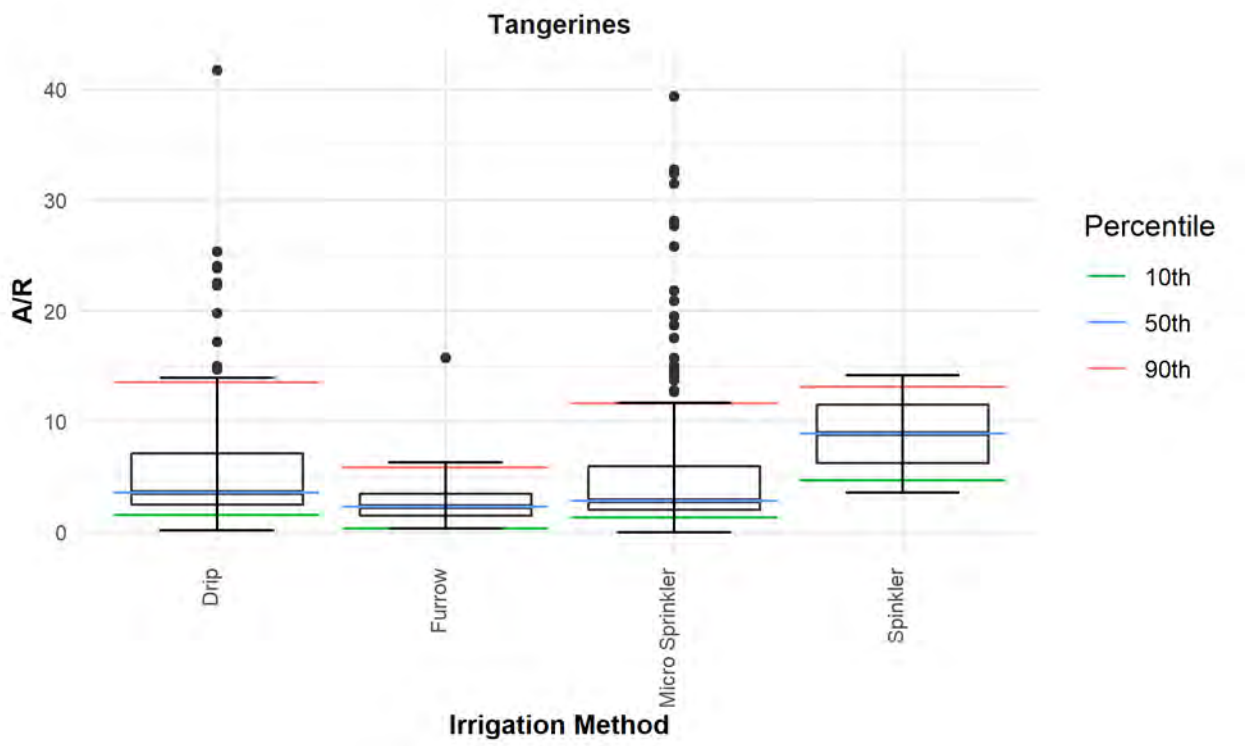

Figure 4-33. Box and Whisker Plots of A/R by Irrigation Practice for Tangerines

Table 4-31. A/R by Irrigation Practices for Tangerines

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	125.9843	125.9843	125.9843	125.9843	125.9843	125.9843	125.9843	6	1	1	100%
Drip	A/R	0.1417	45.6693	1.5630	2.5039	3.5646	7.4961	13.7244	3,980	156	12	8%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	-	-	-	-	-	-	-	-	-	-	-
Furrow	A/R	0.3150	6267.8689	0.3150	1.8534	2.4396	5.5906	47.2441	367	21	4	19%
Micro Sprinkler	A/R	0.0032	1574.8032	1.3366	2.0571	2.8732	6.6142	14.6063	8,680	350	41	12%
Spinkler	A/R	3.5996	14.1732	4.6569	6.2430	8.8864	11.5298	13.1159	20	2	0	0%

4.3.12 Plums

Plums represent the eleventh largest commodity reported in KRWQC, with 505 fields making up 11,746 acres (3%) of the coalitions total reported acreage. Of the total 505 fields, 445 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-34 compares the calculated A/R values from the reported A/Y values for plums corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0035 to a maximum of 11,778 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-32** 12% of the filtered plums A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-35** and **Table 4-33** as well as irrigation practices in **Figure 4-36** and **Table 4-34**. Medium soil type was most commonly reported texture while furrow irrigation was the primary reported irrigation practice for plums.

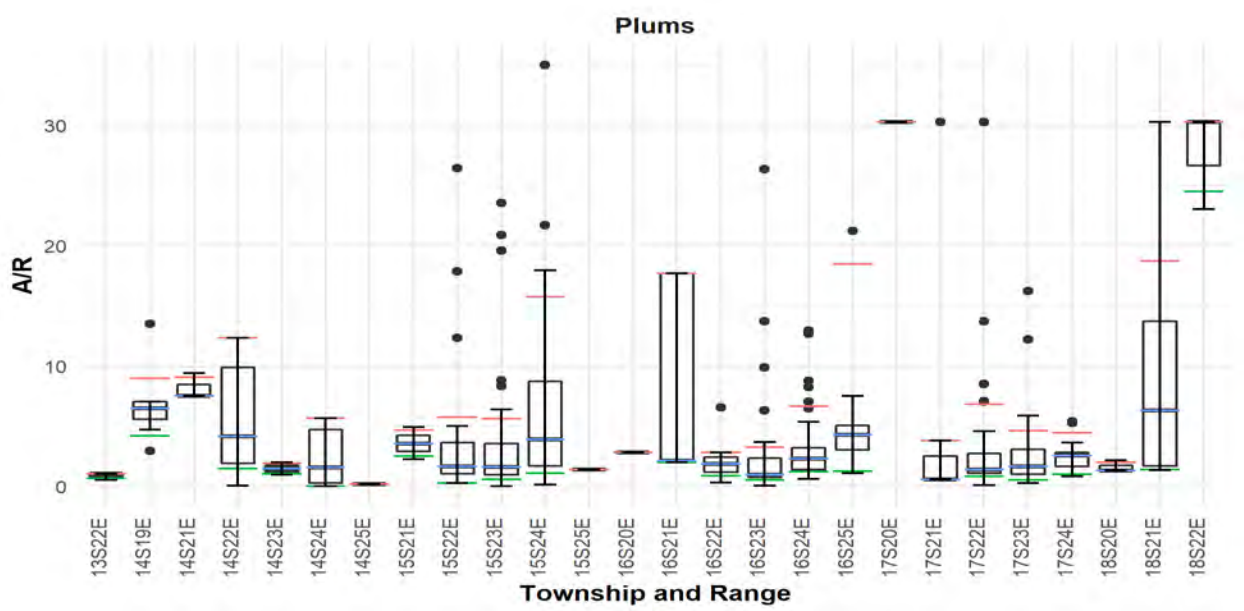

Figure 4-34. Box and Whisker Plots of A/R by Township and Range for Plums

Table 4-32. A/R by Township and Range for Plums

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
13S21E	A/R	155.4770	155.4770	155.4770	155.4770	155.4770	155.4770	155.4770	1	1	1	100%
13S22E	A/R	0.5376	1.0475	0.6396	0.7925	1.0475	1.0475	1.0475	16	3	0	0%
14S19E	A/R	2.9446	13.5453	4.1814	5.5948	6.4782	7.0671	9.0106	33	8	1	13%
14S21E	A/R	7.5406	42.4028	7.5406	7.5406	8.4894	17.6793	32.5134	48	4	1	25%
14S22E	A/R	0.0481	12.3675	1.4616	1.9081	4.1608	9.8940	12.3675	174	13	0	0%
14S23E	A/R	0.9420	212.2665	1.1529	1.4693	1.9965	107.1315	170.2125	92	3	0	0%
14S24E	A/R	0.0283	5.6890	0.0283	0.2880	1.5689	4.7253	5.6890	365	14	0	0%
14S25E	A/R	0.1802	0.1802	0.1802	0.1802	0.1802	0.1802	0.1802	200	5	5	100%
15S21E	A/R	2.2615	4.9470	2.5159	2.8975	3.5336	4.2403	4.6643	97	3	0	0%
15S22E	A/R	0.2827	1,519.4346	0.3028	1.0922	1.8202	4.6678	24.7152	459	33	6	18%
15S23E	A/R	0.0035	42.4028	0.5654	0.9647	1.6635	3.6526	5.6855	1,409	84	7	8%
15S24E	A/R	0.1343	37.7385	1.1310	1.6961	4.3031	10.6007	17.5406	557	33	2	6%
15S25E	A/R	1.3922	1.3922	1.3922	1.3922	1.3922	1.3922	1.3922	84	2	2	100%
16S20E	A/R	2.8269	2.8269	2.8269	2.8269	2.8269	2.8269	2.8269	9	1	1	100%
16S21E	A/R	1.9894	11,778.5630	1.9982	2.0353	9.8940	17.6678	5,898.1154	319	6	1	17%
16S22E	A/R	0.3281	6.5654	0.8922	1.1979	1.8551	2.4099	2.8198	299	18	1	6%
16S23E	A/R	0.0348	706.7138	0.5477	0.7597	0.9844	2.6302	7.7569	707	57	7	12%
16S24E	A/R	0.6360	141.3428	1.2065	1.4134	2.3074	3.5866	8.2450	836	61	9	15%
16S25E	A/R	1.1030	21.2014	1.2802	3.0288	4.2908	5.0480	18.4686	286	13	2	15%
17S20E	A/R	30.2785	30.2785	30.2785	30.2785	30.2785	30.2785	30.2785	222	2	2	100%
17S21E	A/R	0.5936	30.2785	0.5936	0.5936	0.5936	2.5053	3.8092	1,330	11	1	9%
17S22E	A/R	0.1178	30.2785	0.8198	1.0813	1.3746	2.7407	6.8198	2,084	62	7	11%
17S23E	A/R	0.2759	16.2090	0.5200	1.0039	1.6482	3.0931	4.6260	846	38	2	5%
17S24E	A/R	0.8300	5.4221	1.0139	1.6594	2.5377	2.8254	4.4452	332	16	2	13%
18S20E	A/R	1.3049	2.1590	1.3049	1.3049	1.3049	1.7320	1.9882	50	3	0	0%
18S21E	A/R	1.3286	30.2785	1.3731	1.6784	6.3269	13.7350	18.6980	504	8	0	0%
18S22E	A/R	23.0389	30.2785	24.4868	26.6587	30.2785	30.2785	30.2785	386	3	0	0%
Plums Coalition-Wide:	**A/R**	**0.0035**	**11,778.5630**	**9.1004**	**9.5116**	**10.6893**	**16.6338**	**239.9878**	**11,746**	**505**	**60**	**12%**

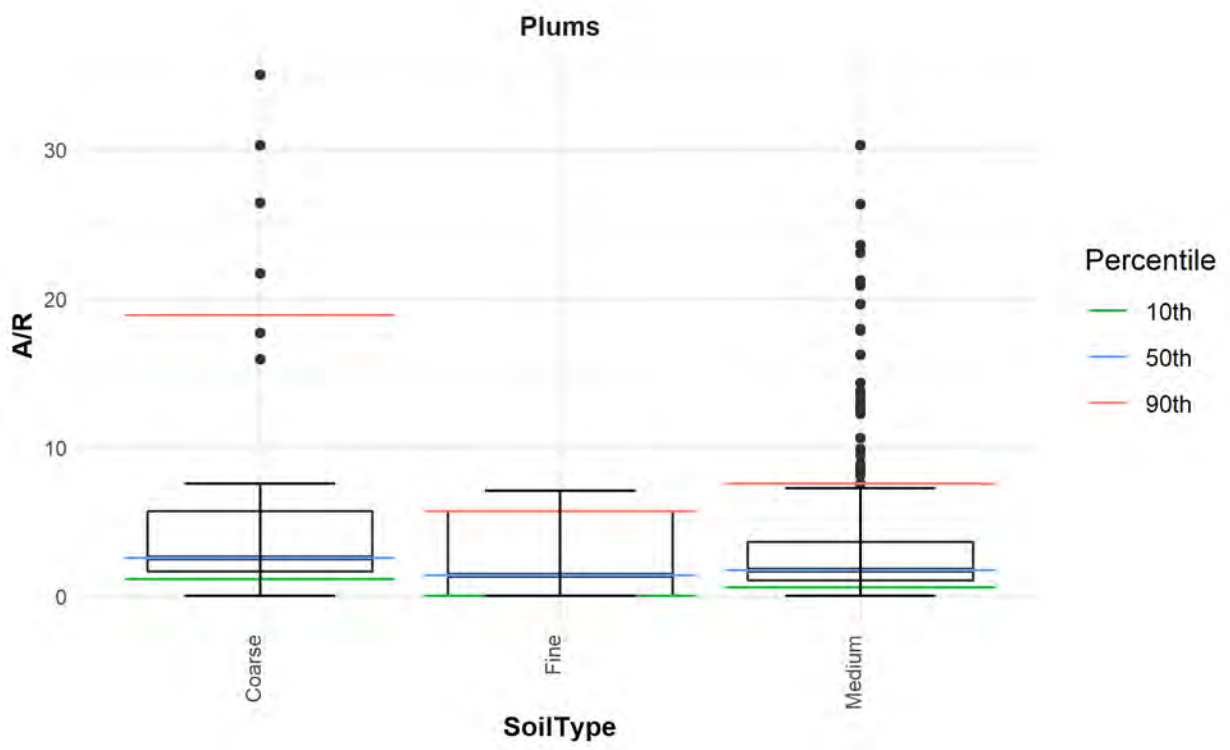

Figure 4-35. Box and Whisker Plots of A/R by Soil Type for Plums

Table 4-33. A/R by Soil Types for Plums

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.0283	7.0671	0.0283	0.0283	1.3922	5.6890	5.6890	426	12	0	0%
Medium	A/R	0.0122	11778.5630	0.5717	1.0813	1.8297	3.9258	10.3887	10,745	454	56	12%
Coarse	A/R	0.0035	37.7385	1.1512	1.6805	2.7511	6.3763	22.6233	575	39	8	21%

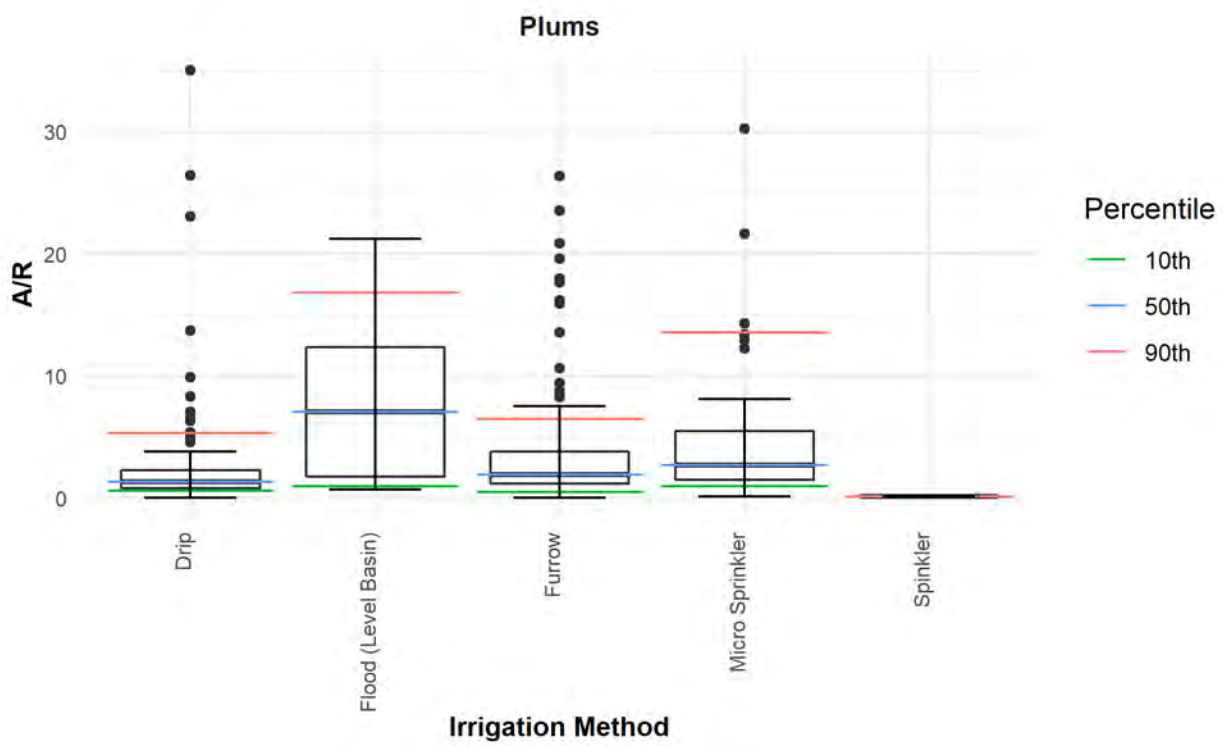

Figure 4-36. Box and Whisker Plots of A/R by Irrigation Practice for Plums

Table 4-34. A/R by Irrigation Practices for Plums

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	141.3428	141.3428	141.3428	141.3428	141.3428	141.3428	141.3428	5	1	1	100%
Drip	A/R	0.0353	11778.5630	0.5936	0.8693	1.3507	2.3383	8.7986	4,963	148	25	17%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.7067	21.2014	0.9480	1.7373	7.0671	12.3675	16.8193	394	23	0	0%
Furrow	A/R	0.0035	706.7138	0.5265	1.1562	1.9536	3.9258	7.0671	3,614	230	20	9%
Micro Sprinkler	A/R	0.1131	1519.4346	0.9635	1.5414	2.7577	5.6855	20.9360	2,759	102	16	16%
Spinkler	A/R	0.1178	0.1178	0.1178	0.1178	0.1178	0.1178	0.1178	11	1	1	100%

4.3.13 Nectarines

Nectarines represent the twelfth largest commodity reported in KRWQC, with 625 fields making up 11,199 acres (2%) of the coalitions total reported acreage. Of the total 625 fields, 546 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-37 compares the calculated A/R values from the reported A/Y values for nectarines corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0002 to a maximum of 33,716 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-35** 13% of the filtered nectarines A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-38** and **Table 4-36** as well as irrigation practices in **Figure 4-39** and **Table 4-37**. Medium soil type was most commonly reported texture while furrow irrigation was the primary reported irrigation practice for nectarines.

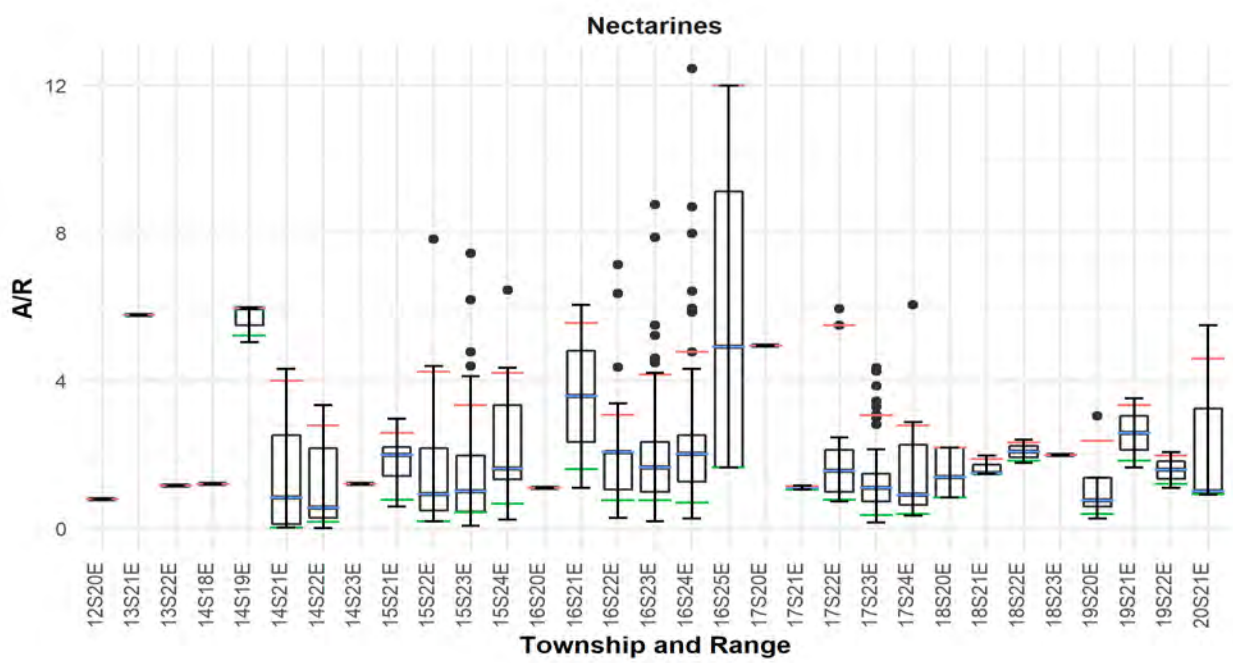

Figure 4-37. Box and Whisker Plots of A/R by Township and Range for Nectarines

Table 4-35. A/R by Township and Range for Nectarines

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
12S20E	A/R	0.7849	0.7849	0.7849	0.7849	0.7849	0.7849	0.7849	34	1	1	100%
13S21E	A/R	5.7747	109.8901	16.1863	31.8036	57.8324	83.8613	99.4786	11	2	0	0%
13S22E	A/R	1.1597	1.1597	1.1597	1.1597	1.1597	1.1597	1.1597	7	1	1	100%
14S18E	A/R	1.1951	1.1951	1.1951	1.1951	1.1951	1.1951	1.1951	16	1	1	100%
14S19E	A/R	5.0366	5.9524	5.2198	5.4945	5.9524	5.9524	5.9524	10	3	0	0%
14S21E	A/R	0.0110	4.3104	0.0222	0.1099	0.8242	2.5247	3.9918	108	9	0	0%
14S22E	A/R	0.0002	17.8571	0.1924	0.2747	1.2363	2.6424	7.6898	180	8	1	13%
14S23E	A/R	1.1951	1.1951	1.1951	1.1951	1.1951	1.1951	1.1951	169	5	5	100%
15S20E	A/R	32.9670	32.9670	32.9670	32.9670	32.9670	32.9670	32.9670	14	1	1	100%
15S21E	A/R	0.5887	2.9670	0.7747	1.4148	1.9780	2.1978	2.5824	225	14	0	0%
15S22E	A/R	0.1830	76.9231	0.2198	0.5826	1.1335	3.6319	20.9275	577	49	6	12%
15S23E	A/R	0.0714	53.1136	0.4396	0.4599	1.0104	2.0777	3.5404	1,011	87	5	6%
15S24E	A/R	0.2289	23.1899	0.7433	1.3187	1.7308	4.2033	23.1899	394	27	4	15%
16S20E	A/R	1.0989	1.0989	1.0989	1.0989	1.0989	1.0989	1.0989	21	1	1	100%
16S21E	A/R	1.0989	6.0440	1.5934	2.3352	3.5714	4.8077	5.5495	160	2	0	0%
16S22E	A/R	0.2747	30.8352	0.7555	1.0989	2.0604	2.0604	3.5758	692	49	5	10%
16S23E	A/R	0.1896	4,038.5213	0.7555	0.9890	1.6484	2.6511	4.5408	2,063	119	11	9%
16S24E	A/R	0.2576	24.2130	0.6923	1.3538	2.0440	2.6374	5.9524	1,292	81	12	15%
16S25E	A/R	1.6462	11.9824	1.6462	1.6462	4.9066	9.1209	11.9824	176	8	0	0%
17S20E	A/R	4.9451	4.9451	4.9451	4.9451	4.9451	4.9451	4.9451	15	1	1	100%
17S21E	A/R	1.0412	1.1511	1.0522	1.0687	1.0962	1.1236	1.1401	144	2	0	0%
17S22E	A/R	0.7253	24.4755	0.7781	1.0151	1.6456	2.2926	5.5824	403	19	4	21%
17S23E	A/R	0.1517	33,716.7791	0.4011	0.7282	1.1565	1.5055	3.4352	2,260	97	15	15%
17S24E	A/R	0.3355	6.0440	0.3926	0.6333	0.9047	2.2557	2.7798	312	14	1	7%
18S20E	A/R	0.8330	2.1868	0.8330	0.8330	1.3890	2.1868	2.1868	46	5	0	0%
18S21E	A/R	1.4780	1.9670	1.4797	1.4821	1.4863	1.7266	1.8709	75	3	0	0%
18S22E	A/R	1.7637	2.3889	1.8263	1.9200	2.0763	2.2326	2.3264	211	2	0	0%
18S23E	A/R	1.9780	1.9780	1.9780	1.9780	1.9780	1.9780	1.9780	330	2	2	100%
19S20E	A/R	0.2576	3.0352	0.3880	0.5836	0.7527	1.3687	2.3686	35	4	1	25%
19S21E	A/R	1.6484	3.5137	1.8349	2.1147	2.5810	3.0474	3.3272	37	2	0	0%
19S22E	A/R	1.0989	2.0604	1.1951	1.3393	1.5797	1.8201	1.9643	16	2	0	0%
20S21E	A/R	0.9011	5.4945	0.9209	0.9505	1.0000	3.2473	4.5956	75	3	0	0%
22S20E	A/R	17.9945	17.9945	17.9945	17.9945	17.9945	17.9945	17.9945	80	1	1	100%
Nectarines Coalition-Wide:	**A/R**	**0.0002**	**33,716.7791**	**3.1412**	**3.7839**	**4.9974**	**6.4998**	**8.9045**	**11,199**	**625**	**79**	**13%**

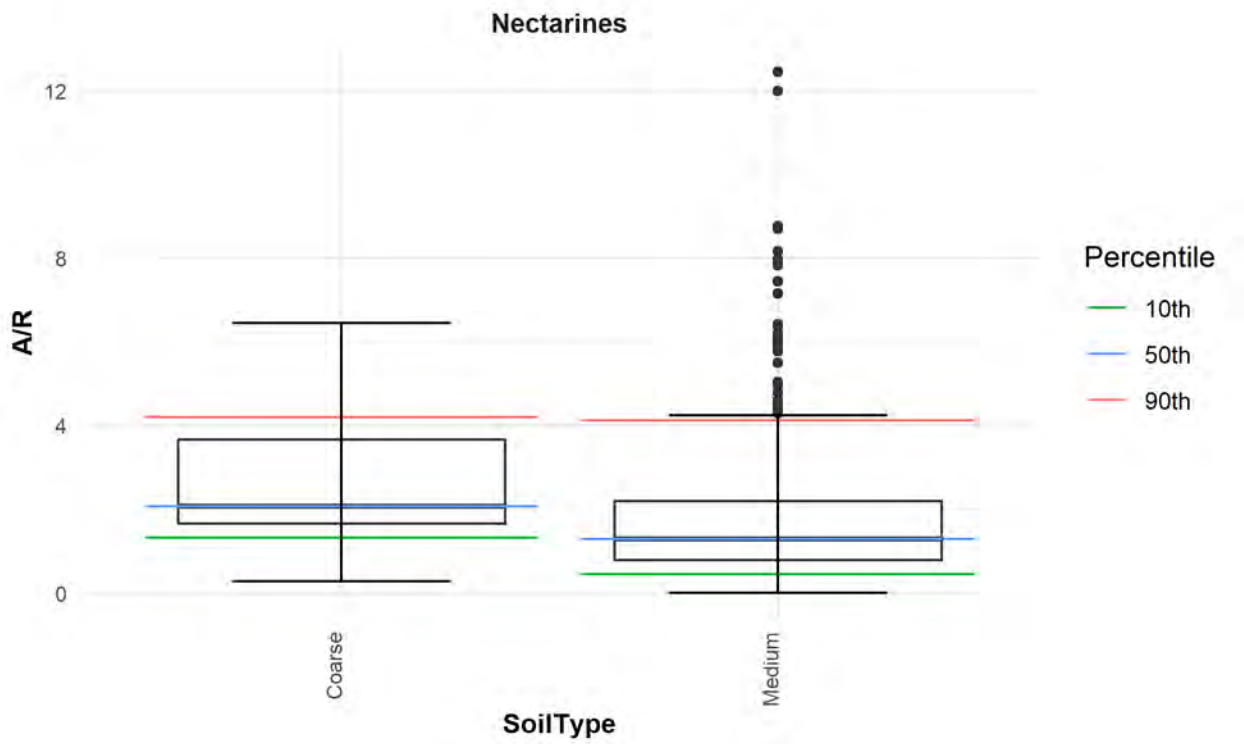

Figure 4-38. Box and Whisker Plots of A/R by Soil Type for Nectarines

Table 4-36. A/R by Soil Types for Nectarines

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Medium	A/R	0.0002	33716.7791	0.4694	0.7954	1.3363	2.3383	5.0824	10,541	580	63	11%
Coarse	A/R	0.2809	148.3515	1.3187	1.6484	2.0604	3.8297	4.3560	658	45	2	4%

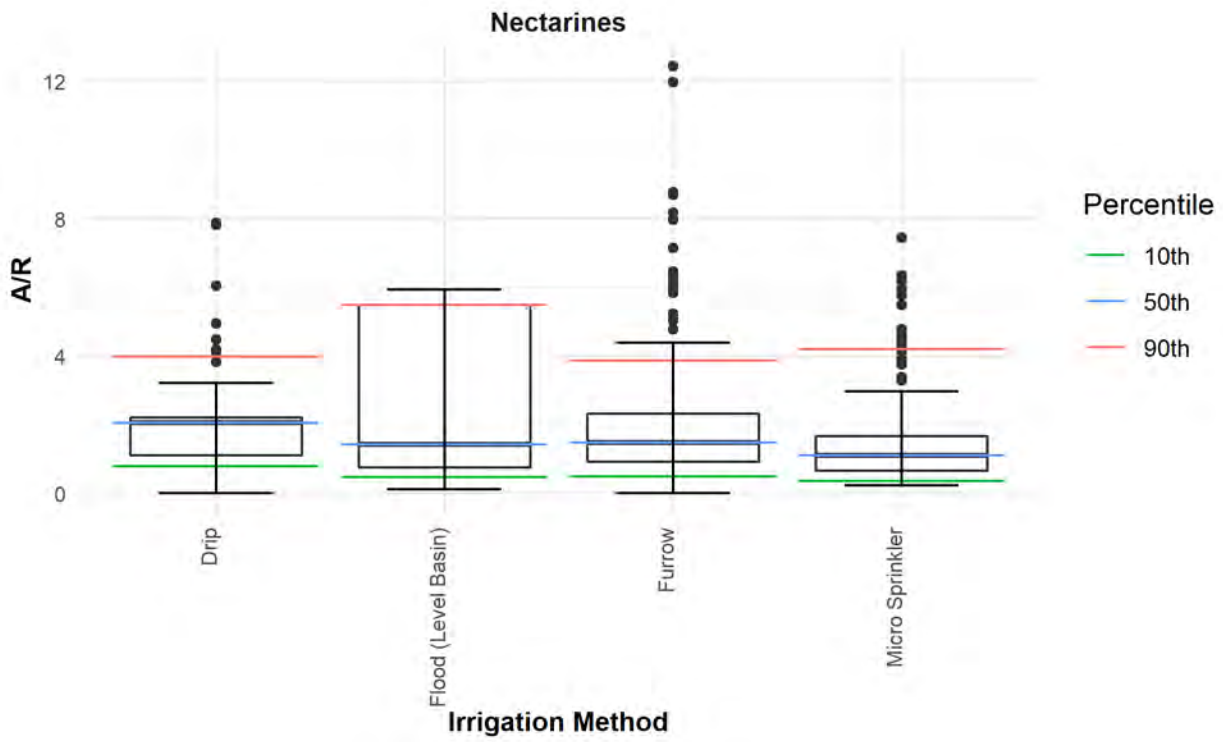

Figure 4-39. Box and Whisker Plots of A/R by Irrigation Practice for Nectarines

Table 4-37. A/R by Irrigation Practices for Nectarines

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	76.9231	76.9231	76.9231	76.9231	76.9231	76.9231	76.9231	8	1	1	100%
Drip	A/R	0.0110	461.5385	0.8242	1.2342	2.0604	3.6745	31.4747	2,060	78	14	18%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.1099	17.8571	0.5448	0.7555	1.9780	5.4945	13.0879	202	15	2	13%
Furrow	A/R	0.0002	33716.7791	0.5203	0.9250	1.5055	2.4038	4.3461	6,612	362	30	8%
Micro Sprinkler	A/R	0.2289	24.2130	0.3678	0.6835	1.1074	1.9584	4.3952	2,317	169	26	15%
Spinkler	A/R	-	-	-	-	-	-	-	-	-	-	-

4.3.14 Corn (Silage)

Corn represents the thirteenth largest commodity reported in KRWQC, with 259 fields making 9,869 acres (2%) of the coalitions total reported acreage. Of the total 259 fields, 227 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-40 compares the calculated A/R values from the reported A/Y values for corn corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0156 to a maximum of 2,603 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-38** 12% of the filtered corn A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-41** and **Table 4-39** as well as irrigation practices in **Figure 4-42** and **Table 4-40**. Medium soil type was most commonly reported texture while flood irrigation was the primary reported irrigation practice for corn.

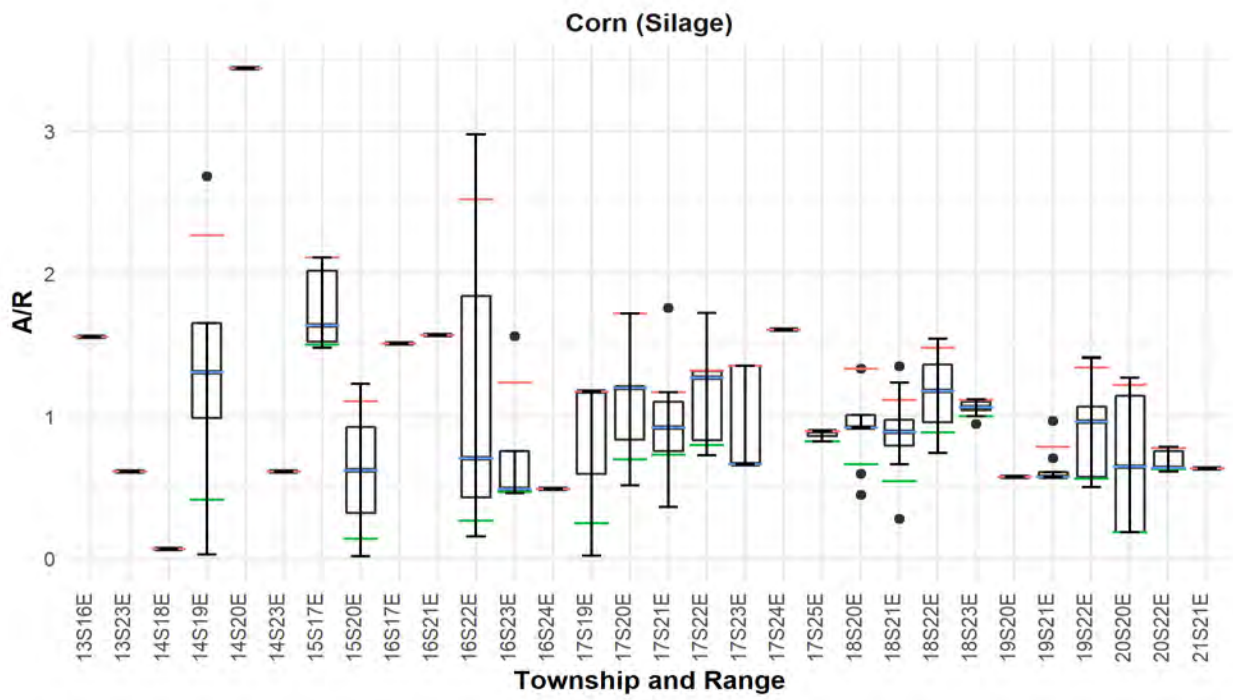

Figure 4-40. Box and Whisker Plots of A/R by Township and Range for Corn

Table 4-38. A/R by Township and Range for Corn (Silage)

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
13S16E	A/R	1.5542	1.5542	1.5542	1.5542	1.5542	1.5542	1.5542	185	3	3	100%
13S23E	A/R	0.6111	0.6111	0.6111	0.6111	0.6111	0.6111	0.6111	60	1	1	100%
14S18E	A/R	0.0661	0.0661	0.0661	0.0661	0.0661	0.0661	0.0661	35	1	1	100%
14S19E	A/R	0.0291	2.6799	0.4132	0.9894	1.3095	1.6521	2.2688	114	4	1	25%
14S20E	A/R	3.4392	3.4392	3.4392	3.4392	3.4392	3.4392	3.4392	15	1	1	100%
14S23E	A/R	0.6111	0.6111	0.6111	0.6111	0.6111	0.6111	0.6111	60	1	1	100%
15S17E	A/R	1.4770	2.1095	1.4990	1.5211	1.6337	2.0188	2.1095	443	6	0	0%
15S20E	A/R	0.0156	84.6561	0.2579	0.6214	1.2272	42.9416	67.9703	84	3	0	0%
16S17E	A/R	1.5076	1.5076	1.5076	1.5076	1.5076	1.5076	1.5076	250	2	2	100%
16S21E	A/R	1.5661	1.5661	1.5661	1.5661	1.5661	1.5661	1.5661	74	3	3	100%
16S22E	A/R	0.1556	2.9762	0.2655	0.4305	0.7054	1.8408	2.5220	173	3	0	0%
16S23E	A/R	0.4603	1.5556	0.4690	0.4821	0.4894	0.7560	1.2357	25	4	1	25%
16S24E	A/R	0.4894	0.4894	0.4894	0.4894	0.4894	0.4894	0.4894	6	1	1	100%
17S19E	A/R	0.0185	1.1746	0.2497	0.5966	1.1746	1.1746	1.1746	200	3	0	0%
17S20E	A/R	0.5160	5.2765	0.7010	0.8373	1.2003	1.2229	1.7196	586	20	1	5%
17S21E	A/R	0.3624	1.7553	0.7298	0.7540	0.9206	1.1019	1.1680	579	21	2	10%
17S22E	A/R	0.7249	1.7209	0.7969	0.8323	1.2698	1.3188	1.3228	1,115	38	0	0%
17S23E	A/R	0.6614	1.3545	0.6614	0.6614	0.6614	1.3545	1.3545	297	5	0	0%
17S24E	A/R	1.6045	1.6045	1.6045	1.6045	1.6045	1.6045	1.6045	31	1	1	100%
17S25E	A/R	0.8241	0.8942	0.8241	0.8591	0.8942	0.8942	0.8942	270	7	0	0%
18S20E	A/R	0.4484	2,603.1746	0.7252	0.9180	0.9180	1.3333	1,556.0842	380	15	2	13%
18S21E	A/R	0.2760	105.8201	0.5843	0.7937	0.9259	1.0086	1.1235	1,194	39	2	5%
18S22E	A/R	0.7440	1,917.9894	0.8955	0.9590	1.1772	1.3677	1.5205	978	25	1	4%
18S23E	A/R	0.9444	1.1177	1.0005	1.0440	1.0622	1.1023	1.1162	240	12	0	0%
19S20E	A/R	0.5754	0.5754	0.5754	0.5754	0.5754	0.5754	0.5754	78	1	1	100%
19S21E	A/R	0.5741	0.9667	0.5741	0.5741	0.5741	0.6069	0.7838	567	8	2	25%
19S22E	A/R	0.5017	1,261.6371	0.5605	0.6224	1.0053	1.0661	1.4109	800	14	1	7%
20S20E	A/R	0.1862	1.2685	0.1862	0.1862	0.6440	1.1435	1.2185	111	4	0	0%
20S22E	A/R	0.6138	0.7837	0.6285	0.6369	0.6369	0.7566	0.7746	609	9	0	0%
21S21E	A/R	0.6327	0.6327	0.6327	0.6327	0.6327	0.6327	0.6327	310	4	4	100%
Corn Coalition-Wide:	**A/R**	**0.0156**	**2,603.1746**	**0.8227**	**0.8992**	**1.0362**	**2.5773**	**55.3477**	**9,869**	**259**	**32**	**12%**

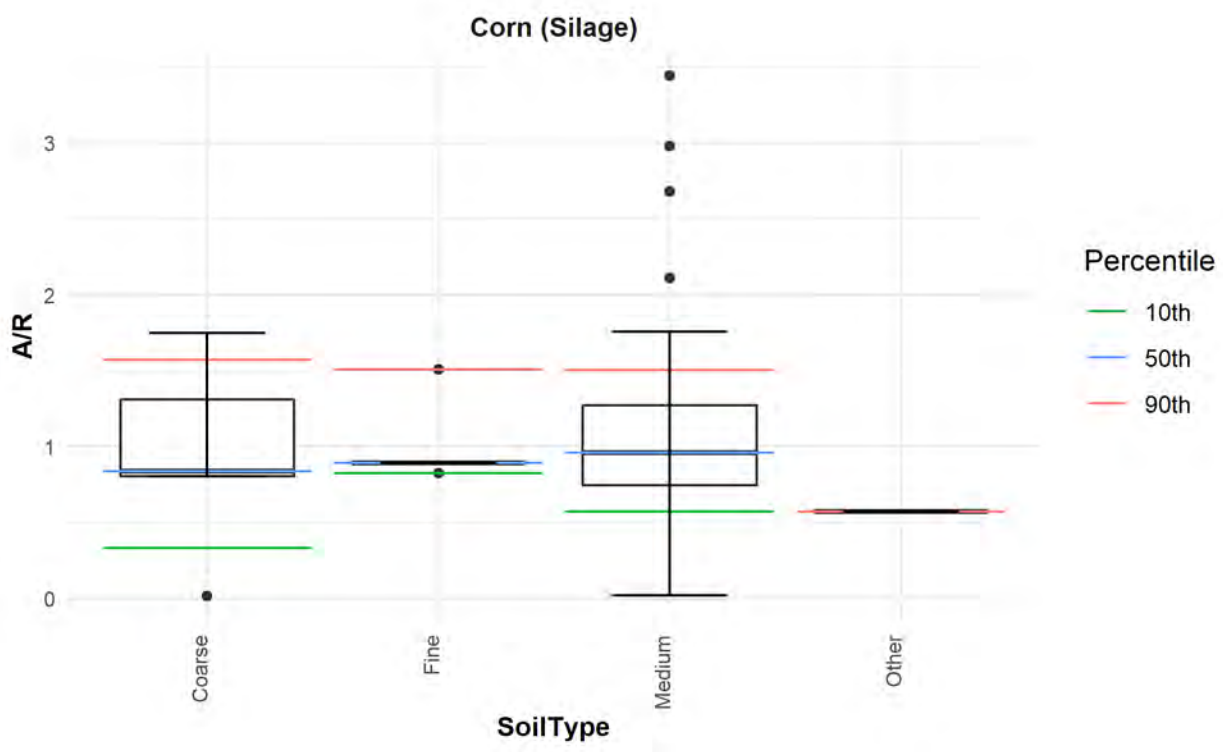

Figure 4-41. Box and Whisker Plots of A/R by Soil Type for Corn

Table 4-39. A/R by Soil Types for Corn

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.8241	1.5076	0.8241	0.8942	0.8942	0.8942	1.5076	520	9	7	78%
Medium	A/R	0.0185	2603.1746	0.5741	0.7554	0.9815	1.3188	1.5542	9,131	244	10	4%
Coarse	A/R	0.0156	1.7464	0.3305	0.8029	0.8373	1.3095	1.5717	171	5	0	0%
Other	A/R	0.5741	0.5741	0.5741	0.5741	0.5741	0.5741	0.5741	47	1	1	100%

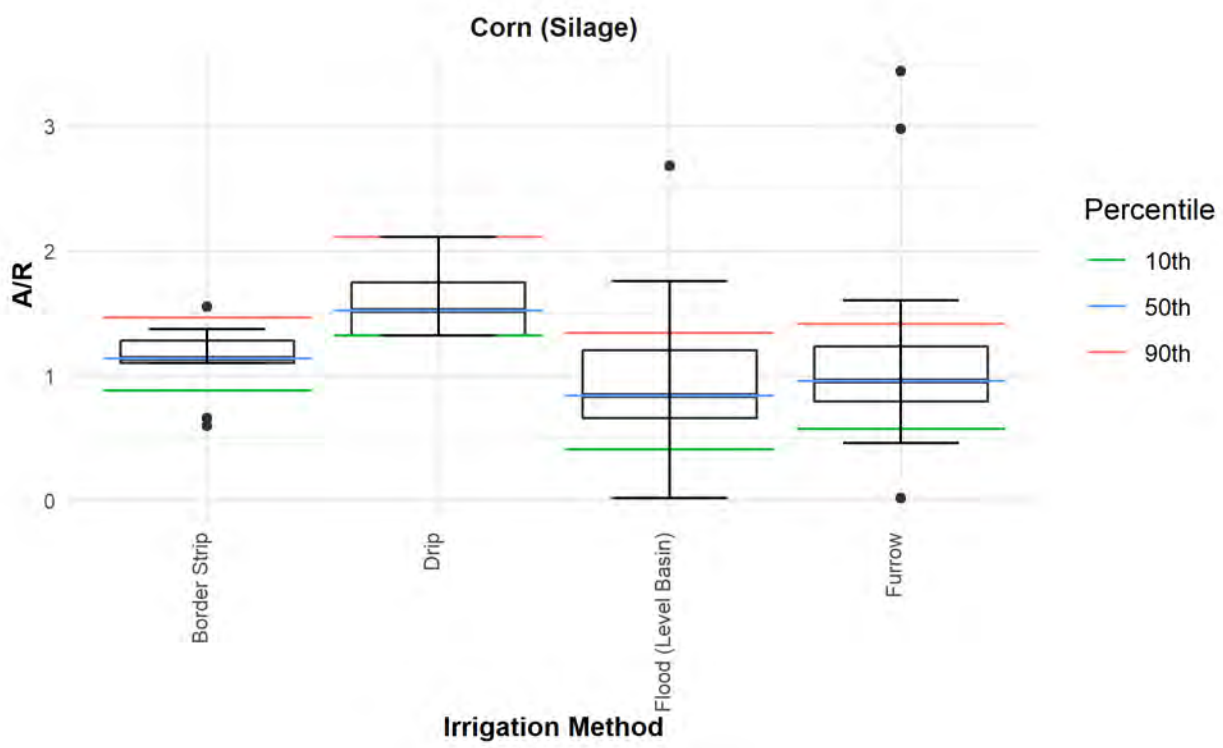

Figure 4-42. Box and Whisker Plots of A/R by Irrigation Practice for Corn

Table 4-40. A/R by Irrigation Practices for Corn

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	0.5966	1.5542	0.8816	1.1019	1.1382	1.2798	1.4630	648.97	16	2	13%
Drip	A/R	1.3228	2.1095	1.3228	1.3228	1.5211	1.7464	2.1095	557	9	0	0%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	0.0185	2603.1746	0.4312	0.6614	0.8532	1.2229	1.5421	4,470	109	4	4%
Furrow	A/R	0.0156	1917.9894	0.5889	0.7937	0.9590	1.3188	1.5076	4,193	125	6	5%
Micro Sprinkler	A/R	-	-	-	-	-	-	-	-	-	-	-
Spinkler	A/R	-	-	-	-	-	-	-	-	-	-	-

4.3.15 Wheat (Silage)

Wheat represents the fourteenth largest commodity reported in KRWQC, with 118 fields making up 5,583 acres (1%) of the coalitions total reported acreage. Of the total 118 fields, 85 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-43 compares the calculated A/R values from the reported A/Y values for wheat corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.0008 to a maximum of 1,904 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-41** 28% of the filtered wheat A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-44** and **Table 4-42** as well as irrigation practices in **Figure 4-45** and **Table 4-43**. Medium soil type was most commonly reported texture while flood irrigation was the primary reported irrigation practice for wheat.

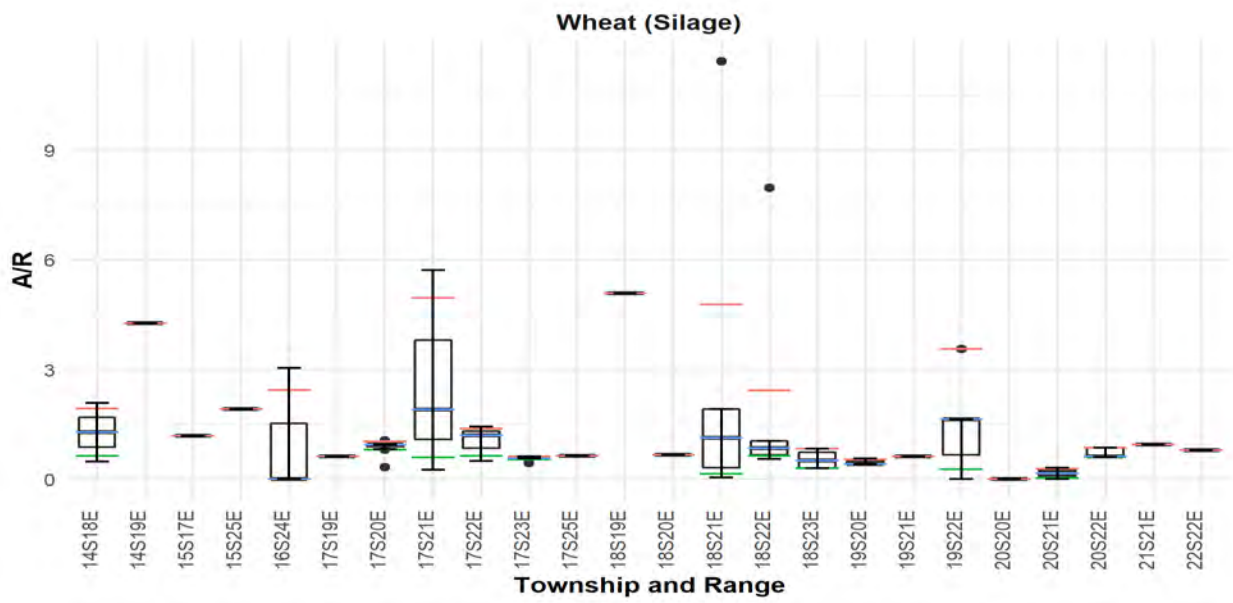

Figure 4-43. Box and Whisker Plots of A/R by Township and Range for Wheat (Silage)

Table 4-41. A/R by Township and Range for Wheat (Silage)

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
14S18E	A/R	0.4762	2.0952	0.6381	0.8810	1.2857	1.6905	1.9333	115	2	0	0%
14S19E	A/R	4.2710	4.2710	4.2710	4.2710	4.2710	4.2710	4.2710	58	7	7	100%
15S17E	A/R	1.1861	1.1861	1.1861	1.1861	1.1861	1.1861	1.1861	301	1	1	100%
15S25E	A/R	1.9188	1.9188	1.9188	1.9188	1.9188	1.9188	1.9188	8	1	1	100%
16S24E	A/R	0.0008	3.0476	0.0008	0.0008	0.0008	1.5242	2.4383	55	3	0	0%
17S19E	A/R	0.6190	0.6190	0.6190	0.6190	0.6190	0.6190	0.6190	157	5	5	100%
17S20E	A/R	0.3310	1,904.7619	0.8091	0.9104	0.9524	0.9524	1.0607	422	14	3	21%
17S21E	A/R	0.2610	5.7143	0.5897	1.0829	1.9048	3.8095	4.9524	39	3	0	0%
17S22E	A/R	0.4989	1.4365	0.6391	0.8494	1.2000	1.3182	1.3892	147	3	0	0%
17S23E	A/R	0.4381	1,142.8571	0.5581	0.5714	0.6000	0.6286	114.8514	717	10	1	10%
17S25E	A/R	0.6438	0.6438	0.6438	0.6438	0.6438	0.6438	0.6438	200	4	4	100%
18S19E	A/R	5.0790	5.0790	5.0790	5.0790	5.0790	5.0790	5.0790	75	1	1	100%
18S20E	A/R	0.6657	1,904.7619	0.6657	0.6657	9.8567	1,433.3333	1,904.7619	91	6	0	0%
18S21E	A/R	0.0397	11.4286	0.1499	0.3064	1.1238	1.9188	4.7717	318	8	1	13%
18S22E	A/R	0.5505	7.9676	0.6427	0.6657	0.8476	1.0410	2.4263	550	9	1	11%
18S23E	A/R	0.2943	0.8286	0.2990	0.3060	0.5110	0.7429	0.8286	190	8	0	0%
19S20E	A/R	0.4143	0.5714	0.4143	0.4143	0.4143	0.4929	0.5400	137	3	0	0%
19S21E	A/R	0.6210	0.6210	0.6210	0.6210	0.6210	0.6210	0.6210	165	2	2	100%
19S22E	A/R	0.0062	3.5714	0.2718	0.6724	1.6327	1.6327	3.5714	968	14	3	21%
20S20E	A/R	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	7	1	1	100%
20S21E	A/R	0.0010	0.3152	0.0324	0.0795	0.1581	0.2367	0.2838	200	2	0	0%
20S22E	A/R	0.6055	0.8571	0.6141	0.6163	0.6163	0.8571	0.8571	417	9	0	0%
21S21E	A/R	0.9524	0.9524	0.9524	0.9524	0.9524	0.9524	0.9524	136	1	1	100%
22S22E	A/R	0.7857	0.7857	0.7857	0.7857	0.7857	0.7857	0.7857	110	1	1	100%
Wheat Coalition-Wide:	**A/R**	**0.0008**	**1,904.7619**	**1.0118**	**1.0852**	**1.6178**	**58.7901**	**82.5752**	**6,038**	**120**	**33**	**28%**

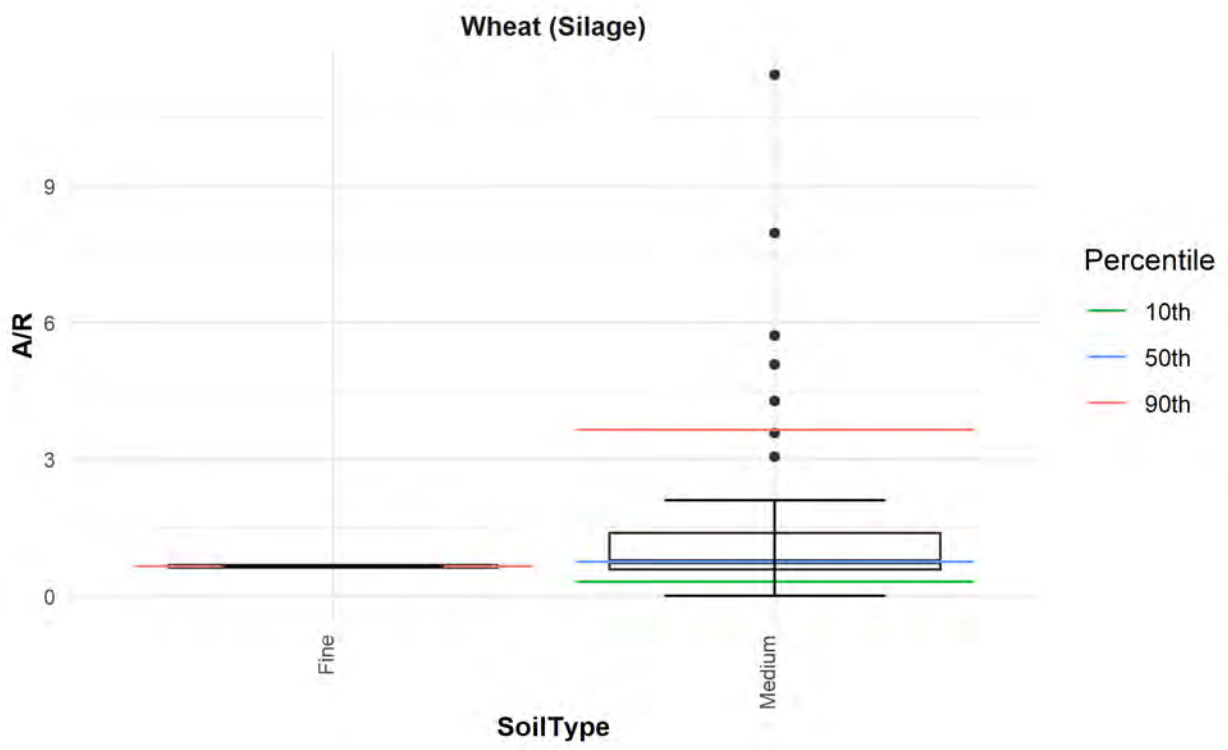

Figure 4-44. Box and Whisker Plots of A/R by Soil Type for Wheat (Silage)

Table 4-42. A/R by Soil Types for Wheat (Silage)

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.6438	0.6438	0.6438	0.6438	0.6438	0.6438	0.6438	156	3	3	100%
Medium	A/R	0.0008	1904.7619	0.3076	0.5714	0.8149	1.6327	4.2710	5,427	115	19	17%

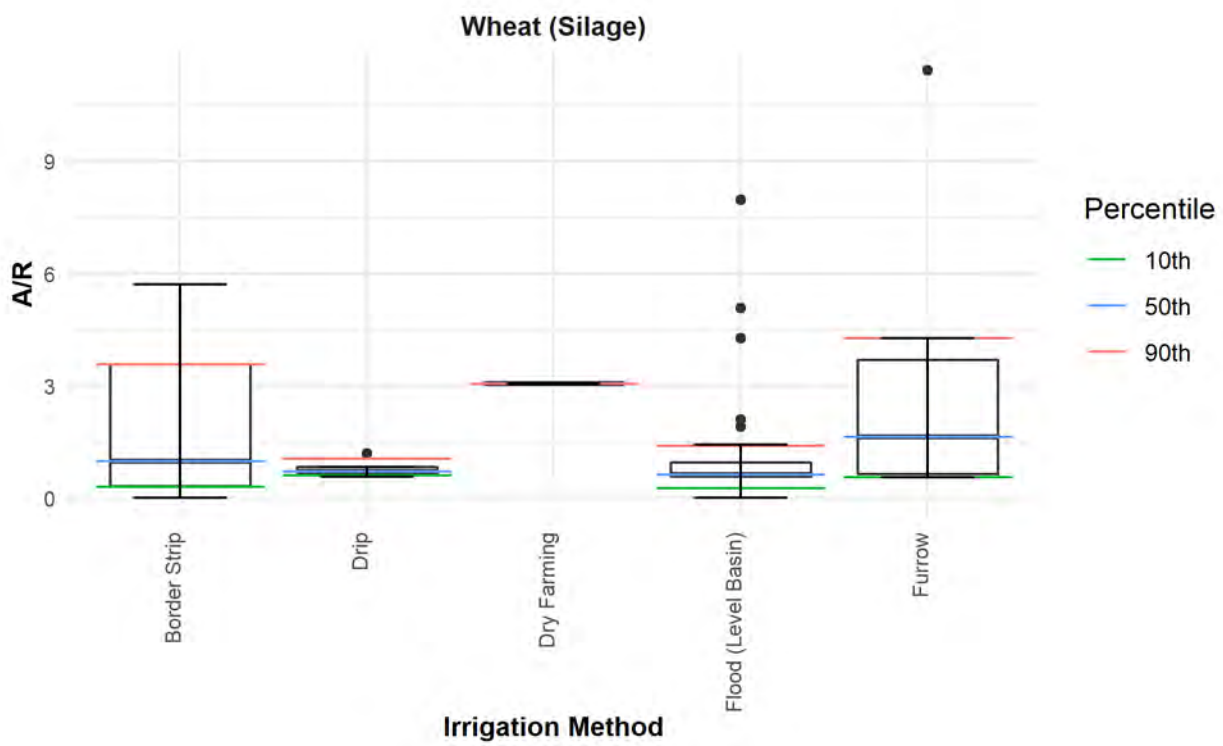

Figure 4-45. Box and Whisker Plots of A/R by Irrigation Practice for Wheat (Silage)

Table 4-43. A/R by Irrigation Practices for Wheat (Silage)

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	0.0048	5.7143	0.2956	0.3076	0.9800	3.5714	3.5714	860	13	0	0%
Drip	A/R	0.5714	1.1861	0.6143	0.6786	0.7143	0.8322	1.0445	397	4	1	25%
Dry Farming	A/R	3.0476	3.0476	3.0476	3.0476	3.0476	3.0476	3.0476	17	1	1	100%
Flood (Level Basin)	A/R	0.0008	1904.7619	0.2990	0.5714	0.6657	0.9524	4.2710	3,530	78	12	15%
Furrow	A/R	0.5505	11.4286	0.5598	0.6438	1.6327	3.6829	4.2710	779	22	1	5%
Micro Sprinkler	A/R	-	-	-	-	-	-	-	-	-	-	-
Spinkler	A/R	-	-	-	-	-	-	-	-	-	-	-

4.3.16 Tomatoes (Processing)

Tomatoes represents the sixteenth largest commodity reported in KRWQC, with 53 fields making up 4,949 acres (1%) of the coalitions total reported acreage. Of the total 53 fields, 30 were found to be adequate for analysis and are summarized in this report. The remaining fields were not included due to potentially erroneous, incorrect or incomplete data for reasons previously discussed.

Figure 4-46 compares the calculated A/R values from the reported A/Y values for wheat corresponding to township and range. The aggregate A/R ratios from the data set ranged from a minimum of 0.6740 to a maximum of 35 pounds of nitrogen applied over pounds of nitrogen removed (lbs N/lbs N) as shown in **Table 4-44** 43% of the filtered wheat A/R field values were identified as outliers. A/R ratios were also analyzed based on soil types in **Figure 4-47** and **Table 4-45** as well as irrigation practices in **Figure 4-48** and **Table 4-46.** Fine soil type was most commonly reported texture while flood irrigation was the primary reported irrigation practice for wheat.

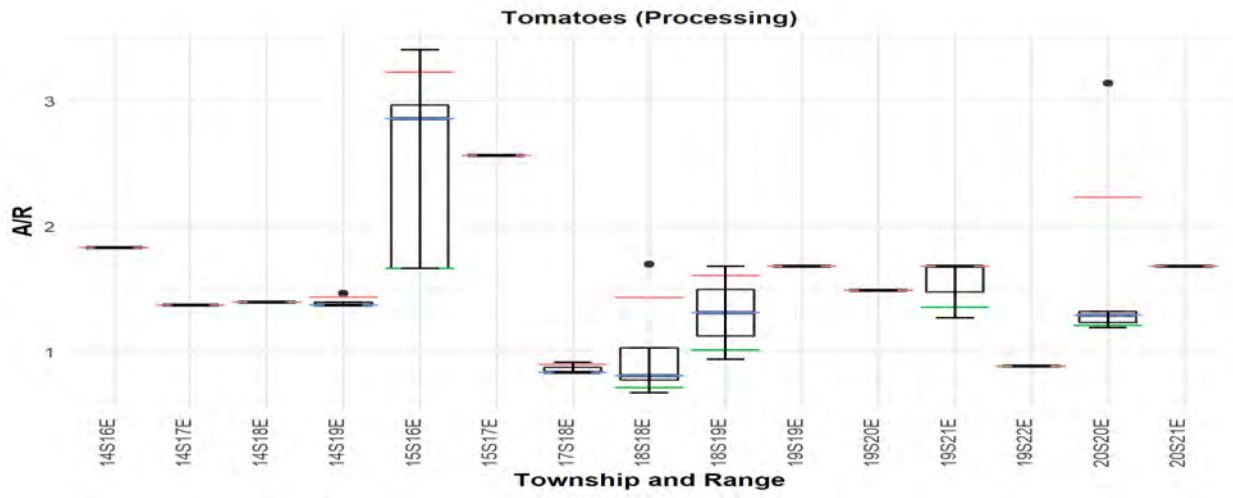

Figure 4-46. Box and Whisker Plots of A/R by Township and Range for Tomatoes (Processing)

Table 4-44. A/R by Township and Range for Tomatoes (Processing)

T-R	Parameter	Percentile Values							Sum Acres	# of Points	# outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
14S16E	A/R	1.8315	1.8315	1.8315	1.8315	1.8315	1.8315	1.8315	480	8	8	100%
14S17E	A/R	1.3736	1.3736	1.3736	1.3736	1.3736	1.3736	1.3736	140	1	1	100%
14S18E	A/R	1.3956	1.3956	1.3956	1.3956	1.3956	1.3956	1.3956	67	1	1	100%
14S19E	A/R	1.3736	1.4652	1.3736	1.3736	1.3736	1.3965	1.4377	297	4	1	25%
15S16E	A/R	1.6667	3.4066	1.6667	1.6667	2.8571	2.9670	3.2308	219	5	0	0%
15S17E	A/R	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	74	2	2	100%
15S22E	A/R	30.4762	30.4762	30.4762	30.4762	30.4762	30.4762	30.4762	26	1	1	100%
17S18E	A/R	0.8352	0.9158	0.8352	0.8352	0.8352	0.8755	0.8996	101	3	0	0%
17S22E	A/R	18.3150	18.3150	18.3150	18.3150	18.3150	18.3150	18.3150	133	1	1	100%
18S18E	A/R	0.6740	35.2527	0.7282	0.8095	0.8095	1.6996	21.8315	653	5	1	20%
18S19E	A/R	0.9414	1.6817	1.0154	1.1265	1.3115	1.4966	1.6077	374	2	0	0%
19S19E	A/R	1.6813	1.6817	1.6814	1.6815	1.6817	1.6817	1.6817	480	3	0	0%
19S20E	A/R	1.4897	1.4897	1.4897	1.4897	1.4897	1.4897	1.4897	314	2	2	100%
19S21E	A/R	1.2714	1.6835	1.3538	1.4775	1.6835	1.6835	1.6835	338	3	0	0%
19S22E	A/R	0.8839	0.8879	0.8843	0.8849	0.8859	0.8869	0.8875	206	2	0	0%
20S20E	A/R	1.1941	3.1418	1.2108	1.2356	1.2908	1.3216	2.2317	622	6	1	17%
20S21E	A/R	1.6835	1.6835	1.6835	1.6835	1.6835	1.6835	1.6835	425	4	4	100%
Tomatoes Coalition-Wide:	**A/R**	**0.6740**	**35.2527**	**4.1105**	**4.1306**	**4.2270**	**4.3023**	**5.5659**	**4,949**	**53**	**23**	**43%**

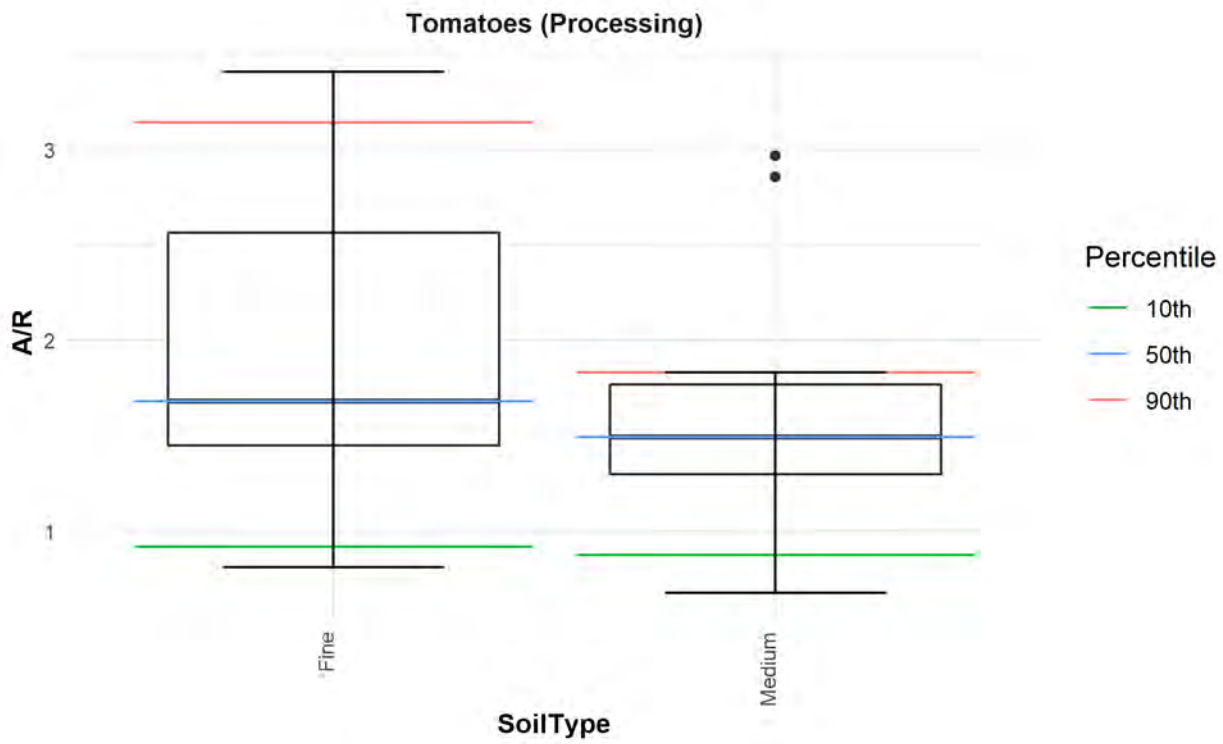

Figure 4-47. Box and Whisker Plots of A/R by Soil Types for Tomatoes (Processing)

Table 4-45. A/R by Soil Types for Tomatoes (Processing)

Soil Type	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Fine	A/R	0.8095	3.4066	0.9158	1.4471	1.6813	2.5641	3.1418	937	11	0	0%
Medium	A/R	0.6740	35.2527	0.8839	1.3216	1.6817	1.8315	1.8315	3,986	41	4	10%
Coarse	A/R	30.4762	30.4762	30.4762	30.4762	30.4762	30.4762	30.4762	26	1	1	100%

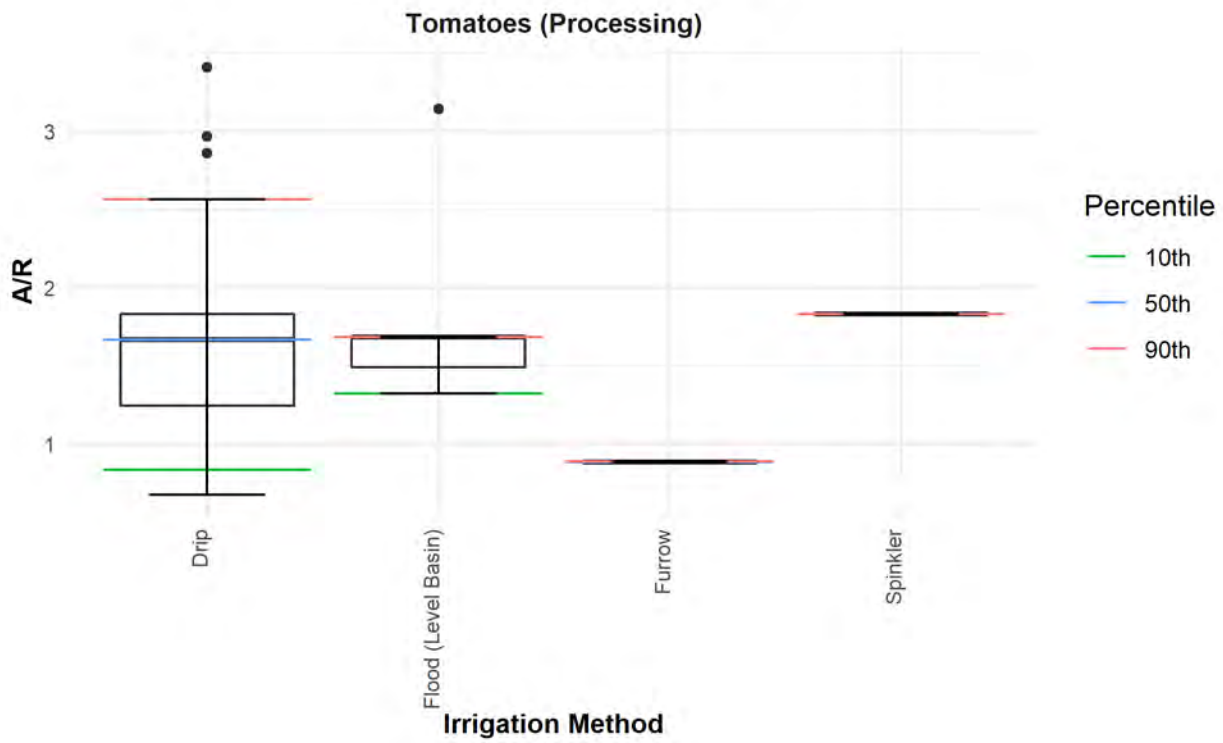

Figure 4-48. Box and Whisker Plots of A/R by Irrigation Practice for Tomatoes (Processing)

Table 4-46. A/R by Irrigation Practices for Tomatoes (Processing)

Irrigation Practice	Parameter	Percentile Values							Sum Acres	# of Points	# Outliers	% Outliers
		Min	Max	Lower	Q1	IQR	Q3	Upper				
				0.1	0.25	0.5	0.75	0.9				
Border Strip	A/R	-	-	-	-	-	-	-	-	-	-	-
Drip	A/R	0.6740	35.2527	0.8352	1.2601	1.6667	1.8315	2.9011	3,335	37	5	14%
Dry Farming	A/R	-	-	-	-	-	-	-	-	-	-	-
Flood (Level Basin)	A/R	1.3216	3.1418	1.3216	1.4897	1.6835	1.6835	1.6835	1,230	11	1	9%
Furrow	A/R	0.8839	30.4762	0.8847	0.8859	0.8879	15.6821	24.5585	232	3	0	0%
Micro Sprinkler	A/R	-	-	-	-	-	-	-	-	-	-	-
Spinkler	A/R	1.8315	1.8315	1.8315	1.8315	1.8315	1.8315	1.8315	152	2	2	100%

5 Farm Evaluation Summary

The data provided in Section 5 "Farm Evaluation Summary" was summarized, tabulated and analyzed by 4 Creeks Inc..

5.1 Required Grower Submittals

The General Order designates requirements for members of a third-party group, including submission of required reports and notices. Member required reports include Farm Evaluations, Sediment and Erosion Control Plans (**SECP**s), NMP Worksheets, and NMP Summary Reports. Note that the NMP Worksheet and the SECP are not submitted to coalitions.

On November 3, 2014, the EO issued a Farm Evaluation Template to be completed by members. These data allow coalitions to monitor farm-level and field-level management practices by members in high and low groundwater vulnerability areas. Information gathered reflects general farm practices, active irrigation and abandoned irrigation well information, as well as field-specific irrigation management, nutrient management, and sediment and erosion control practices. Implementation of management practices will be monitored over time to evaluate trends, as defined in the SSJV MPEP and the KRWQC CGQMP. Many of the management practices noted in the Farm Evaluation are protective of surface and/or groundwater quality.

Submission requirements and timelines are dependent on groundwater vulnerability, surface water vulnerability, and farm size designations. The KRWQC GAR was submitted on November 20, 2014 and included evaluation of high and low vulnerability areas. This GAR was amended with updated High Vulnerability Areas on February 25, 2015. See **Figure 3-2** for the KRWQC GAR designated HVAs. Growers were informed of their vulnerability designation, farm size classification, and the required reporting schedules.

5.1.1 Schedule of Grower Submittals

Farm Evaluations for the 2018 Crop/Harvest Year were due by March 1, 2019, for all members with enrolled parcels within HVAs. The 2018 Crop/Harvest Year provided information on management practices for crops harvested between January 1 and December 31, 2018. For members of the KRWQC, March 1, 2019 was the third-year submittal of the Farm Evaluation Survey and was required for all members located within the High Vulnerability areas.

The Farm Evaluation Survey template includes four sections (Part A, B, C, and E) for the members to complete and submit to the Coalition, along with the preparation of a farm map (Part D) to identify the locations of specific items within the member's farm. Each section of the Farm Evaluation Survey template is specifically identified as:

- Part A: General Farm Practices
- Part B: Irrigation Well Information
- Part C: Field Specific Information
- Part D: Farm Map (kept on-farm)
- Part E: Sediment and Erosion Control Practices

The Coalition is required to submit a report summarizing the information provided by the Farm Evaluation Surveys within the Annual Report each year, due August 31 along with the individual data recorded in an electronic format by Township. The members and parcels are not to be identified. The Annual Report period covers data collected from the previous calendar year, defined as 01 January through 31 December. The Farm Evaluation Surveys are required to be submitted by each member on or before March 1 each year covering data of the prior crop year. The Farm Evaluation Survey data provides a summary of the management practices of the previous crop year.

5.2 Farm Evaluation Outreach & Submission Process

This being the third year for reporting Farm Evaluation Survey data to the Coalition, several separate outreach meetings were provided by the Coalition for the members. Following are the actions completed by the Coalition to assist members in completing and submitting their Farm Evaluation Surveys:

- Workshops were conducted to specifically assist the members in the preparation of the Farm Evaluation Survey. Members were provided a copy of the Farm Evaluation Survey Template, and staff answered questions of members on the following dates: 12/4/18, 12/13/18, 12/19/18, 1/9/19, 1/15/19, 1/24/19, 1/29/19, and 1/30/19;
- Updated the online tool for members to complete their Farm Evaluation Survey through the Coalition website, including training videos;
- Contacted members by phone and email for follow up when Farm Evaluation Surveys submitted that had missing or erroneous information, and contacted those members that did not respond;
- Hosted weekly staff time at the Coalition Office for assistance to members for preparation and completion of the Farm Evaluation Survey.

5.2.1 Submission Statistics

Based upon the 2018 membership of the Kings River Water Quality Coalition, 97% of the Coalition members submitted a Farm Evaluation Survey.

5.3 Farm Evaluation Approach

Growers completed parts A, B, C, D, and E of the Farm Evaluation. Parts A and B are related to farm-level practices, whereas parts C and E are related to field-level practices. Growers were not required to submit a farm map, Part D, but were required to confirm that they maintain a farm map onsite.

Once the Coalition received the Farm Evaluation Surveys, concerted efforts were made to audit the data and input the data into a common database for use in compiling and organizing the data submitted. During this data entry and audit process, the following items were identified that were not fully accurate or complete:

- Surveys were submitted to the Coalition without all questions completed
- Some parcels were duplicated for different management practices, making it difficult to understand if the parcel had multiple management practices or if the parcel was erroneously entered twice
- Some parcels of the member were omitted from the Farm Evaluation Survey

- Some of the Farm Evaluation Surveys manually submitted had illegible handwriting
- Acreage is greater than the Member Reported Irrigated acreage due to double cropping, cover crops, or changes in cropping patterns during the period covered by the Farm Evaluation Survey. In this scenario, the total farmed acres reported by the member within a parcel was greater than the actual parcel acreage
- Members may have dropped and/or added to their Membership after submitting their Farm Evaluation. Only the data from those members in good standing that submitted a Farm Evaluation Survey to the Coalition are included in the summary report
- Parcel data was updated by the County during the period of collecting the farm evaluation surveys. Some parcels were adjusted or removed by the County, leaving some member parcels identified in the FES without valid Parcel Data. Efforts to merge the old parcel data to the new parcel data were conducted, but minor variations in parcel acreage remained.

When any of these data entry issues were identified, efforts were made by the Coalition to contact the member to update the erroneous or missing data.

5.4 Farm Evaluation Survey Summary

The following tabulations and figures provide a summary of the data obtained from the submittal of the 2018 Farm Evaluation Surveys to the Coalition.

5.4.1 Part A: General Farm Practices

5.4.1.1 Pesticide Application Practices

Members identified each of the pesticide application practices generally utilized throughout their farm from the list included within the Farm Evaluation Survey Template (note that members checked all that applied to their farm). Of the submitted responses, 98.73% of the members responded to at least one pesticide application practice, 85.96% responded to more than one pesticide application practice, and 80.58% responded to five or more pesticide application practices. A tabulation of the Pesticide Application Practices utilized within the KRWQC members during 2018 are identified in **Table 5-1**.

A graphical representation of the Pesticide Application Practices used during 2018 within the KRWQC are identified in **Figure 5-1**.

5.4.1.2 Nutrient Management Plan Preparation Assistance

Members identified those person(s) that assisted in the preparation of the Nutrient Management Plan (NMP) for their farm from the list included within the Farm Evaluation Survey Template (*note that members checked all that applied to their farm*). Of the submitted responses, 95.89% of the members responded that at least one party was used for assistance in preparation of the NMP, 47.82% responded that more than one party was utilized for preparation of the NMP, and 18.25% responded to three or more parties were utilized in preparation of the NMP. A tabulation of the type of NMP preparation assistance, if any, used by members in the KRWQC are set forth within **Table 5-2**.

Table 5-1. 2018 Pesticide Application Practices

Total FES Submitted	County Permit Followed	Follow Label	Sensitive Areas Mapped	Attend Trainings	End of Row Shutoff	Avoid Surface Water	Reapply Rinsate	Target Sensing Sprayer	Use Drift Control Agents	Monitor Wind Conditions	Use Buffer Zones	Use Vegetated Ditches	Monitor Rain Forecast	Use PCA Recommendations	Chemigation	No Pesticides Applied	Other
4,462	3,886	3,781	1,779	3,226	3,478	3,289	1,923	460	**2,509**	3,581	2,790	241	3,272	3,466	1,105	564	235
% Members	87.1%	84.7%	39.9%	72.3%	77.9%	73.7%	43.1%	10.3%	56.2%	80.3%	62.5%	5.4%	73.3%	77.7%	24.8%	12.6%	5.3%

Figure 5-1. KRWQC 2018 Pesticide Application Practices

Table 5-2. 2018 NMP Preparation Assistance

	Total Members	Certified Crop Advisor	Pest Control Advisor	Certified Technical Service Provider	Professional Soil Scientist	Professional Agronomist	Self-Certified	UCCE	None of the Above
Members	**4,462**	1,821	2,993	102	522	618	979	186	617
% of total Members	-	40.8%	67.1%	2.3%	11.7%	13.9%	21.9%	4.2%	13.8%

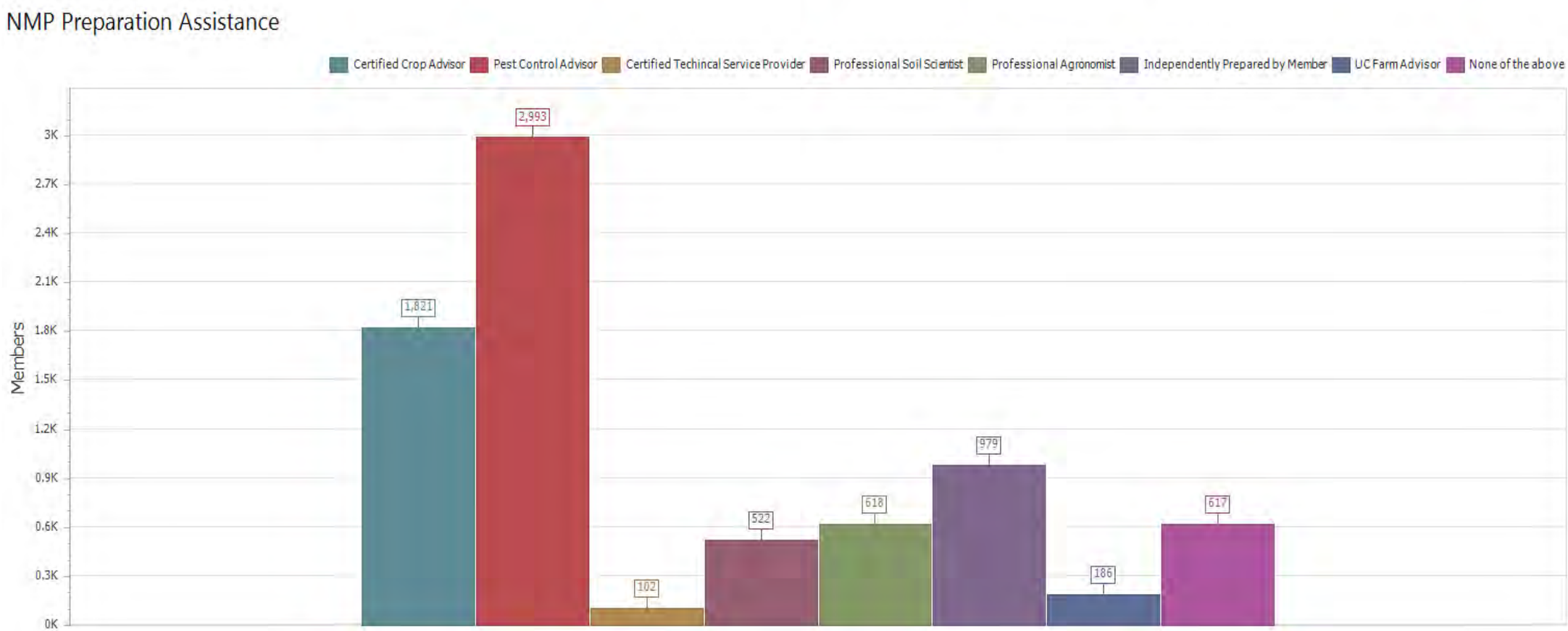

Figure 5-2. 2018 NMP Preparation Assistance

5.4.1.3 Discharge of Sediment to Off-Farm Surface Water

Members responded as to whether their farm has the potential to discharge sediment to an off-farm surface water. Of those 4,462 members that submitted a 2018 Farm Evaluation Survey, 4,148 members responded no, and 110 members responded yes.

5.4.2 Part B: Irrigation Well Information

Members identified active irrigation wells, abandoned irrigation wells, and observation/monitoring wells located on their farm. In total, 15,121 wells were identified, of which 14,704 wells are active irrigation wells, 380 are abandoned or destroyed wells, and 37 are monitoring wells.

For the active irrigation wells, the member identified any wellhead protection measures in place. The wellhead protection measures (*of which the member identified all protection measures that apply to each well*) utilized by members within the KRWQC are set forth in **Figure 5-3**.

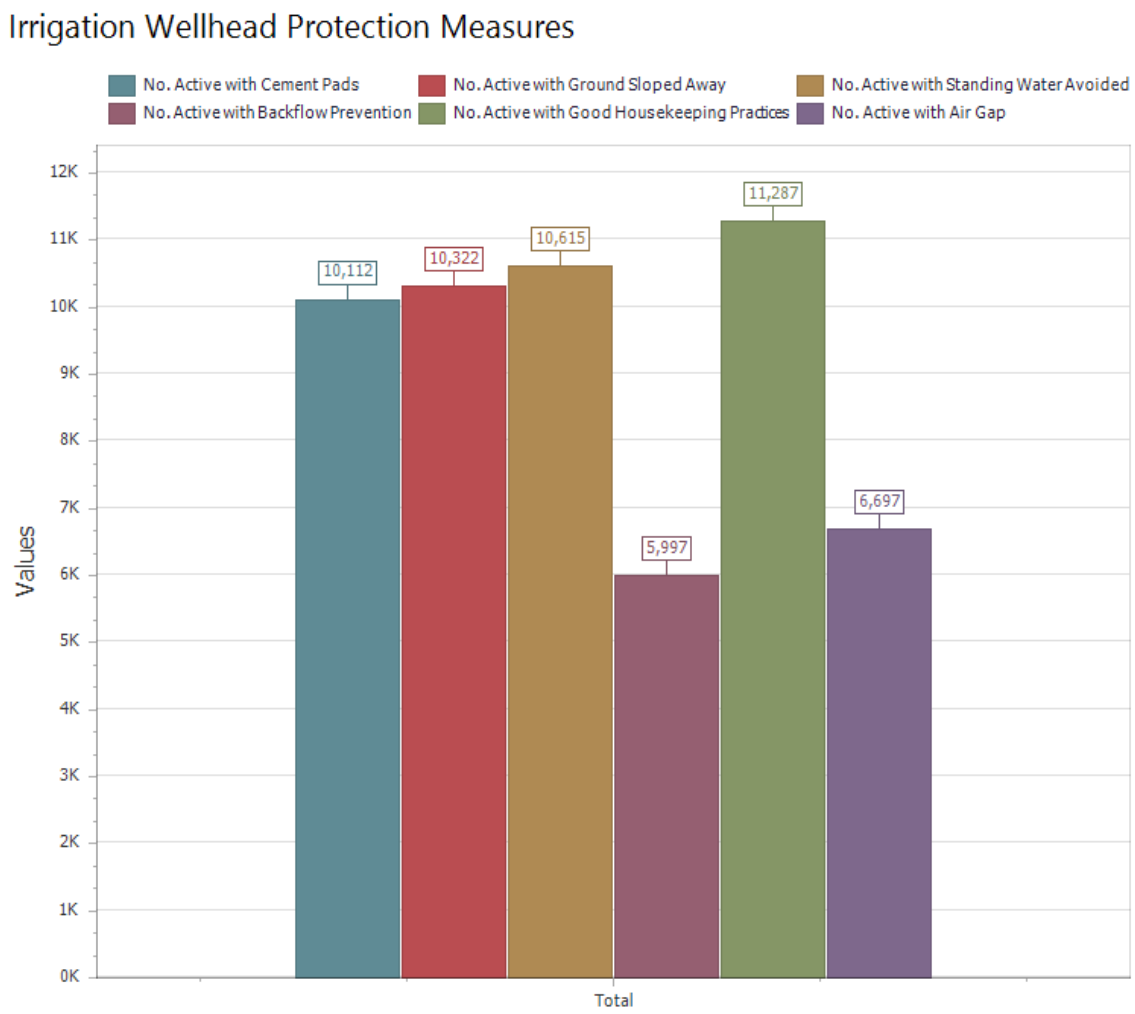

Figure 5-3. Irrigation Wellhead Protection Measures

For the 380 abandoned wells, the members within the KRWQC identified the method for which the well was destroyed as set forth in **Figure 5-4**. Wells destroyed with an unknown method may have been destroyed prior to owner management of the lands.

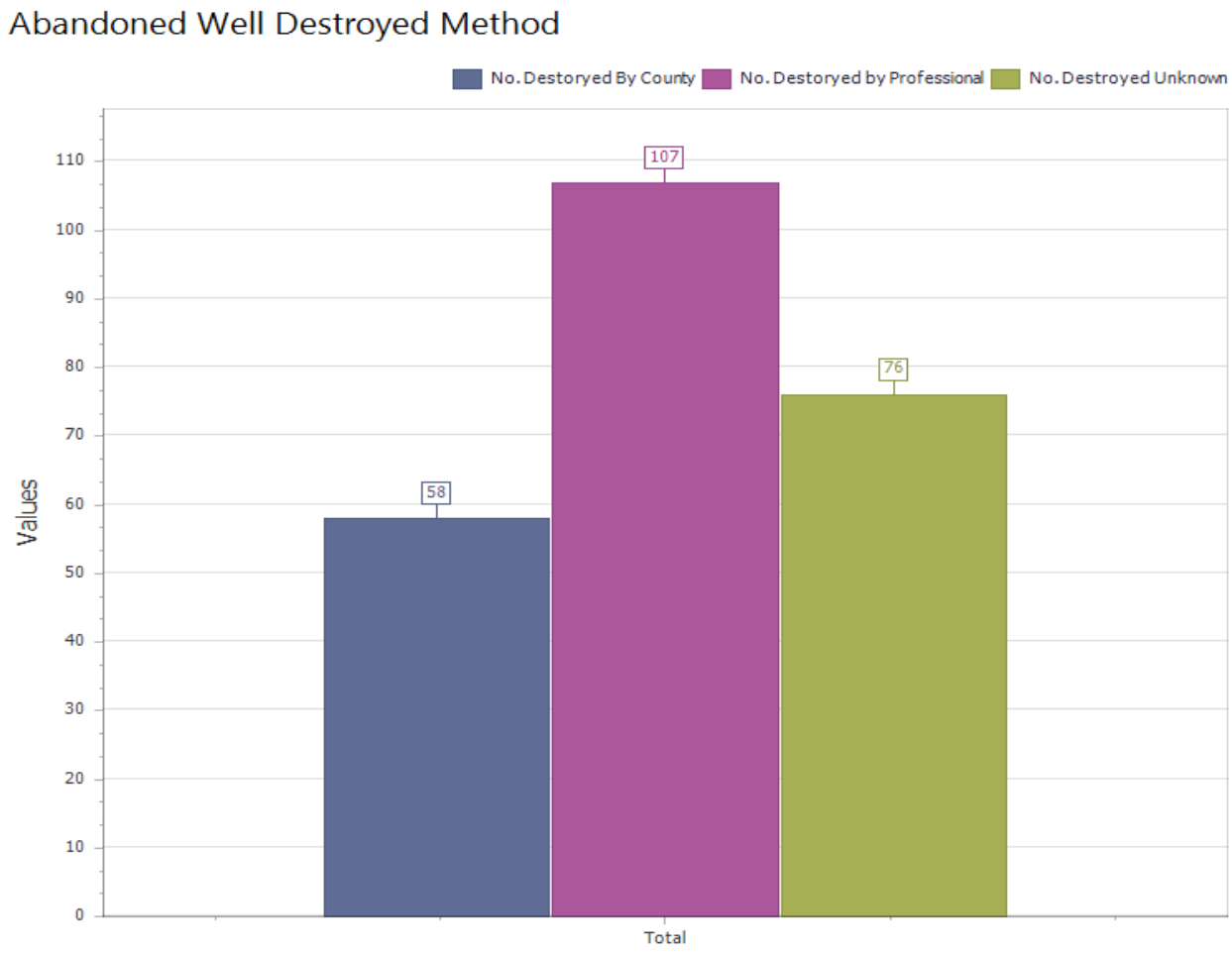

Figure 5-4. Abandoned Well-Destroyed Method

Those members who identified a destroyed well were cross checked with county records and verified as properly destroyed. Those members who did not identify a well destruction method will be contacted by the coalition to ensure proper destruction methods and groundwater projection measures were undertaken.

5.4.3 Part C: Field Specific Evaluation

5.4.3.1 Crop Types

The crop types submitted by the members within the KRWQC were categorized into one of the following agriculture classes, defined by the California Department of Water Resources, as set forth in **Table 5-3**.

Table 5-3. Agriculture Classes

G - GRAIN AND HAY CROPS				
	1	Barley	6	Miscellaneous grain and hay
	2	Wheat	7	Mixed grain and hay
	3	Oats		
F - FIELD CROPS				
	1	Cotton	9	Castor beans
	2	Safflower	10	Beans (dry)
	3	Flax	11	Miscellaneous field
	4	Hops	12	Sunflowers
	5	Sugar Beets	13	Hybrid sorghum / Sudan
	6	Corn (field & sweet)	14	Millet
	7	Grain sorghum	15	Sugar cane
	8	Sudan		
P - PASTURE				
	1	Alfalfa & alfalfa mixtures	6	Miscellaneous grasses
	2	Clover	7	Turf farms
	3	Mixed Pasture	8	Bermuda grass
	4	Native Pasture	9	Rye grass
	5	Induced high water table	10	Klein grass native pasture
T - TRUCK, NURSERY AND BERRY CROPS				
	1	Artichokes	15	Tomatoes (processing)
	2	Asparagus	16	Flowers, nursery & Christmas tree farms
	3	Beans (green)	17	Mixed (four or more)
	4	Cole crops (mixture of 22-25)	18	Miscellaneous truck
	5	Carrots	19	Bush berries
	6	Celery	20	Strawberries
	7	Lettuce (all types)	21	Peppers (chili, bell, etc.)
	8	Melons, squash, and	22	Broccoli
	9	cucumbers (all types)	23	Cabbage
	10	Onions and garlic	24	Cauliflower
	11	Peas	25	Brussels sprouts
	12	Potatoes	26	Tomatoes (market)
	13	Sweet Potatoes	27	Greenhouse
	14	Spinach		
D - DECIDUOUS FRUITS AND NUTS				
	1	Apples	8	Figs
	2	Apricots	9	Miscellaneous deciduous
	3	Cherries	10	Mixed deciduous
	4	Peaches and Nectarines	11	Almonds
	5	Pears	12	Walnuts
	6	Plums	13	Pistachios
	7	Prunes		
C - CITRUS AND SUBTROPICAL				
	1	Grapefruit	7	Miscellaneous subtropical fruits
	2	Lemons	8	Kiwis
	3	Oranges	9	Jojoba
	4	Dates	10	Eucalyptus
	5	Avocados	11	Mixed subtropical fruits
	6	Olives		
V - VINEYARDS				
	1	Table Grapes	3	Raisin Grapes
	2	Wine Grapes		
I - IDLE				
	1	Land not cropped the current or previous crop season, but cropped within the past three years		
	2	New lands being prepared for crop production.		

A tabulation of the Agriculture Class, number of parcels and irrigated acres reported by the Coalition Members within the KRWQC are set forth in **Table 5-4**.

Table 5-4. KRWQC 2018 Agriculture Classes

Agricultural Class	Number of Parcels	Irrigated Acres	Percentage of Acres
Field Crops	1,519	280,595	28.4%
Vineyards	4,016	134,122	13.6%
Citrus and Subtropical	3,015	72,784	7.4%
Grain and Hay Crops	493	30,558	3.1%
Idle	897	37,493	3.8%
Deciduous Fruits and Nuts	8,972	298,713	30.2%
Truck, Nursery and Berry Crops	779	100,639	10.2%
Pasture	688	34,086	3.4%
Total:	**20,379**	**988,989**	**100%**

A graphical representation of the Agricultural Class by percent of total acreage in the KRWQC are provided in **Figure 5-5**.

5.4.3.2 Irrigation Management Practices

Irrigation practices are surveyed in part C, questions 2 and 3 of the Farm Evaluation. Members are required to report primary irrigation systems, secondary irrigation systems, and irrigation efficiency practices.

The primary irrigation practices on the 2018 Crop/Harvest Year Farm Evaluations are presented in **Figure 5-6**. A total of 36.75% of total reported areas use drip irrigation, with the next largest proportion using border strip irrigation systems (23.17% of total reported acres). Altogether KRWQC has reported 49.03% of field acres employing surface irrigation, including border strip, furrow, and level basin flood irrigation systems. Pressurized irrigation systems (drip, micro-spray, and sprinkler systems) were reported on 47.23% of field acres. The remaining 3.74% of total reported acreage reported use of dry farming techniques or recorded the field as fallow.

A tabulation of 2018 Irrigation Management Practices is identified in **Table 5-9**.

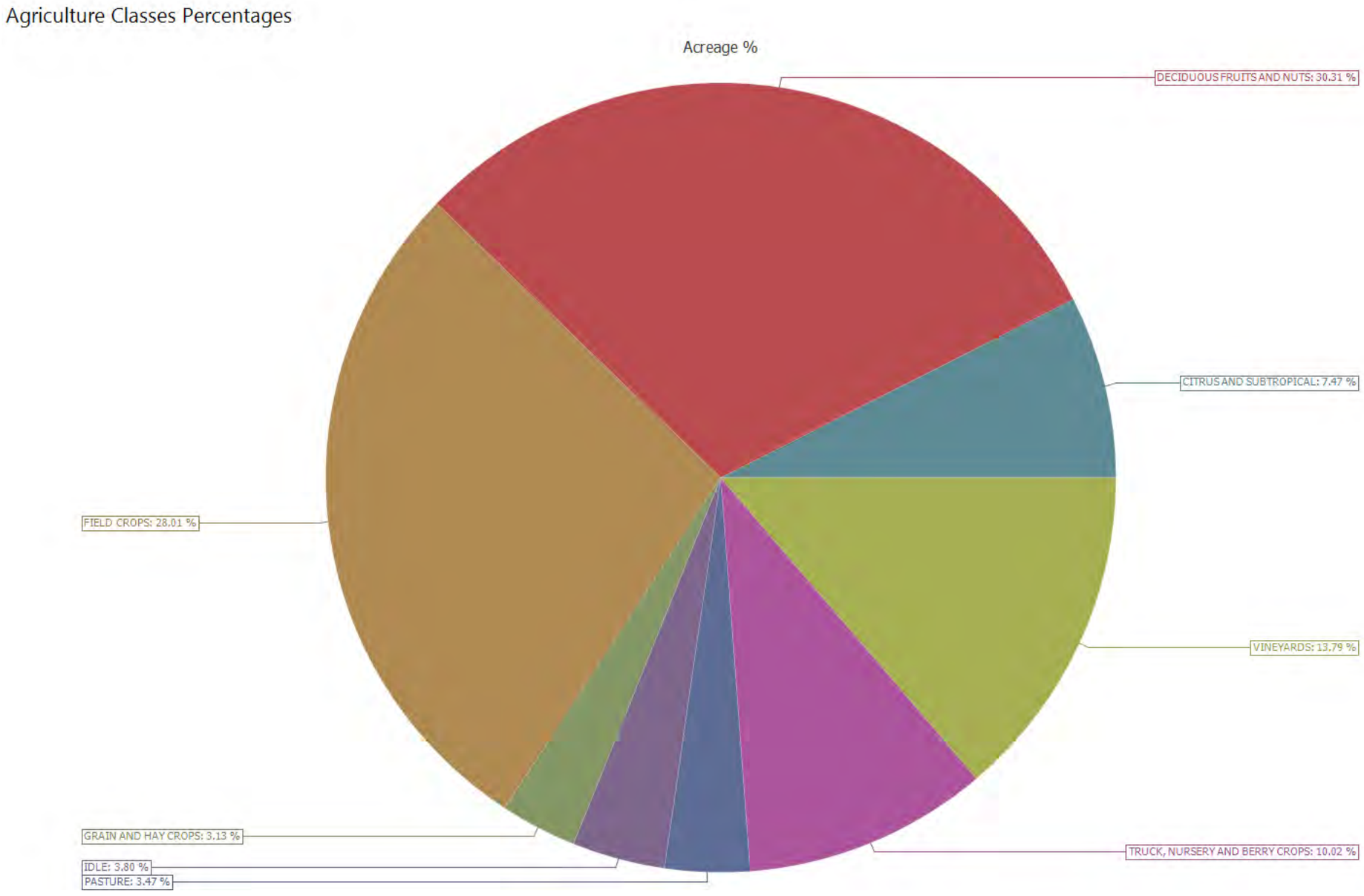

Figure 5-5. KRWQC Agricultural Classes Percentages

Table 5-5. 2018 Primary Irrigation Management Practices

Irrigation Management Practice	Agriculture Class (acres)									Grand Total	% of Total Acres
	Citrus & Subtropical	Deciduous Fruit & Nuts	Field Crops	Grain & Hay Crops	Idle	Pasture	Rice	Truck, Nursery & Berry Crops	Vines		
Border Strip	29	5,892	215,007	3,597	580	8,289	-	957	638.5	234,989	23.17%
Drip	17,665	160,264	9,236	1,033	986.12	1,446	-	94,023	88,127	372,781	36.75%
Dry Farming	-	50	379	746	89.94	705.27	-	-	-	1,970	0.19%
Fallow	22	218	4	15	35,572	199	-	-	16	36,046	3.55%
Flood (Level Basin)	487.15	40,652	37,458	22,157	176.5	17,995		1759	10,688	131,372	12.95%
Furrow	5,373	53,884	20,587	3,948	358.78	5,504	4	2,732	38,513	130,904	12.91%
Micro Sprinkler	51,350	44,916	86.75	15	213.5	-	-	74	1,727	98,382	9.70%
Sprinkler	832.34	1,727	1,445	274.5	393	1035	-	2098	76	7,881	0.78%
Grand Total:	**75,758**	**307,605**	**284,202**	**31,786**	**38,370**	**35,173**	**4**	**101,643**	**139,785**	**1,014,326**	**100.00%**

*Acreage is greater than the Member Reported Irrigated acreage due to double cropping, cover crops, or changes in cropping patterns during the period covered by the Farm Evaluation Survey. In this scenario, the total farmed acres reported by the member within a parcel was greater than the actual parcel acreage.

A graphical representation of the 2018 Primary Irrigation Practices used within the KRWQC are provided in **Figure 5-6**.

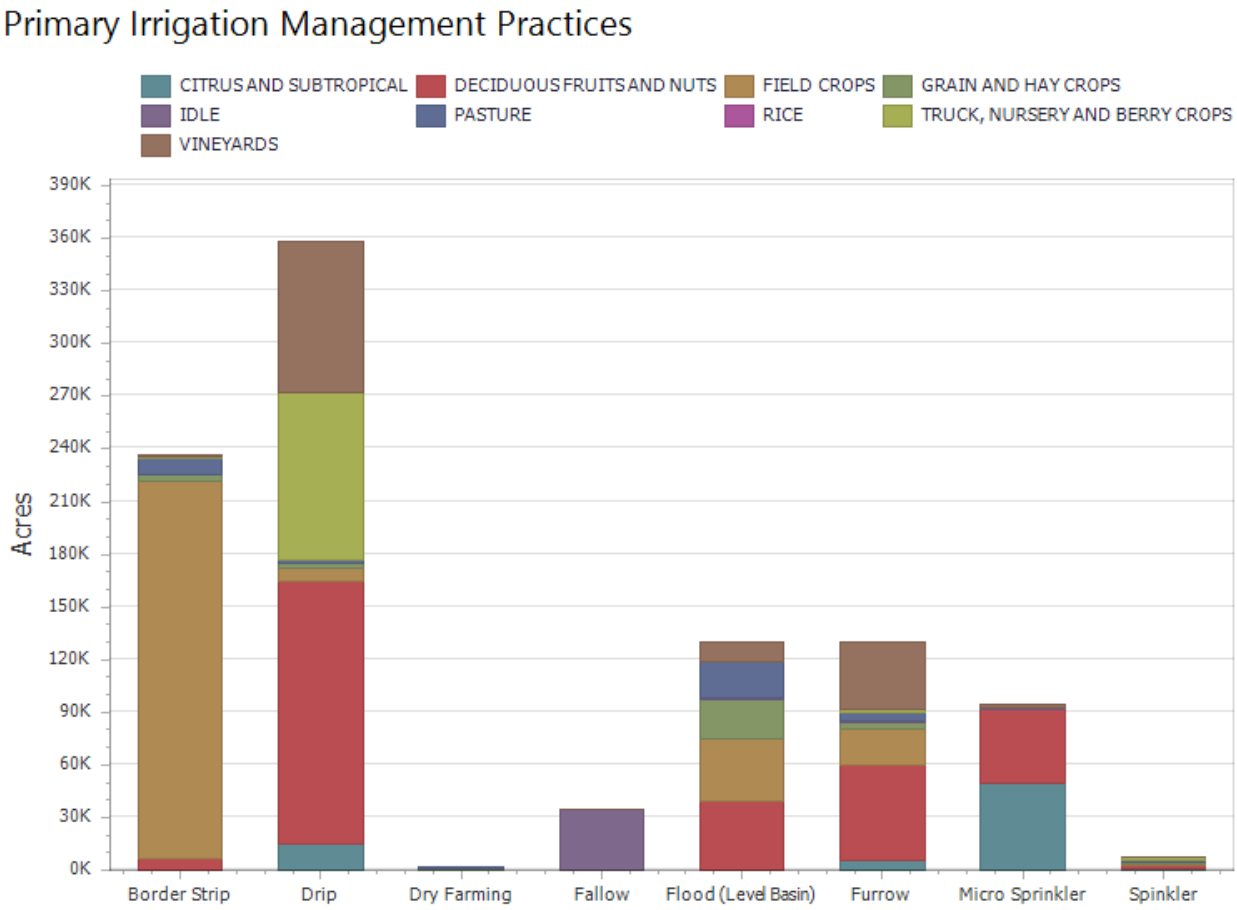

Figure 5-6. 2018 Primary Irrigation Management Practices

A tabulation of the 2018 Secondary Irrigation Management Practices used within the KRWQC are identified in **Table 5-9**.

Table 5-6. 2018 Secondary Irrigation Practices

Irrigation Practice	Agriculture Class (acres)									Grand Total	% of Total Acres
	CITRUS AND SUBTROPICAL	DECIDUOUS FRUITS AND NUTS	FIELD CROPS	GRAIN AND HAY CROPS	IDLE	PASTURE	RICE	TRUCK, NURSERY AND BERRY CROPS	VINEYARDS		
Border Strip	160	4,369	3,731	1,295	195	1,337		690	567.17	12,343	1.22%
Drip	1,385	14,159	610	75	126	285		998	5,408	23,047	2.27%
Flood (Level Basin)	914.5	40,368	4,753	1,978	604	1,834		2694.5	12,742	65,888	6.50%
Furrow	3,641	21,629	3,015	2,173	411	1,350		1,238	25,308	58,765	5.79%
Micro Sprinkler	9,286	33,317	717	472.46	171	78.04		422	5,750	50,213	4.95%
None	60,075	192,284	132,596	25,076	36,771	25,215	4	92,474	89,301	653,795	64.46%
Sprinkler	296.4	1,479	138,781	717	92	5075		3125.7	709	150,275	14.82%
Grand Total	**75,758**	**307,605**	**284,202**	**31,786**	**38,370**	**35,173**	**4**	**101,643**	**139,785**	**1,014,326**	**100.00%**

*Acreage is greater than the Member Reported Irrigated acreage due to double cropping, cover crops, or changes in cropping patterns during the period covered by the Farm Evaluation Survey. In this scenario, the total farmed acres reported by the member within a parcel was greater than the actual parcel acreage.

A graphical representation of the 2018 Secondary Irrigation Management Practices used within the KRWQC are identified in **Figure 5-7**.

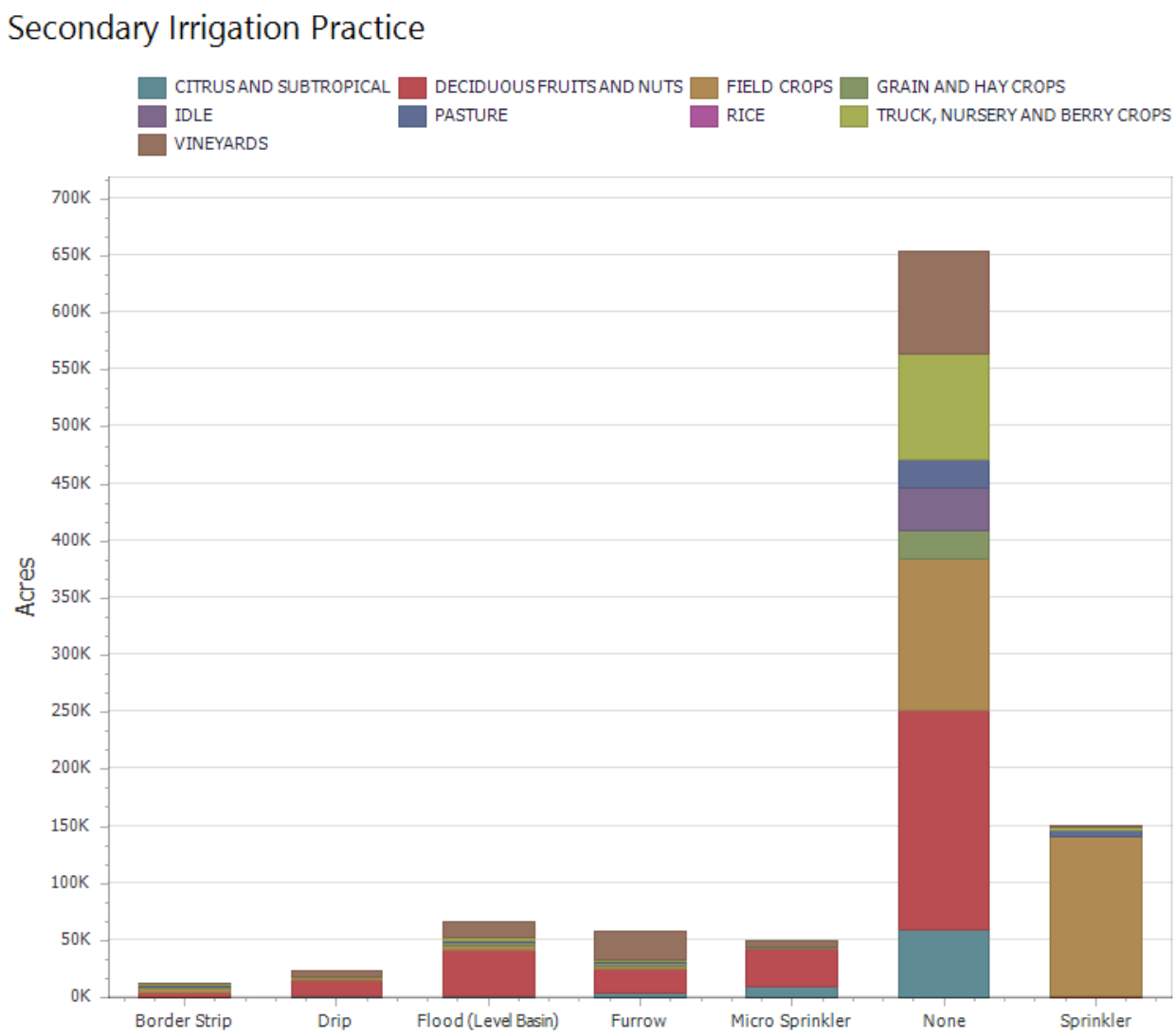

Figure 5-7. 2018 Secondary Irrigation Management Practices

5.4.4 Irrigation Efficiency Practices

Members identified the Irrigation Efficiency Practices associated with each field on their farm. A summary of the irrigation efficiency practices by acres (*of which the member identified all protection measures that apply to each management practice*) as utilized within the KRWQC are summarized in **Table 5-7**. Irrigation Efficiency Practices include practices to increase irrigation distribution uniformity (e.g. laser leveling) and a variety of practices to more precisely match applications to water requirements. The largest proportion of acreage reported that water application is "always scheduled to need" (922,602 field acres, 93.3%) or laser leveling is used (704,349, 71.2%). Some acreage reported utilizing evapotranspiration (ET) (55.0%) and/or soil moisture probe (51.1%)

data to schedule irrigations (**Figure 5-8**). A graphical representation of the 2018 Irrigation Efficiency Practices as utilized within the KRWQC are set forth in **Figure 5-8**.

Table 5-7. 2018 Irrigation Efficiency Practices

Total Reported Acres	Laser Leveling	ET in Irrigations	Water Application Scheduled	Soil Moisture Probe	Soil Moisture Neutron Probe	Pressure Bomb	Other
988,989	704,349	544,190	922,602	505,491	73,770	211,624	54,869
% of Total Acres	71.2%	55.0%	93.3%	51.1%	7.5%	21.4%	5.5%

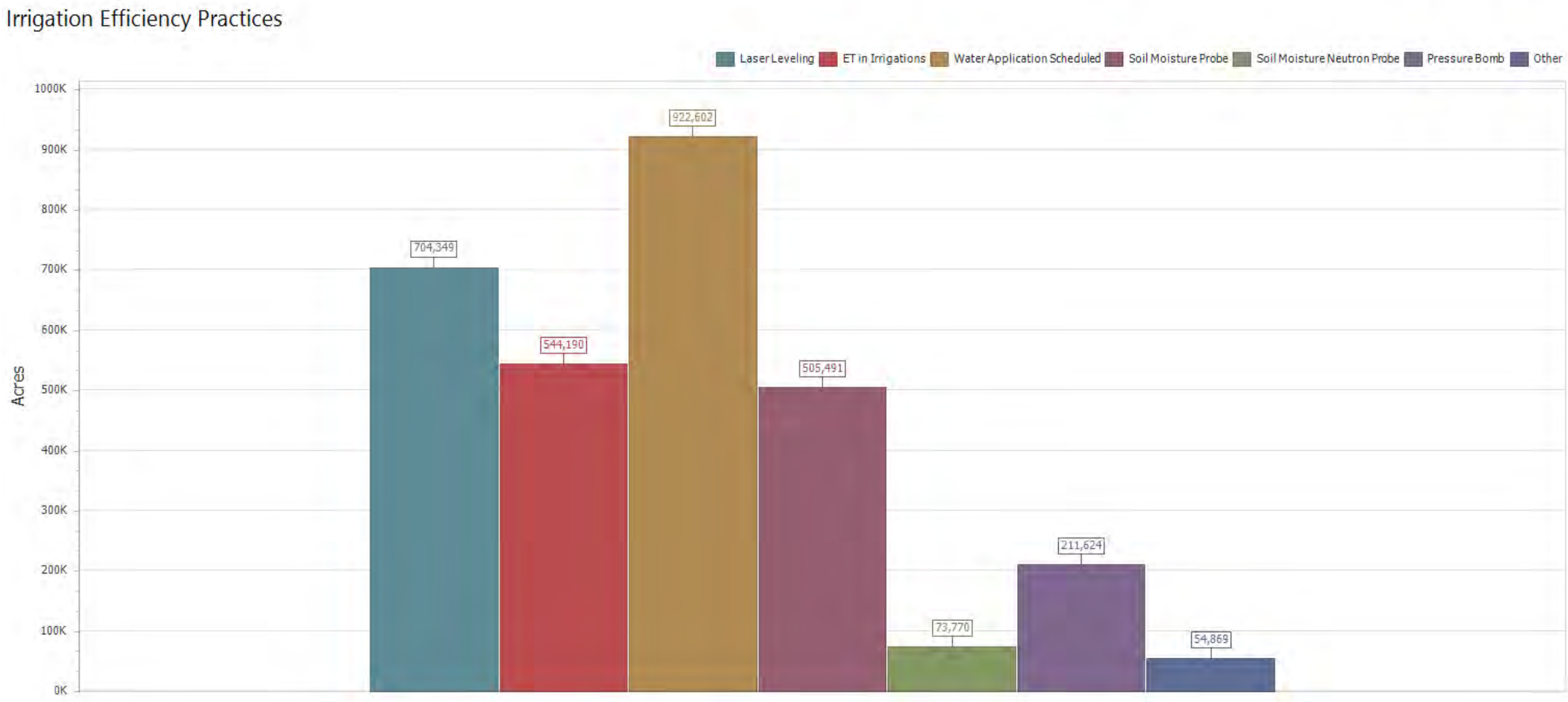

Figure 5-8. 2018 Irrigation Efficiency Practices

5.4.5 Nitrogen Management Methods to Minimize Leaching

Members reported field-level nitrogen management methods to minimize leaching past the root zone in question 4 of part C. A graphical representation of the 2018 Nitrogen Management Methods utilized in the KRWQC are identified in **Figure 5-9**.

Three practices were implemented on over 72% of reported acreage (**Table 5-8**). These practices, in order of reported acreage, include:

- Soil Testing (837,256 field acres, 84.7%);
- Split Fertilizer Applications (732,589 field acres, 74.1%);
- Tissue/Petiole Testing (715,553 field acres, 72.4%).

Table 5-8. 2018 Nitrogen Management Methods

Total FES Acres	Cover Crops	Split Fertilizer Applications	Soil Testing	Tissue, Petiole Testing	Variable Rate Application	Foliar N	Irrigation Water Testing	Fertigation	Other	Do Not Apply Nitrogen
988,989	277,711	732,589	837,256	715,553	318,720	613,257	686,501	638,652	31,827	39,139
% Total	28.1%	74.1%	84.7%	72.4%	32.2%	62.0%	69.4%	64.6%	3.2%	4.0%

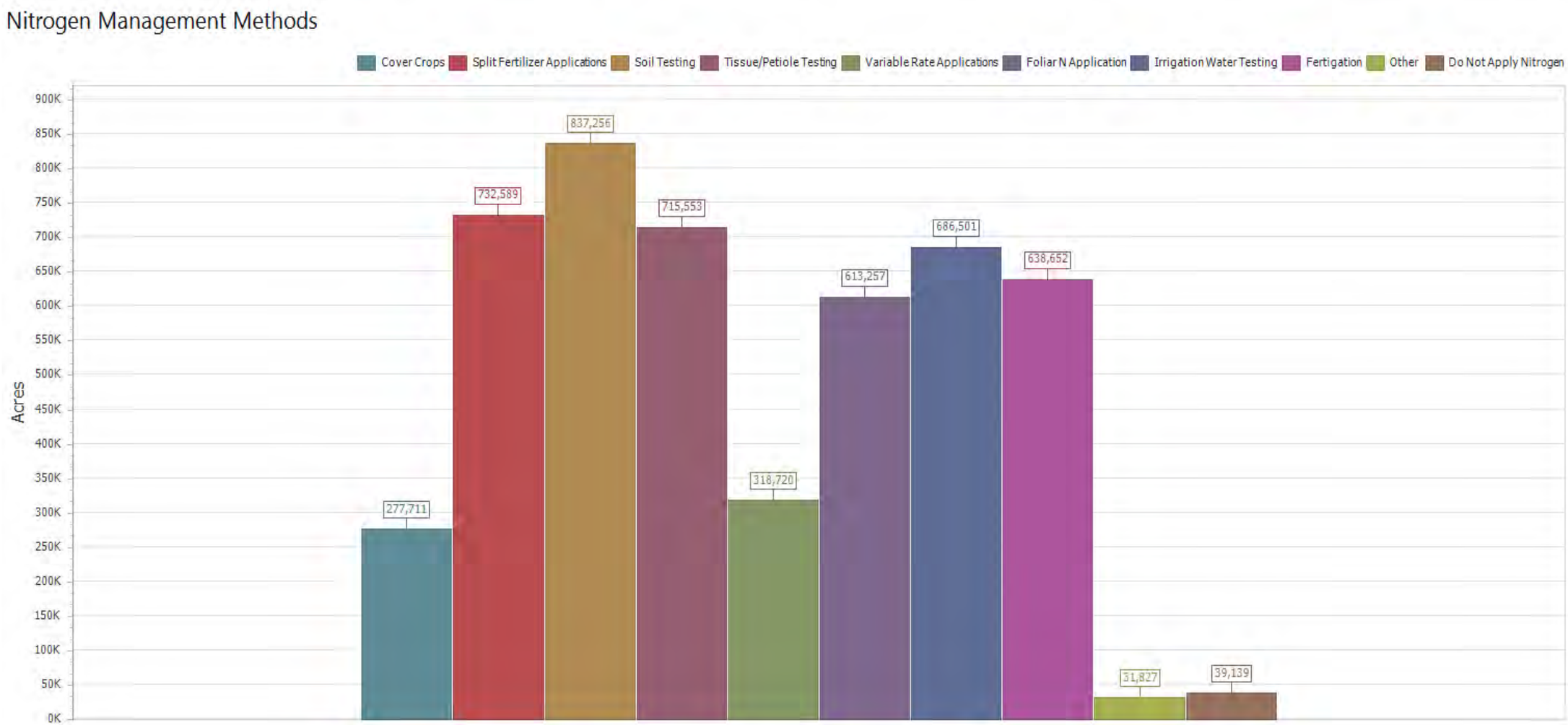

Figure 5-9. Nitrogen Management Methods

5.5 Sediment and Erosion Control Practices

On Part E of the Farm Evaluation, KRWQC members provided responses for field-level practices to manage sediment and erosion, including irrigation practices (question 2) and cultural practices (question 3).

Seventy-nine percent of field acres reported no irrigation runoff. The irrigation practices to manage sediment and erosion with the most significant field acreage reported include the use of drip/micro irrigation (33.7%) and maximizing the time between pesticide applications and the next irrigation set (25.7%). The percentage of total field acreage reported for each irrigation practice is provided in **Figure 5-10** and **Table 5-9**.

Seventy-seven percent of field acres reported no storm drainage due to field or soil conditions. The cultural practices with the largest reported implementation by acreage are an increase in soil water penetration (35.5%) followed by minimum tillage (28.3%). Cultural practices are presented in **Figure 5-11** and **Table 5-10**.

Table 5-9. 2018 Irrigation Practices for Managing Sediment and Erosion

Total FES Acres	No Irrigation Drainage	In-Furrow Dams	Time Between Pesticide and Irrigation	Shorter Irrigation Runs	PAM in Furrow	Drip or Micro Irrigation	Flow Dissipaters	Tailwater Return System	Catchment Basin	Other
988,989	785,765	74,765	254,638	148,098	3,241	332,963	25,866	49,112	23,143	27,435
% of Total Acres	79.5	7.5	25.7	15.0	0.3	33.7	2.6	5.0	2.3	2.8

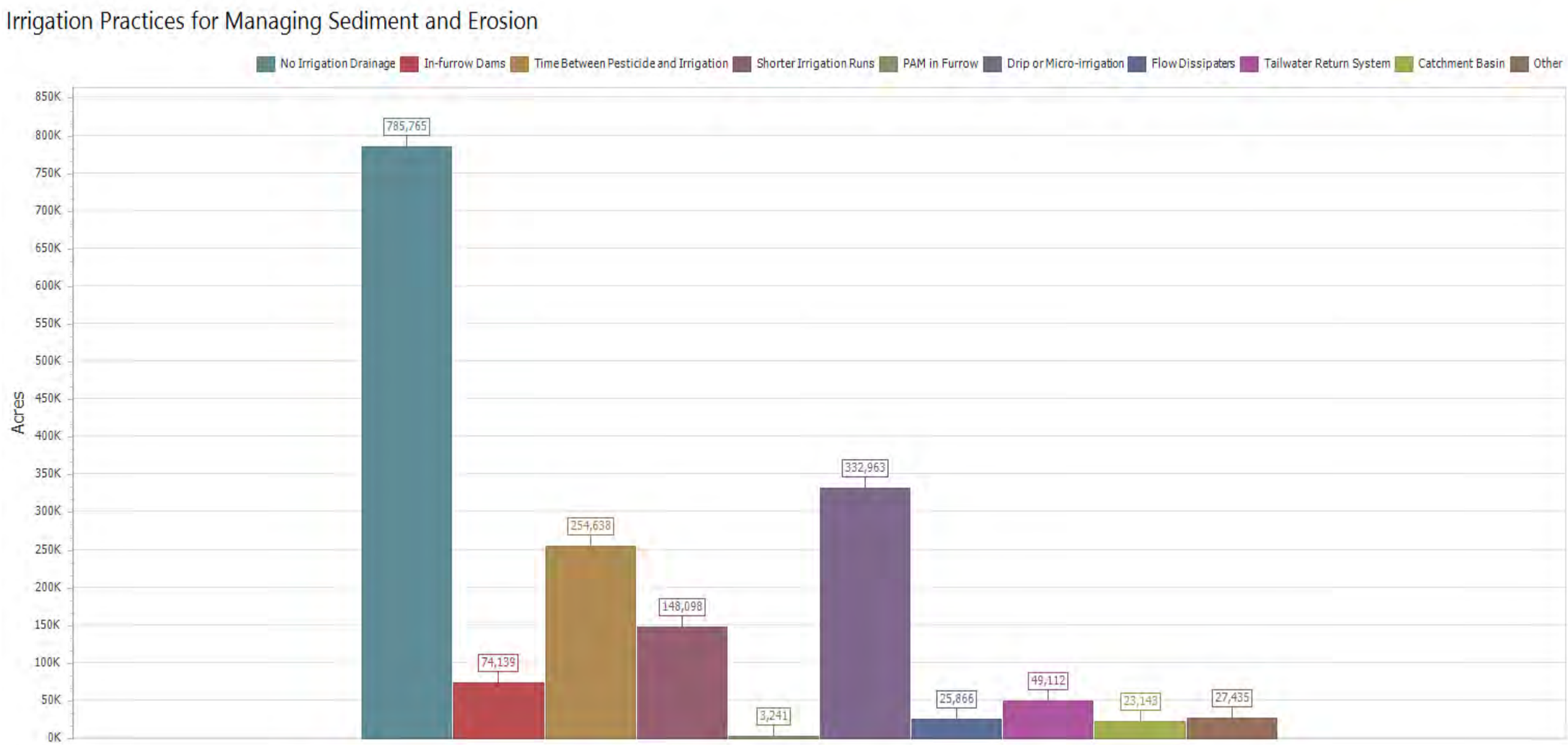

Figure 5-10. 2018 Irrigation Practices for Managing Sediment and Erosion

Table 5-10. 2018 Cultural Practices for Managing Sediment and Erosion

Total Acres Submitted FES	No Storm Drainage	Storm Water Captured	Vegetated Ditches	Vegetative Filter Strips	Sediment Basins/Holding Ponds	Cover Crops/Native Vegetation	Hedgerows/Trees	Soil Water Penetration Increased
988,989	764,350	178,730	15,940	16,069	9,460	133,159	50,299	351,505
% of Total Acres	77.3%	18.1%	1.6%	1.6%	1.0%	13.5%	5.1%	35.5%
	Crop Rows Graded	Stablized Creek Banks	Subsurface Pipelines	Berms	Minimum Tillage	Field is Lower	Field is Terraced	Other
	228,002	39,730	20,261	118,192	280,152	116,733	50,661	23,409
	23.1%	4.0%	2.0%	12.0%	28.3%	11.8%	5.1%	2.4%

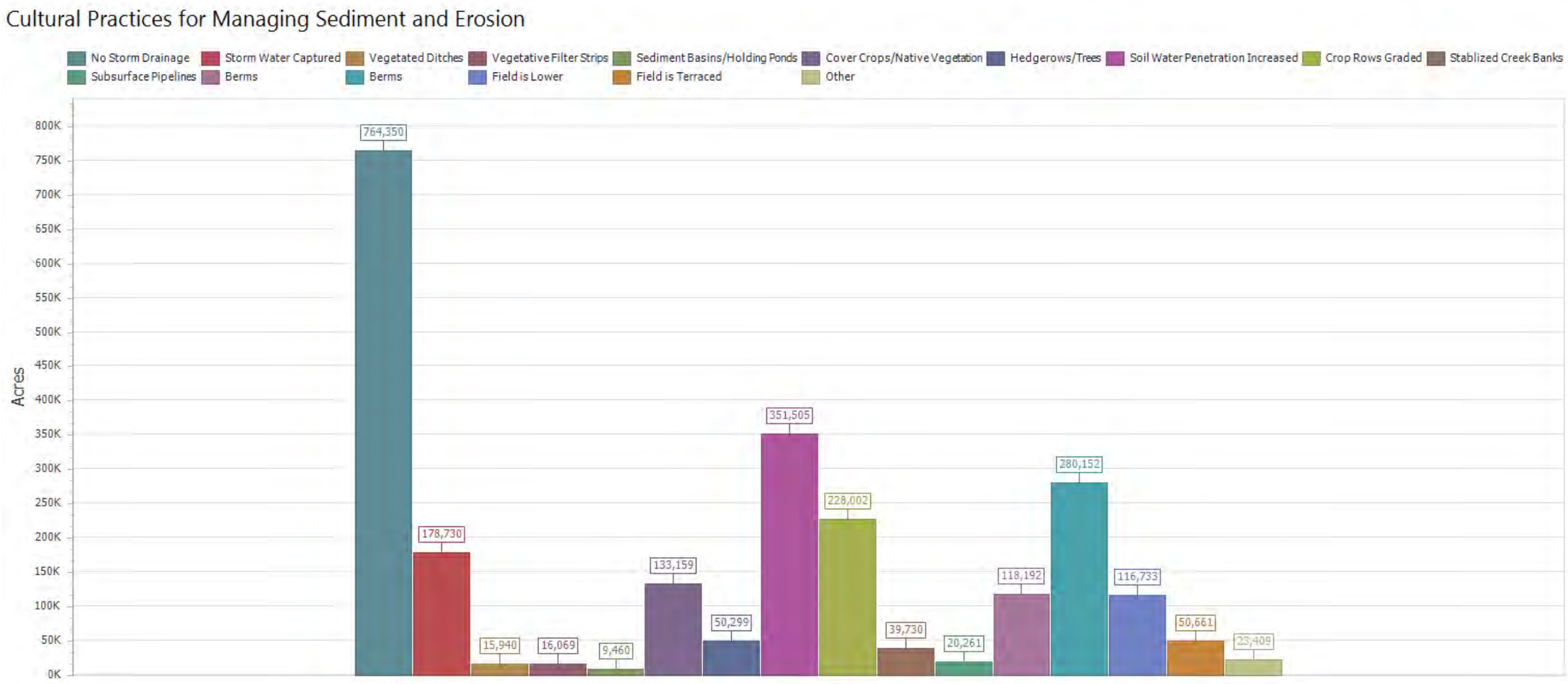

Figure 5-11. 2018 Cultural Practices for Managing Sediment and Erosion

6 Mitigation Monitoring

6.1 Summary

No mitigation monitoring occurred during the 2018 Calendar Year.

7 Education & Outreach

As required by the General Order, the KRWQC conducted education and outreach events for enrolled grower members. Presentations included information on the completion and submittal of Farm Evaluations, NMP worksheets and NMP Summary Reports, as well as self-certification training opportunities for the completion of NMPs and SECPs. The KRWQC also conducted specific outreach to satisfy the Continuing Education requirements for those who have passed the Self-Certification examination. Education and outreach efforts continued to include outlining the requirements of the General Order, communicating the role of the KRWQC, supporting member compliance, describing the methodologies employed in the various technical reports developed by KRWQC, and assisting members in understanding and meeting the NMP Worksheet, NMP Summary Report, and Farm Evaluation reporting requirements.

ILRP annual re-enrollment and reporting requirements were highly publicized through direct mailings, email blasts, notifications on the KRWQC website, and by holding grower education meetings. Resources for grower education and outreach meetings are routinely posted online at http://www.kingsriverwqc.org. These resources including meeting notifications, PDF copies of Power Point presentations, and video links (if education workshops were filmed). Report templates and instructions are also accessible online.

7.1 Events

The KRWQC conducted 30 outreach events between October and March for NMP self-certification, or continuing education outreach events. Several of the meeting locations had multiple sessions per date, and many were specifically designed to have members complete the required templates with staff at remote locations. The KRWQC estimates that the total direct attendance was greater than 2,300. This does not include presentations to commodity groups or other interested professional organizations such as the San Joaquin Valley Winegrowers, California Association of Pest Control Advisors (**PCA**s), and others, where the KRWQC did not track attendance. Specialized outreach was also done via radio interviews for Hmong and Punjabi audiences, as well as one-on-one meetings with members in the field and in the KRWQC office. Services for those who speak Spanish was also made available.

- **Mailings:** The KRWQC distributed a newsletter with the yearly invoices to all active members. Notices for special workshops, NMP training, or revised outreach activities were also mailed out as necessary. Each member received a specific package tailored to their reporting requirements: high vs. low vulnerability, large vs. small farm, and need for Farm Evaluation, NMP/Summary Report, or both.

- **General Outreach Meetings:** Outreach by the KRWQC included sessions covering the General Order requirements, status reports on the East San Joaquin Coalition petition at the State Water Resources Control Board, the Farm Evaluation template, and the NMP template. Outreach locations included Hanford, Selma, Easton, Riverdale, Kerman, Dinuba, Tulare (part of Kaweah/Tule events) and Parlier. Multiple locations and multiple sessions per site were conducted to make attendance convenient for members. All sessions were well attended. A breakdown of the events conducted is shown in **Table 7-1**.

  Typical outreach events consisted of a PowerPoint presentation concerning the history of the program and regulatory development process, potential penalties for non-compliance, current developments within the program (assorted updates to the General Order and future events), and the presentation of the templates currently required (Farm Evaluation and NMP), followed by a question

and answer session. A discussion of the Farm Evaluation and NMP data is also presented, tailored to the crops grown around each venue.

- **NMP Self-Certification Trainings:** NMP Self-Certification classes were offered multiple times during 2018. The KRWQC will continue to offer such classes periodically. The continuing education sessions for those who passed the NMP Self-Certification test were each awarded three (3) hours of continuing education credit. Such classes will also be offered periodically.
- **Online Education:** Online participation was available for all members during 2018. A small number of members opted for this method of compliance, and more utilized the video presentation of the Farm Evaluation Template.

7.2 Attendance

The KRWQC education and outreach events held during the 2018 Calendar Year are summarized in **Table 7-1**. A total of 1,640 memberships were represented collectively at the outreach workshops and trainings. A total of 2,581 members reported attending or participating in an outreach event either through in person attendance, online workshop materials or a designated representative.

Table 7-1. 2018 Calendar Year KRWQC Education & Outreach Events

Date	Event	Location	KRWQC Attendance
February 20, 2018 April 17, 2018 June 19, 2018 August 21, 2018 October 16, 2018 December 18, 2018	KRWQC Board Meetings	Kings River Conservation District, Fresno	150
January 5, 2018	Grower Education Workshops (one session) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Kings County Fairgrounds, Hanford, CA	55
January 11, 2018	Grower Education Workshops (one session) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Sanger Community Center, Sanger, CA	100
January 19, 2018	Grower Education Workshops (two sessions) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	CPDES Hall, Easton, CA	105
January 25, 2018	Grower Education Workshops (one session) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Veterans Memorial Hall, Riverdale, CA	44
February 1, 2018	Grower Education Workshops (two sessions) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Swan Court, Selma, CA	240

Date	Event	Location	KRWQC Attendance
February 7, 2018	Grower Education Workshops (two sessions) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Veterans Memorial Hall, Dinuba, CA	131
February 16, 2018	Grower Education Workshops (one session) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Kerman Community Center, Kerman, CA	127
November 8, 2018	NMP Continuing Education Course	Veterans Memorial Hall, Riverdale, CA	72
March 7, 2018	FCFB Outreach	Fresno Co. Farm Bureau, Fresno, CA	75
March 14, 2018	Nitrogen Management Plan Self-Certification Training	Kearney Ag Center, Parlier, CA	80
September 2, 2018	Nitrogen Management Plan Self-Certification Training	Veterans Memorial Hall, Riverdale, CA	88
March 29, 2018	Nitrogen Management Plan Continuing Education Meeting	Kearney Ag Center, Parlier, CA	75
July 25, 2018	Organic Growers Mtg: ILRP Updates	Clovis Veterans Hall, Clovis CA	60
December 4, 2018	Grower Education Workshops (one session) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	Kings County Fairgrounds, Hanford, CA	105
December 13, 2018	Grower Education Workshops (one session) – Farm Evaluations, Nitrogen Management Plans and Nitrogen Management Plan Summary Reports	CPDES Hall, Easton, CA	108
December 19, 2018	UCCE Minority Growers Mtg	UCCE Office, Fresno, CA	25
Total Outreach Attendance for 2018 Calendar Year Events:			**1,640**

7.3 Resources & Accessibility

Grower education and outreach events and 2018 reporting deadlines, postcards and/or informational letters were sent to all KRWQC members. The KRWQC also sent meeting and deadline reminders to members via email blasts utilizing Constant Contact. Members without email addresses were mailed hard copies of the email blasts.

Outreach presentation and mailed materials are included in **Appendix C**.

8 Conclusions & Recommendations

8.1 Water Quality Monitoring

During the 2018 Calendar Year the KRWQC continued to conduct surface water quality monitoring and reporting. The KRWQC also initiated groundwater quality monitoring and reporting. Both surface water and groundwater quality monitoring results met QAPP and QAPrP acceptance criteria and completeness requirements. The KRWQC will complete data analysis as additional water quality data are collected in future years.

8.2 Grower Reported Information

During the 2018 Calendar Year KRWQC members continued to maintain compliance with the General Order's requirements for submittal of NMP and Farm Evaluation information. KRWQC will continue to work to refine data collection to eliminate data gaps and ensure reliable long-term analysis of implemented management practices.

8.3 Outreach and Education

As required by the General Order, the KRWQC conducted education and outreach events for enrolled grower members. The KRWQC conducted 30 outreach events between October and March of 2018. Presentations included information on the completion and submittal of Farm Evaluations, NMP worksheets and NMP Summary Reports, as well as self-certification training opportunities for the completion of NMPs and SECPs. A total of 1,279 memberships were represented collectively at the outreach workshops and trainings. A total of 2,581 members reported attending or participating in an outreach event either through in person attendance, online workshop materials or a designated representative.

9 References

4 Creeks Inc. July 2018. *Groundwater Quality Trend Monitoring Workplan.* Available at: https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/kings_river/ground_water/2018_0731_kings_gqtmp.pdf.

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Appendix A

Surface Water Quality Data

Appendix B

Groundwater Quality Data

Management Practices Evaluation Program Annual Update

Appendix C

Outreach & Education Materials

Appendix D

Shape Files

KINGS RIVER
WATER QUALITY COALITION