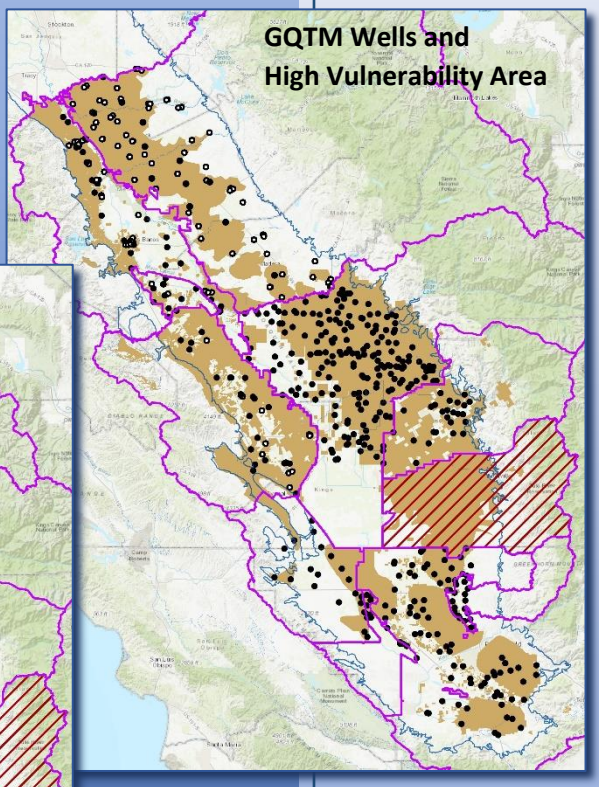
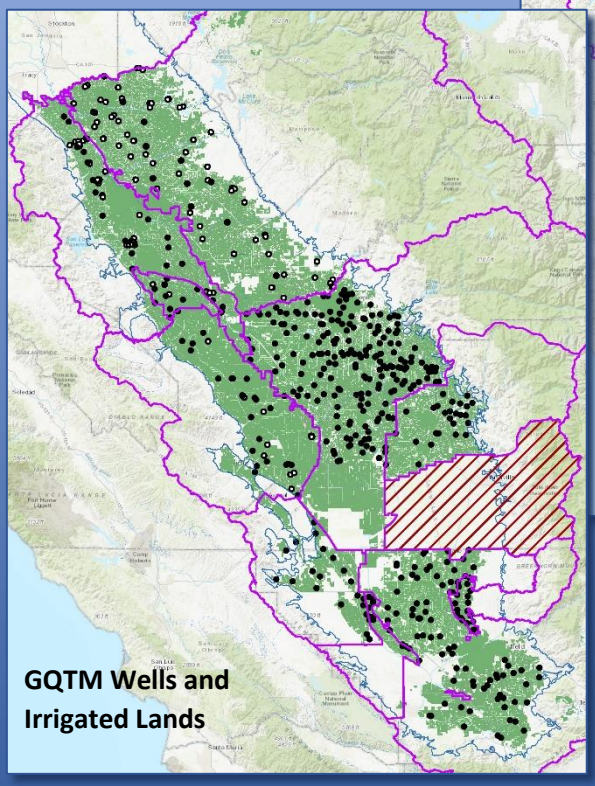
CENTRAL VALLEY GROUNDWATER MONITORING COLLABORATIVE

ILRP Groundwater Quality Trend Monitoring Program Workplan Update

May 2020





Prepared by

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Central Valley Groundwater Monitoring Collaborative

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Table of Contents

1 Introduction and Background 1
1.1 CVGMC Objectives 3
1.2 CVGMC Workplan Update Organization 4
1.2.1 Governance 4
1.2.2 CVGMC Network Design Approach 4
1.2.3 Monitoring Network Designs: Coalition Networks and CVGMC Coordination 4
1.2.4 Groundwater Sampling Program 5
1.2.5 Data Management 5
1.2.6 Data Analysis, Reporting, and Schedule 5
1.3 Comprehensive Quality Assurance Plan 5
2 CVGMC Governance 6
3 CVGMC Monitoring Network Design Approach 8
3.1 Monitoring Objectives 8
3.2 Spatial Considerations 9
3.3 Emphasis on Monitoring in Upper Part of Groundwater System 10
3.4 Prioritization of Monitoring Areas 11
3.4.1 High Vulnerability Areas 11
3.4.2 Irrigated Agriculture and Commodities 12
3.4.3 Irrigated Agriculture within Lands Enrolled in the ILRP and Associated Commodities 12
3.4.4 Groundwater Quality Trends 12
3.4.5 Nitrate MCL Exceedances 12
3.4.6 Communities 13
3.4.7 Recharge Areas Relative to Communities 13
3.5 Well and Aquifer Characteristics 13
3.6 Dynamic Network: Adaptive Design and Refinement 14
3.6.1 Other Considerations 14
3.7 Well Construction Requirements 15
4 Monitoring Network Design 16
5 Groundwater Sampling Program 17
5.1 Analytes: Annual and Five-Year Sampling Events 17
5.2 Coordination with SAMP 18

5.3 Sampling Schedule 18
5.4 Overview of Comprehensive Quality Assurance Plan 18
6 Centralized Data Management System 19
7 Data Analysis, Reporting, and Schedule 20
7.1 Annual GQTM Report 20
7.2 Five-Year Report 20
7.2.1 Additional Groundwater Quality Data Acquisition 21
7.2.2 Comparison of Regional Groundwater Quality and Trends 22
7.3 Report Discussion 23
7.4 CVGMC Regional Monitoring, Central Valley Groundwater Monitoring Program and ILRP Five-Year GAR Update 23
7.5 Schedule 24
8 References 25

List of Tables

Table 1-1 Required Technical Elements for Individual GQTM Workplans
Table 3-1 Crop Category Acreage (2014) for CVGMC Region
Table 5-1 GQTM Water Quality Testing Requirements
Table 7-1 CVGMC Reporting and Implementation Elements for Annual GQTM and Five-Year Assessment Reports

List of Figures

Figure 2-1 CVGMC Participating Coalitions
Figure 3-1 Schematic of Zone Nomenclature for CV-SALTS
Figure 3-2 Depth to the Bottom of the Upper Zone (CV-SALTS)
Figure 3-3 DWR Spring 2017 Depth to Unconfined to Uppermost Semi-Confined Groundwater
Figure 3-4 Average Domestic Well Depth by Section
Figure 3-5 Public Water Supply Wells Screened Only Within the Upper Zone
Figure 3-6 Histogram of Well Depths for the Entire CVGMC Region
Figure 3-7 Key Factors Considered in Prioritization of Monitoring
Figure 3-8 High Vulnerability Areas
Figure 3-9 Irrigated Agriculture – All Commodities
Figure 3-10 Summary of Top 10 Commodities by Area for CVGMC
Figure 3-11 Irrigated Agriculture – DWR Crop Categories
Figure 3-12 Summary of Crop Categories by Area for CVGMC
Figure 3-13 Irrigated Agriculture within ILRP Area of CVGMC – All Commodities
Figure 3-14 Summary of Top 10 Commodities by Area for ILRP Area within CVGMC
Figure 3-15 Irrigated Agriculture within ILRP Area of CVGMC – DWR Crop Categories
Figure 3-16 Summary of Crop Categories by Area for ILRP Area within CVGMC
Figure 3-17 Disadvantaged Communities
Figure 3-18 Conceptual Schematic of Capture Zone Differences for Wells in Hypothetical Unconfined Aquifer
Figure 3-19 Concepts and Key Factors for Identification of Candidate Network Wells
Figure 6-1 CVGMC DMS Relational Database Structure
Figure 7-1 Conceptual Integration of Monitoring Programs

List of Abbreviations & Acronyms

Nitrate as N	Nitrate as nitrogen
BVC	Buena Vista Coalition
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CQAP	Comprehensive Quality Assurance Plan
CVGMC	Central Valley Groundwater Monitoring Collaborative
CWDC	Cawelo Water District Coalition
DDW	Division of Drinking Water
DMS	Data Management System
DO	dissolved oxygen
DPR	California Department of Pesticide Regulation
DWR	California Department of Water Resources
EC	electrical conductivity
EDF	electronic data format
ESJWQC	East San Joaquin Water Quality Coalition
GAMA	Groundwater Ambient Monitoring Assessment
GAR	Groundwater Quality Assessment Report
GDA	Grassland Drainage Area
GQMP	Groundwater Quality Management Plan
GQTM	Groundwater Quality Trend Monitoring
GSAs	Groundwater Sustainability Agencies
GSPs	Groundwater Sustainability Plans
GWPAs	Groundwater Protection Areas
HVAs	High Vulnerability Areas
ILRP	Irrigated Lands Regulatory Program
KBWQA	Kaweah Basin Water Quality Association
KRWCA	Kern River Watershed Coalition Authority
KRWQC	Kings River Water Quality Coalition
LVA	Low Vulnerability Areas
MCL	Maximum Contaminant Level

MOA	Memorandum of Agreement
MPEP	Management Practices Evaluation Program
MQOs	Measurement Quality Objectives
MRP	Monitoring and Reporting Program
POTWs	Publicly Owned Treatment Works
PLSS	Public Land Survey System
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
Regional Water Board	Central Valley Regional Water Quality Control Board
SAMP	Surveillance and Monitoring Program
SGMA	Sustainable Groundwater Management Act
SNMP	Salt and Nitrate Management Plan
SOPs	Standard Operating Procedures
State Board	State Water Resources Control Board
TDS	total dissolved solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WDRs	Waste Discharge Requirements
WSJRWC	Westside San Joaquin River Watershed Coalition
Westside WQC	Westside Water Quality Coalition

1 Introduction and Background

The Central Valley Regional Water Quality Control Board (Regional Board, or Regional Water Board) revised the Irrigated Lands Regulatory Program Monitoring and Reporting Program Orders (May 5, 2017; MRP Orders) for all agricultural coalitions to allow for participation in a regional groundwater quality trend monitoring program in lieu of individual trend monitoring programs. As a result, ten agricultural coalitions developed a collaborative groundwater monitoring program that will characterize groundwater quality across the Central Valley. Envisioned as a program initially involving the Central Valley agricultural coalitions, the regional monitoring program may be expanded to include other dischargers/programs with a current groundwater monitoring element, as well as future coordination with Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and groundwater monitoring identified within the Central Valley Salt and Nitrate Management Plan (SNMP) (CV-SALTS, 2016).

A Conceptual Work Plan submitted to the Regional Board in October 2017 (CVGMC, 2017) describes the collaborative groundwater monitoring program being developed by irrigated agriculture to fulfill groundwater monitoring requirements of the Irrigated Lands Regulatory Program (ILRP). This monitoring program, called the Central Valley Groundwater Monitoring Collaborative (CVGMC Program), is the first step in developing a Central Valley-wide program that may eventually incorporate additional groundwater quality monitoring elements of other programs.

The program described in the Conceptual Work Plan (CVGMC, 2017) proposed the evaluation of groundwater quality conditions in regions dominated by irrigated agriculture. In addition, the CVGMC will collect groundwater quality information that can be used to evaluate potential effects of irrigated agriculture. Collected groundwater quality data may also be used to document long-term improvements in groundwater quality resulting from implementation of ILRP efforts, such as the localized Groundwater Quality Management Plans (GQMP) and the Management Practices Evaluation Program (MPEP). Additionally, because of the similarities between the regional groundwater quality trend monitoring program proposed in the Conceptual Work Plan and the groundwater monitoring program proposed by CV-SALTS through the SNMP, this program is envisioned to serve as a functional equivalent to the Surveillance and Monitoring Program (SAMP) required to support implementation of the SNMP once the Basin Plan amendment process is complete. Within one year of the effective date of the Central Valley Salinity and Nitrate Control Program (i.e., following adoption of the Central Valley Basin Plan amendment), requirements will be triggered for all dischargers of salt and nitrate to participate in other existing groundwater quality monitoring programs that will contribute data to the Central Valley Salt and Nitrate Monitoring Program. The purpose of the Salt and Nitrate Groundwater Monitoring Program (or Central Valley Groundwater Monitoring Program [also referred to as the SAMP]) is to evaluate ambient water quality and trends in groundwater basins in the floor of the Central Valley Region, including the CVGMC region.

On May 16, 2018, the CVGMC submitted the Phase 1: ILRP Technical Workplan (LSCE, MLJ, P&P; 2018) on behalf of its participating members. The CVGMC submitted a letter on July 25, 2019 highlighting updates to the proposed schedule and content presented in the May 2018 Workplan. Waste Discharge Requirements General Orders (General Orders) applicable to owners and operators of irrigated lands within the Central Valley require the development of a Groundwater Quality Trend Monitoring (GQTM) Workplan by either an individual third-party group (Coalition) or, alternatively, by a regional Groundwater Quality Trend Monitoring Group. The CVGMC is considered a regional Group.

Regional Water Board staff reviewed the May 2018 Workplan and the July 25, 2019 letter and requested an update to the Workplan to reflect recent developments and updated timelines (Regional Board; April 1, 2020 letter). This May 2020 Workplan Update responds to the Regional Board's direction to address staff's comments and update the following items: 1) clarification that all available data will be considered when evaluating monitoring well networks, 2) updated monitoring period to reflect May – August (late Spring/Summer), 3) reference to a Comprehensive Quality Assurance Plan instead of a Quality Assurance Program Plan, 4) updated description of the Data Management System, 5) updated reporting requirements and schedule as outlined in the July 25, 2019 letter. The updated Workplan is due to the Regional Board on May 18, 2020.

SUBMITTAL DATE	DOCUMENT	PURPOSE
October 2017	Conceptual Work Plan	Outlined the organization structure and intent of the CVGMC including a phased approach and timeline.
May 16, 2018	Phase 1: ILRP Technical Workplan (May 2018 Workplan)	Required per Waste Discharge Requirements (WDRs).
May 16, 2018	Quality Assurance Project Plan Documents	Umbrella Quality Assurance Project Plan was originally proposed with project specific plans attached as appendices. The format was revised after discussions with Regional and State Boards and reformatted to follow QAPP guidelines.
July 25, 2019	Proposed Schedule Update Letter	Letter submitted to the CVGMC with updated deliverable timelines and proposed synchrony of annual and 5-Year reporting deadlines.
April 7, 2020	Comprehensive Quality Assurance Plan (CQAP)	Resubmittal of the quality assurance plan following recommendations of structure and formatting per Regional and State Board staff.
May 18, 2020	ILRP GQTM Workplan Update (Workplan Update)	Per Regional Board April 1, 2020 letter, Workplan Update submittal is required by May 18, 2020 to reflect developments since

		the May 2018 Workplan submittal, including timelines.

1.1 CVGMC Objectives

The long-term objectives of the CVGMC were developed using the phased approach defined in the updated MRPs.

- **Phase 1: ILRP Workplan** – In Phase 1, the CVGMC developed a Workplan (May 2018) that identifies consistent approach(es) for monitoring and reporting among the Coalitions to meet requirements of the General Orders. This Workplan Update outlines how monitoring and reporting will occur, and how quality assurance will be maintained as part of the CVGMC. The CVGMC envisions potential linkages between the CVGMC regional groundwater quality monitoring program and the future SAMP, which will be implemented as required by the CV-SALTS and Central Valley Basin Plan amendments.
- **Phase 2: Coordination Among Existing Groundwater Monitoring Programs** - After developing the initial groundwater monitoring components and common approach(es) between the ILRP Coalitions, Phase 2 will examine potential expansion of the CVGMC within each Coalition by identifying other permittees within the Coalition boundaries that are required to monitor groundwater. These permittees include but are not limited to dairy operations, food processors, Publicly Owned Treatment Works (POTWs), and oil and gas operations. Several of these groups participated in the early discussions when developing the CVGMC and are anticipated to participate in future CVGMC processes.
- **Phase 3: Future Groundwater Monitoring Program Coordination** - Phase 3 will work to coordinate CVGMC planning and efforts with the requirements of the 2014 Sustainable Groundwater Management Act (SGMA) Groundwater Sustainability Plans (GSPs) and SAMP.

The CVGMC Workplan Update summarizes in **Table 1-1** the required technical elements for the individual GQTM Workplans developed under the individual Coalitions' WDRs. The coordinated program is consistent with these elements. Other elements coordinated by the CVGMC to establish a common approach among participating Coalitions were outlined within the May 2018 Workplan and are discussed herein. The CVGMC Workplan (2018) and this Workplan Update outline how monitoring, data management and reporting have been occurring and will in the future occur, and how quality assurance will be maintained as part of the CVGMC. The Workplan Update also describes coordination and integration with other related programs, particularly the SNMP SAMP and also the ILRP Five-Year GAR update. Individual Coalitions can reference approaches, design elements, reporting, and schedule requirements in the CVGMC Workplan Update and the Comprehensive Quality Assurance Plan. Each Coalition was responsible for submitting its own GQTM Workplan and the design and rationale for their respective Coalition-specific GQTM network.

1.2 CVGMC Workplan Update Organization

This CVGMC Workplan Update is organized into sections on CVGMC governance, monitoring network design approach, overarching descriptions of GQTM network design and coordination, groundwater sampling program, data management, data analysis, reporting, and schedule. Information previously presented in the May 2018 Workplan has been updated herein to reflect recent developments and updated timelines. The updates focus on the CQAP, data management system (DMS), report content (for consistency), and schedule.

1.2.1 Governance

Section 2 describes the Coalitions participating in the CVGMC, the principles outlined in the Memorandum of Agreement (October 2017) for CVGMC operations, and the governance structure.

1.2.2 CVGMC Network Design Approach

Section 3 describes the design of the CVGMC regional groundwater monitoring program, which is based on the monitoring networks developed by individual Coalitions for their respective GQTM programs. The CVGMC design is founded on the requirements in the ILRP General Orders for the GQTM program and key factors considered, including areas designated as having high vulnerability to effects on groundwater quality, irrigated agriculture and top commodities in the CVGMC region; the delineation of the upper part of the groundwater system; and typical depths of completion for irrigation, municipal, industrial, and domestic wells in the CVGMC region. An overview of the considerations and criteria for the design of the CVGMC GQTM with respect to the objectives of the program and requirements of the General Orders is provided, including rationale for appropriate monitoring well distribution, encompassing agricultural irrigated regions of the Central Valley.

1.2.3 Monitoring Network Designs: Coalition Networks and CVGMC Coordination

Section 4 provides a broad overview of monitoring network design considerations. Each Coalition was required to prepare a GQTM Workplan to establish long-term groundwater monitoring within their Coalition area. GQTM Workplans were due one year following approval or conditional approval of each Coalition's Groundwater Quality Assessment Report (GAR) by the Regional Board. The Coalitions comprising the CVGMC have completed these plans per the required ILRP General Order requirements. Conditional approvals of individual Coalition workplans have been issued for all ten Coalitions. Many of the individual Coalitions continue to coordinate with the Regional Board regarding the number of wells contained in their individual Coalition GQTM well networks and rationale for their selection.

The individual Coalition workplans address the development of the GQTM well networks, while this CVGMC Workplan Update addresses how consistent monitoring, quality assurance, data management, and reporting will be completed for the CVGMC.

1.2.4 Groundwater Sampling Program

Section 5 contains a description of the groundwater sampling constituents and schedule required by the WDRs for the GQTM. An overview of the CVGMC Comprehensive Quality Assurance Plan is also contained in **Section 5**.

1.2.5 Data Management

The CVGMC is using a coordinated data management system (DMS) that is centrally maintained for the purpose of implementing the regional CVGMC. Each Coalition may elect to maintain their own data in their own database, if desired, but a coordinated DMS is being used to facilitate analyses and reporting of regional groundwater quality data across the CVGMC area and submittal of CVGMC data. The DMS is described briefly in **Section 6**. More information on the DMS is available in the CVGMC Comprehensive Quality Assurance Plan.

1.2.6 Data Analysis, Reporting, and Schedule

Annual GQTM Reports and Five-Year Assessment Reports will be completed using a common framework between Coalitions and the CVGMC. As required by the ILRP General Orders, each Coalition will provide an Annual GQTM Report describing groundwater monitoring in their region. Every five years starting in 2021[1], a coordinated Five-Year Assessment Report presenting results of regional analyses of groundwater quality conditions and trends across the entire Central Valley (or the portions of the Central Valley participating in the CVGMC) will be provided to the Regional Board. This report is also intended to meet the objectives of the SAMP and the Five-Year GAR update (see **Section 5**). The proposed content for the Annual GQTM Report and Five-Year Assessment Report is described in **Section 7**.

1.3 Comprehensive Quality Assurance Plan

The Coalitions participating in the CVGMC will follow a Comprehensive Quality Assurance Plan (CQAP) that meets the requirements described in the General Order. The CVGMC CQAP has been prepared as a standalone document following EPA guidelines and sections for developing Quality Assurance Project Plans and includes descriptions of the annual sampling schedule, analytical methods with detection and reporting limits, Standard Operating Procedures (SOPs) used for sample collection, and data management procedures. All monitoring by entities participating in the CVGMC will be performed using the standardized methods for sample collection, same analytical methods, and quality assurance procedures. Each Coalition is responsible for performing groundwater monitoring and data analysis in their region.

[1] The first Five-Year Report will occur in 2021 to facilitate integration of CVGMC, SAMP/Central Valley Groundwater Monitoring Program, and Coalition Five-Year GAR Updates. Subsequent Five-Year Reports will be submitted every five years.

2 CVGMC Governance

The CVGMC participating Coalitions work collaboratively under a Memorandum of Agreement (MOA) signed on October 27, 2017. The Memorandum of Agreement[2] outlines the purpose, organization, roles and responsibilities of the member Coalitions, administrative procedures, length of time the terms of the MOA remain in force, termination procedures, and rules of operation. In addition, there is a cost allocation schedule agreed upon by all member coalitions.

There are eleven coalitions that signed the MOA (**Figure 2-1**):

- Westside San Joaquin River Watershed Coalition
- East San Joaquin Water Quality Coalition
- Westlands Water Quality Coalition
- Grassland Drainage Area Coalition
- Kings River Water Quality Coalition
- Kaweah Basin Water Quality Association
- Cawelo Water District Coalition
- Buena Vista Coalition
- Tule Basin Water Quality Coalition[3]
- Kern River Watershed Coalition Authority
- Westside Water Quality Coalition

The MOA develops several key principles by which the CVGMC operates:

- The MOA does not form a new legal entity,
- Parties collectively designate a Coordination Committee,
- All parties remain individually responsible for sampling and monitoring groundwater wells that are part of an individual Groundwater Trend Monitoring Program approved by the Regional Board,
- All Parties agree to collect samples in accordance with an approved Quality Assurance Project Plan,
- All Parties agree to transmit, or have transmitted, groundwater monitoring sample results to the designated entity/consultant for common data management purposes,
- Should Parties decide to submit a combined report through the CVGMC to meet individual GQTM requirements, all Parties must approve the combined report prior to submission to the Regional Board,

[2] Memorandum of Agreement for a Central Valley Groundwater Monitoring Collaborative, October 27, 2017. The MOA provides flexibility for additional members, including those in other groundwater quality monitoring programs.

[3] Tule Basin Water Quality Coalition was a signatory to the original MOA; however, on April 23, 2018, this Coalition withdrew its membership in the CVGMC.

- No Party is responsible for the costs incurred for the purposes of implementing any other Party's approved GQTM,
- Each Party agrees to cooperate and coordinate with other Parties to share information and work in good faith,
- The contributions of each Party will be proportional based on a variety of factors including but not limited to, the size of the Party's geographic area of coverage, number of irrigated acres in high vulnerability areas, and the number of groundwater wells present in the Party's area.

The CVGMC activities are managed by a Coordination Committee which consists of a member from each Coalition. David Cory (Westside San Joaquin River Coalition) is the Chair and Nicole Bell (Kern River Watershed Coalition Authority) is the Vice Chair of the Coordination Committee. The Coordination Committee is responsible for approving scope of work documents for any contractor and provides oversight for any work performed by outside contractors.

3 CVGMC Monitoring Network Design Approach

This section describes the design of the CVGMC GQTM program and key considerations in the design rationale, including: areas designated as having high vulnerability, irrigated agriculture and top commodities in the CVGMC region, the delineation of the upper part of the groundwater system, and typical depths of completion for irrigation, municipal, industrial, and domestic wells in the CVGMC region. An overview of the considerations and criteria for the design of the CVGMC GQTM with respect to the objectives of the program and requirements of the General Orders is provided, including rationale for the appropriate monitoring well distribution, encompassing irrigated agricultural regions of the Central Valley.

This Workplan Update summarizes information provided in the May 2018 Workplan. Future reports, such as the Five-Year GAR update to be submitted to the Regional Board by November 30, 2021, will update this information as applicable. Each Coalition works to maintain their well network to meet the monitoring objectives described in this Workplan Update. Updates to well networks may occur due to various reasons, including newly identified wells that meet well network criteria, new wells drilled for SGMA or other purposes, and/or a need to remove/update originally proposed wells due to additional information indicating they are no longer suitable to meet the program objectives. Well network updates will be submitted to the Regional Board at least 30 days prior to monitoring for that year and will be reflected in amendments to the CQAP.

3.1 Monitoring Objectives

The primary objectives of the CVGMC GQTM include:

1) Assess current water quality conditions of groundwater relevant to irrigated agriculture (as required by the General Order);
2) Develop long-term groundwater quality information that can be used to evaluate the regional effects (i.e., not site-specific) of irrigated agriculture and its practices (as required by the General Order);
3) Understand long-term temporal trends in regional groundwater quality, particularly as they relate to effects from irrigated agriculture on potential sources of drinking water for communities;
4) Evaluate regional groundwater quality conditions in the CVGMC region, particularly in High Vulnerability Areas (HVAs), and identify differences in groundwater quality laterally and vertically within the CVGMC region; and
5) Distinguish groundwater quality changes associated with irrigated agriculture compared to other non-agricultural contributing factors.

Characterization of groundwater quality conditions relevant to irrigated agriculture occurred as part of individual Coalition GARs through the assembly and evaluation of extensive current and historical groundwater quality information for each Coalition region. Groundwater quality conditions in individual Coalition areas and the CVGMC will continue to be evaluated through the GQTM program and also other

parallel and intersecting programs, including SGMA GSPs and the groundwater quality evaluations and SAMP associated with the Basin Plan amendments. The CVGMC GQTM places primary focus on temporal trend monitoring of groundwater quality for the purpose of evaluating long-term regional effects of irrigated agricultural practices. Of particular focus are locations, and within vertical horizons, where groundwater represents a significant source of drinking water supply for communities within the CVGMC region.

Municipal and domestic water supplies represent an important beneficial use of groundwater in the CVGMC region and the protection of this beneficial use is a key goal of the ILRP. In addition to domestic wells, irrigation and other wells suitable for monitoring of groundwater conditions in the upper part of the aquifer system may be selected by individual Coalitions for their GQTMs. The CVGMC also incorporates data collected from public water supply wells (community water systems) completed in the upper part of the aquifer system as part of the monitoring program. Although some community water system wells are deep and may be slow to respond to influences from land use practices at the surface, there are community water system wells in many parts of the CVGMC region that are constructed at similar depths as domestic wells. Examples of such wells include schools and large businesses or commercial operations. The longer period of record of groundwater quality for some of these wells represents a valuable source of data for evaluating long-term regional trends in groundwater quality.

Implementation of the CVGMC GQTM will further the understanding of long-term temporal trends in regional groundwater quality. In contrast to the Management Practice Evaluation Program (MPEP), which evaluates the performance of agricultural practices at a field scale across the Central Valley, the intent of the CVGMC GQTM program is to evaluate long-term changes in groundwater quality conditions at a regional scale as they relate to aggregated effects of irrigated agriculture and changes in agricultural practices. Distinguishing groundwater quality trends that are clearly related to irrigated agriculture from trends unrelated to irrigated agriculture is an important concern of several Coalitions. The source/cause of groundwater degradation needs to be assigned to the appropriate entity/source. Negative groundwater quality trends associated with unrelated factors could be misconstrued as being sourced from irrigated agricultural lands. Potential sources of nitrate not related to irrigated agriculture need to be evaluated as part of the GQTM network design process. For example, during the GQTM well selection process, wells cited near sources of nitrate that are obviously not associated with irrigated lands would not be suitable for inclusion in the network.

3.2 Spatial Considerations

Various spatial considerations exist in designing the individual Coalition GQTM well networks and the CVGMC network. These considerations focus on where and how to effectively monitor groundwater quality to determine the impact of irrigated agricultural activities on groundwater quality. Spatial factors relating to the CVGMC and GQTM network design inform delineation of areas to monitor and specific sites (wells) suitable for groundwater monitoring. The approaches used in developing the individual Coalition GQTM well networks are based on consideration of the GQTM requirements in the WDRs. In accordance with the MRP (Appendix B) of the WDR, the considerations included in the design approach for the GQTM and CVGMC network include the following (see **Table 1-1**):

- Consideration of the variety of agricultural commodities produced within the third-party's boundaries;
- Consideration of conditions discussed/identified in the GAR related to the vulnerability prioritization; and
- Consideration of areas identified in the GAR as contributing significant recharge to urban and rural communities where groundwater serves as a significant source of supply.

3.3 Emphasis on Monitoring in Upper Part of Groundwater System

Nomenclature regarding the groundwater system was developed for CV-SALTS as part of technical work for the Central Valley SNMP (CV-SALTS, 2017). The nomenclature relating to depth zones[4] used in CV-SALTS (LSCE and LWA, 2016) is illustrated in **Figure 3-1** and defined below.

Upper Zone (Central Valley)

- The depth of the Upper Zone is based on well construction information, as possible, and other comparable information that provides the best available indication of well depth for different types of wells, especially domestic wells; the analysis gives the highest weight to domestic well depths.
- Includes the depth from the bottom of the vadose zone to the bottom of the Upper Zone.
- Where the Corcoran Clay is present, the Upper Zone does not extend below the Corcoran Clay.

Lower Zone (Central Valley)

- The depth of the Lower Zone is based on well construction information, as possible, and other comparable information that provides the best available indication of well depth for different types of wells; the analysis gives the highest weight to municipal well depths.
- Includes the depth from the bottom of the Upper Zone to the depth of the bottom of the Lower Zone.
- Within the Corcoran Clay area, the Lower Zone is bounded at the bottom by the top of the Corcoran Clay layer.

Lower Part of the Aquifer System

- This refers to the groundwater beneath the Corcoran Clay, where present, and groundwater at greater depths than most municipal well depths where the Corcoran Clay is not present.

For purposes of characterizing the relatively shallower part of the groundwater system, the CVGMC emphasizes monitoring in the Upper Zone within the upper part of the groundwater system. The delineation of the Upper Zone by CV-SALTS incorporates the depth of domestic wells and represents the zone from which a large fraction of domestic wells produce water. The estimated depth to the bottom of the Upper Zone is shown in **Figure 3-2.** Depths to groundwater vary widely within the CVGMC region and are a consideration in the design of the GQTM well networks. **Figure 3-3** illustrates the Spring 2017

[4] While Section 3.2.1 includes definitions for the Upper Zone and Lower Zone, Figure 3-1 also shows the "Production Zone". The Production Zone is the volume-weighted composite of the Upper Zone and the Lower Zone.

depth to groundwater as compiled and indicated by California Department of Water Resources (DWR) to represent an unconfined to uppermost semi-confined water surface. DWR does not receive and/or has not collected groundwater level data in all areas of the Central Valley. The average depths of domestic wells in the CVGMC region is shown in **Figure 3-4**, and public water supply wells screened only in the Upper Zone are shown in **Figure 3-5**. **Figure 3-6** is a histogram of well depths for domestic, agricultural, and public water supply wells for the entire CVGMC region.

3.4 Prioritization of Monitoring Areas

As noted above, the specific requirements of the GQTM provide the basis for the CVGMC monitoring network. The approach to monitoring for long-term regional groundwater quality trends in the GQTM emphasizes evaluation of trends in wells that may best indicate regional trends in areas dominated by irrigated agriculture. The spatial distribution of wells in the monitoring network across the CVGMC region varies based on the prioritization of monitoring applied by individual Coalitions. The HVAs (coupled with approaches to prioritize HVAs) identified in the Coalition GARs are a greater emphasis for long-term trend monitoring locations than areas of relatively lower priority.

Coalitions prioritized HVAs in the GARs to focus management efforts related to agricultural practices. The prioritization of HVAs in GARs considered various factors relating to the intrinsic hydrogeologic characteristics that affect groundwater vulnerability, existing groundwater quality conditions, land use and associated agricultural practices, and proximity to areas contributing recharge to communities reliant on groundwater.

Similarly, in many Coalition regions the GQTMs evaluated a variety of factors, including in some cases the HVA prioritization developed as part of the GAR, for consideration in the design of the trend monitoring network. Such factors were used to target specific areas for monitoring, consistent with the GQTM objectives identified in the WDRs. As part of individual Coalition GQTMs, a preliminary network of proposed wells exists for each Coalition region; the proposed network design is informed by the applied prioritization and any associated delineation of targeted monitoring areas. A variety of factors were considered by individual Coalitions in prioritizing monitoring areas within their respective regions. Some of the key factors considered in the prioritization of monitoring are highlighted below and presented in **Figure 3-7**. The spatial distribution of Coalition GQTM network wells is based largely on consideration of these factors as emphases for monitoring.

3.4.1 High Vulnerability Areas

Through the collective efforts of the Coalitions participating in the CVGMC, the entire CVGMC region has been evaluated and their respective GARs have delineated the potential vulnerability of groundwater to impacts from irrigated agriculture. These assessments identified high vulnerability areas (HVAs) where physical conditions make groundwater more vulnerable to impacts from overlying land use activities.

The spatial distribution of HVAs[5] in the CVGMC region is shown on **Figure 3-8**. Low vulnerability areas (LVAs), by default, are areas not delineated as HVAs.

3.4.2 Irrigated Agriculture and Commodities

Using available land use data within each Coalition, the spatial distribution and percentage of irrigated agricultural land use types in areas were considered for prioritizing areas to be monitored. The GQTM networks considered the top commodities (i.e., crops covering the largest acreage) present within each of the Coalition regions. The spatial distribution of irrigated areas and crop categories within the CVGMC region based on 2014 data are illustrated in **Figures 3-9 through 3-12**. The number of acres and total irrigated acres in each Coalition in the CVGMC region is presented in **Table 3-1**.

3.4.3 Irrigated Agriculture within Lands Enrolled in the ILRP and Associated Commodities

As the CVGMC region also encompasses irrigated areas not subject to the ILRP (e.g., land use covered under the Dairy General Order), the spatial distribution and percentage of irrigated agricultural land use types specific to only ILRP areas were mapped to illustrate the CVGMC GQTM network coverage with respect to ILRP lands. The spatial distribution of irrigated areas and crop categories associated with the lands enrolled in the ILRP in the CVGMC region based on statewide 2014 crop data provided by DWR (Land IQ, 2017) are illustrated in **Figures 3-13 through 3-16**. The statewide 2014 crop data provide a recent, high-quality and continuous spatial land use dataset for the CVGMC region that is based on a combination of remote sensing and agronomic analyses coupled with ground verification. The number of acres of each of the top acreage crop categories associated with lands enrolled in the ILRP in the CVGMC region is presented in **Table 3-1**.

3.4.4 Groundwater Quality Trends

Results from analyses of historical trends (statistical analyses and/or time series tendencies) in groundwater quality (particularly nitrate concentrations) were considered by many Coalitions during the design of the Coalition trend monitoring networks. Areas with increasing nitrate concentration trends (but not necessarily exceeding the nitrate drinking water standard) represent areas with an increased risk to the beneficial uses of groundwater. Therefore, these represent areas of higher monitoring priority.

3.4.5 Nitrate MCL Exceedances

The locations of wells where historical concentrations of nitrate in groundwater have exceeded the maximum contaminant level (MCL) for drinking water were considered in the network design. Such

[5] The HVAs presented in this Workplan represent the HVAs from the original approved GARs for all Coalitions; the HVAs will be periodically reviewed and potentially modified in accordance with individual Coalition GAR Update requirements.

areas represent areas with an increased risk to the beneficial uses of groundwater for drinking, especially when such exceedances have occurred recently.

3.4.6 Communities

Identified disadvantaged and severely disadvantaged communities are an important consideration in the design of the GQTM network. Emphasis was placed on monitoring in the vicinity of disadvantaged and severely disadvantaged communities (**Figure 3-17**). The need to maintain high quality water and beneficially use groundwater for drinking water supply is critical in and near these communities.

3.4.7 Recharge Areas Relative to Communities

Recharge areas upgradient of communities were considered in designing the GQTM as activities in these areas have the potential to impact downgradient communities reliant on groundwater. Areas of higher recharge potential and where groundwater flow is towards communities reliant on groundwater for drinking water were considered in the Coalition GQTM networks. Increasing trends and historical MCL exceedances in nitrate concentrations were also used to determine whether a community is downgradient of a source of nitrate and potentially at risk of having drinking water supplies impacted.

3.5 Well and Aquifer Characteristics

Well characteristics and the aquifer properties in the CVGMC region were important considerations in design of a network for monitoring regional trends in groundwater quality. It is important to consider the area represented by individual monitoring sites. The physical characteristics of wells (e.g., depth, pumping rate) and the hydrogeologic setting (e.g., aquifer characteristics, groundwater gradient) are factors in the quality of the water that is produced by a given well.

Larger-capacity (higher pumping rate) wells, such as irrigation wells and larger-capacity community water system wells, provide a better representation of regional groundwater quality conditions because these wells have relatively larger groundwater capture zones drawing groundwater from a greater contributing area. The wider capture zone minimizes the degree to which a well only reflects much more localized groundwater quality conditions. Groundwater produced from larger-capacity wells represents a composite of groundwater from a larger well-contributing area. Changes in groundwater quality demonstrated by these wells indicate effects on groundwater across the entire contributing area. Smaller-capacity wells, such as domestic wells or monitoring wells, have a smaller capture zone; therefore, these wells represent groundwater conditions within a smaller contributing area (i.e., local rather than regional conditions). **Figure 3-18** illustrates this concept, i.e., the difference in capture areas for a small- versus a large-capacity well.

Well depth is another key element relating to the contributing area for wells and potential time lag associated with groundwater quality observations. Together, these factors associated with the construction and operation of wells in conjunction with the aquifer properties comprise the primary criteria for evaluating the degree to which potential candidate wells are likely to represent regional groundwater quality trends. Recognizing the characteristics of well capture zones and depth zones and

the land uses represented within the contributing area for a well are critical considerations in the selection of wells for a regional monitoring program and also during analysis of data. A combination of smaller capacity wells coupled with larger capacity wells in a diverse network of well types provides the opportunity to evaluate trends in groundwater from a variety of different aspects.

Figure 3-19 illustrates the concepts and some of the key factors used to identify candidate network wells for further vetting.

3.6 Dynamic Network: Adaptive Design and Refinement

The approach to the design of the individual Coalition GQTM networks and the CVGMC network recognizes the importance for the monitoring program to evolve over time based on consideration of data derived through implementation of the program itself. Alley (1993) emphasizes this approach in describing the importance of a dynamically evolving design: "A characteristic of virtually all water-quality sampling programs is that knowledge is attained about a more efficient design after sampling is completed and the results are analyzed. For long-term studies, the anticipation that modifications may be made to the network at a future date favors the utilization of fairly simple designs at the outset." Therefore, the initial network of GQTM wells for CVGMC is not regarded as a static end result, but rather a beginning of a dynamic process. The individual Coalitions continue to coordinate with Regional Board staff regarding the rationale and sufficiency of the initial GQTM networks to meet the General Order objectives, recognizing that these networks will receive ongoing review, evaluation, and refinement as the program continues. The spatial representation and ongoing sufficiency of the CVGMC and the individual Coalition GQTM well networks will be evaluated on an annual basis. Specific attention will focus on the adequacy of monitoring in areas where the direction and magnitude of temporal trends in groundwater quality suggest a consistent pattern that is likely to be attributable to influences from irrigated agriculture. Recommendations will be made primarily by the individual Coalitions regarding potential addition, elimination, or substitution of wells.

Additional groundwater quality data will continue to be generated by the GQTM program, other ILRP required drinking water (domestic) well monitoring, and numerous other programs. These data will be considered during assessment of the sufficiency of the GQTM network. The Regional Board (April 1, 2020 letter) suggests that due to the timing associated with the start of the ILRP drinking water well monitoring program, the first CVGMC Five-Year Assessment Report completed after the collection of drinking water well data should be used to provide a robust assessment of the representativeness of the Coalition well networks to refine the networks and meet GQTM requirements.

3.6.1 Other Considerations

As described above, community water system wells, especially those with relatively shallower well depths, can represent a valuable source of historical data for evaluating long-term regional trends in groundwater quality. Community water system wells, either individually or together with other water sources, must meet drinking water standards when used for potable purposes. These wells may be subject to discontinued use, well modification, and/or destruction pending groundwater quality trends

and future exceedance of one or more drinking water standards. It will be important to identify whether public supply wells in areas of impaired water quality become subject to discontinuation, well modification and/or destruction. In such cases, steps that may be taken include:

- Coordinate with the water supply system owner or operator for continued sampling if the well is retained for backup, emergency and/or non-potable uses;
- If the subject community water system well is modified, determine whether it would continue to meet GQTM objectives (example, well deepened due to groundwater level declines). If so, ensure modification to the well structure is recorded in the DMS.
- Identify a suitable well to fill data gap as needed.

3.7 Well Construction Requirements

In accordance with the requirements specified in the General Orders, information relating to wells proposed for inclusion as part of the CVGMC are included in the individual Coalition GQTMs. As indicated above, details relating to the construction of wells proposed for the CVGMC are highly important. The well information data required for the GQTM network wells include the well location (GPS coordinates and physical address); State Well Number, if known; well construction details (total depth, top perforation depth, bottom perforation depth, as available); well drillers' log (well completion report), if available; well seal information; and measured depth to water at the time monitoring is implemented. The vetting of candidate GQTM wells is important to investigate and/or confirm details relating to wells and ensure that each proposed well is suitable for including in GQTM network refinements (**Figure 3-19**). Many Coalitions have been challenged with identifying complete well construction information for all wells in their respective GQTM networks. Approaches have been implemented to identify all reasonably available well construction information, e.g., through the owner, communications with DWR, etc.; however, in some instances complete construction records are not available.

4 Monitoring Network Design

Each Coalition developed its own GQTM network distributed between high and low vulnerability regions within their Coalition boundaries. These monitoring networks will be incorporated into the CVGMC network. Each monitoring network has identified relatively shallow wells (i.e., wells completed in the upper part of the groundwater system). These relatively shallow wells are not necessarily wells screened in the uppermost zone of first encountered groundwater. Due to great depths to groundwater in some Coalition areas, deeper wells are necessary to monitor the upper part of the groundwater system.

The individual GQTM networks have been designed to meet the WDR General Order requirements. Collectively, as part of the CVGMC, the networks provide a means to more broadly assess groundwater quality trends and conditions related to irrigated agriculture.

Key considerations used to develop the monitoring networks on both a Coalition scale and CVGMC regional scale include:

- GQTM well network distributed in HVA and LVA areas;
- GQTM well network composed largely of wells completed in the Upper Zone of the groundwater system (some areas of CVGMC region have significant depths to groundwater and corresponding greater well depths);
- GQTM wells distributed across irrigated agriculture, especially irrigated agriculture on lands enrolled in the ILRP and generally not located on irrigated lands not enrolled in the ILRP (e.g., generally not on lands covered by the Dairy General Order);
- GQTM wells in the vicinity of top commodities, especially top commodities associated with ILRP irrigated agriculture but also some non-ILRP irrigated agriculture; and
- GQTM wells in the vicinity of disadvantaged communities, including severely disadvantaged and disadvantaged unincorporated communities.

The regional CVGMC network, including its design basis focused on the above considerations, provides for broad geographic coverage and allows for an analysis of present and future trends and conditions in relation to agricultural land use. More importantly, the CVGMC GQTM results will provide for a more extensive dataset with which to evaluate changes in the regional groundwater quality.

As described in **Section 7**, the broad regional assessment and synthesis of CVGMC GQTM results is proposed to occur every five years. This five-year assessment would also be integrated with the SAMP and the Coalitions' Five-Year GAR update to result in a single, more informative, streamlined, and cost-effective program.

5 Groundwater Sampling Program

5.1 Analytes: Annual and Five-Year Sampling Events

Wells selected for trend monitoring will be sampled and tested at an annual frequency for water quality parameters, including nitrate (as N), electrical conductivity at 25 °C (SC), pH, dissolved oxygen (DO), and temperature. SC, pH, DO, and temperature will be measured in the field whereas nitrate concentration will be analyzed by a certified laboratory. In most Coalition regions, community water system wells represent additional ongoing monitoring wells that are regularly tested.

Although community water system wells designated as complementary wells are not envisioned for inclusion as initially sampled CVGMC GQTM network wells, continued monitoring of these wells will be performed by the water supply system operators in accordance with Division of Drinking Water (DDW) requirements. While the annual sampling of the initial GQTM network wells conducted by each Coalition will include collection of the field parameters identified above, monitoring of additional wells by other monitoring entities (such as community water systems) that are not members of the CVGMC may not include testing of all the identified field parameters. As applicable, should a community water system well become a GQTM network well, individual Coalitions will coordinate with other monitoring entities within their region to include the required field parameters into their monitoring programs in the future.

Every five years, starting with the first monitoring event, all wells selected for inclusion in the CVGMC GQTM will be sampled and tested for additional water quality constituents, including total dissolved solids (TDS), major anions (carbonate, bicarbonate, chloride, sulfate), and major cations (boron, calcium, sodium, magnesium, potassium). Where GQTM wells are monitored by other entities, coordination with those entities will occur to sample for the required constituents and/or obtain the results for the required analytes if those samples have already been collected by others. The testing parameters and monitoring frequency for the GQTM are outlined on **Table 5-1** and are in accordance with the requirements of the General Orders. Groundwater quality testing in additional wells monitored by others may not align exactly with the frequency of testing for all water quality parameters specified in the WDRs, although coordination efforts with cooperating monitoring entities will focus on establishing a testing program that is consistent and compatible with the monitoring objectives for the GQTM program.

Although not required by the General Orders, additional potential water quality parameters, including oxidation-reduction potential (ORP) and turbidity, may be considered for testing, depending on individual Coalition-specific interests.

Field and laboratory methods are further described in the CQAP including standard operating procedures.

5.2 Coordination with SAMP

Groundwater quality monitoring for future SAMP purposes is anticipated to occur on a five-year frequency. Accordingly, monitoring and analyses to be conducted for the five-year GQTM reporting are planned to be coordinated with monitoring activities for the SAMP. To the degree that any additional analytes are required through the SAMP, such analytes may be tested for a limited time to assess their presence or absence; however, any longer-term monitoring for these analytes would not necessarily involve samples collected from all CVGMC monitoring wells.

5.3 Sampling Schedule

Consistent year-to-year timing of sampling of CVGMC GQTM network wells is important for evaluating long-term trends in groundwater quality. Annual sampling for the CVGMC monitoring program takes place each year between May and August (late spring/summer).[6]

5.4 Overview of Comprehensive Quality Assurance Plan

The Comprehensive Quality Assurance Plan (CQAP) describes how the data collected as part of the CVGMC will meet quality control and quality assurance requirements as required by the individual Coalition Orders. The CVGMC CQAP documents the planning, implementation, and assessment procedures of the CVGMC specific to quality assurance and quality control activities.

The CVGMC CQAP addresses common activities that should be implemented by each of the CVGMC member Coalitions. The goal of the CVGMC CQAP is to ensure that all groundwater monitoring data collected by member Coalitions will meet: 1) the same quality objectives; 2) ensure that the data collection, generation, and acquisition methods are appropriate for meeting the project objectives; 3) ensure that the assessment procedures are sufficient for confirming that data meet quality expectations; and 4) identify where any limitations exist on the use of data. The CVGMC CQAP includes an organization chart of CVGMC members and consultants and lists out roles and responsibilities as well as outlines the process for managing and accessing data within the CVGMC DMS. The CVGMC CQAP defines the overall programmatic requirements as well as project specific measurement quality objectives. Each of the Coalitions is a signatory on the CQAP including a project specific Quality Assurance (QA) Officer. Any deviations from the CQAP will be reviewed by the Project QA Officer as well as the Program QA Officer to ensure compliance. As needed, the CVGMC will submit amendments to the Regional Board and State Board QA Officer for approval.

The CVGMC originally submitted to the Regional Board in May 2018 the quality control procedures as outlined above. After working through an updated format, the CQAP has been reviewed and approved by the State Water Resources Control Board Quality Assurance (QA). At the time of this submittal, the CQAP is being circulated for final signatures and approval by the Executive Officer.

[6] On May 8, 2019, the Regional Board approved modifying the sampling time frame shown in the original WDR MRP from fall to late spring/summer.

6 Centralized Data Management System

Appendix II of the CQAP contains the Standard Operating Procedures (SOP) for Groundwater Data Management. The SOP describes the procedures and protocols for managing groundwater data collected and analyzed under the CVGMC. The SOP describes minimum information requirements, data verification and validation procedures for field and laboratory results, and the storage of results in the CVGMC DMS. **Figure 6-1** is a diagram of the data flow associated with the CVGMC DMS and illustrates how data are obtained, received, and managed following the procedures outlined within this document.

The DMS is stored on an Amazon Web Services (AWS) server, which is a fully managed backup server that allows for centralized and automated backup of data. By using AWS, the DMS is backed up with the highest level of security. The CVGMC DMS is designed for storing and managing data to meet the CVGMC goals. Coalitions may utilize this system for their own reporting; therefore, the CVGMC may develop online tools for the member Coalitions and laboratories to upload data and for data to be retrieved using password protected logins. The CVGMC DMS does not preclude individual Coalitions from managing their data on a local level, but the DMS serves as a central repository of information managed in a consistent format.

7 Data Analysis, Reporting, and Schedule

Reporting will be accomplished using a common framework among the participating Coalitions. As required by the ILRP General Orders, each Coalition will provide an Annual GQTM Report describing groundwater monitoring in their region. The individual Coalition Annual GQTM Reports will be consistently formatted to include basic data tables, time series plots (when sufficient data are available), and figures to display the monitoring results of the current year and variation across years. Every five years, a coordinated CVGMC Five-Year Report (Assessment Report) will be provided to the Regional Board that characterizes groundwater quality across the entire Central Valley (or the portions of the Central Valley participating in the CVGMC). The CVGMC Five-Year Assessment Report will be inclusive of the individual Coalition Annual GQTM Reports. **Table 7-1** summarizes the responsibilities of the individual Coalitions and the responsibilities and actions shared collaboratively through participation in the CVGMC.

7.1 Annual GQTM Report

Annual analysis and reporting of results related to the individual Coalition GQTMs will focus on visual and tabular presentation of data with limited representation of data interpretation. Additional interpretations and conclusions relating to trends and relationships in trends will be conducted as part of reporting every five years, as indicated in **Table 7-1**. The GQTM network for each Coalition will be reviewed and recommendations for modifications will be provided as needed.

Annual GQTM Reports will include a map or maps of the wells sampled and monitored as part of the GQTM network. Results from sampling will be provided in a tabulated format consisting of a summary of the results using statistics such as minimum, maximum, and mean result, in addition to a table providing all field and analytical results. Individual Coalitions will perform appropriate quality control on annual data collected and will include an assessment of precision, accuracy, and completeness within their Coalition Annual GQTM Reports. Visual presentation of results with some limited interpretation will be provided in the form of a map of nitrate concentrations in groundwater based on observed groundwater quality in the GQTM network wells, as measured for the most recent monitoring year.

Graphs of time-series groundwater quality data for the wells in the GQTM network will be included in the Annual GQTM Reports. Time-series graphs for GQTM wells will include readily available historical water quality data relevant to potential influences from irrigated agriculture, including data that pre-date the GQTM. Time series plots will focus on nitrate concentrations.

7.2 Five-Year Report

Reporting for the CVGMC will include more extensive analysis at five-year intervals. Every five years, a coordinated Five-Year Assessment Report will be provided to the Regional Board that characterizes groundwater quality across the entire Central Valley (or the portions of the Central Valley participating in the CVGMC). The report will include separate chapters reporting on trends in groundwater quality in each Coalition region as well as a chapter(s) that characterizes groundwater quality across all

participating regions. Each chapter will be consistently formatted with common maps, figures, and text to facilitate review by Regional Board staff and other interested parties.

All participating Coalitions will coordinate so that data analysis and reporting methods used to evaluate groundwater quality will be consistent within each Coalition region and across the CVGMC region. The Five-Year Assessment Report will include all elements in the Annual GQTM Report, as described above, with the additional analyses and presentations described below.

Groundwater elevations will be reported in the first Five-Year Assessment Report using available groundwater elevation data (i.e., groundwater elevation contours available from DWR or SGMA GSPs), with the reporting frequency of groundwater elevations after the first Five-Year Assessment Report to be determined in coordination with the Regional Board.

Table 7-1 summarizes all of the Annual GQTM Report elements and additional reporting elements that will be included in the Five-Year Assessment Report. With the greater level of analysis conducted every five years, the Five-Year Assessment Report is intended to fulfill the requirements of individual Coalition five-year GAR updates, while also serving the objectives of the SAMP and satisfying all SAMP requirements.

7.2.1 Additional Groundwater Quality Data Acquisition

Consistent with the objectives and requirements of the Coalition five-year GAR updates and the SAMP, every five years, readily available public groundwater quality data for water quality constituents relevant to irrigated agriculture will be compiled for the CVGMC region. The acquisition of additional groundwater quality data will focus on nitrate concentrations and SC/TDS data. These data will be in addition to the concentrations of anions and cations collected as part of the individual Coalition GQTM networks and will include data from numerous public water supply wells sampled at a regular interval throughout the CVGMC region. Some individual Coalitions are including public water supply wells as complementary network wells to supplement principal network wells. These wells are also being vetted to identify and associate well construction data with historical water quality data and further enhance the utility and value of those data. Community water systems are required to report water quality parameters for public water supply wells on a triennial or more frequent schedule, pending location of the system and specific circumstances that may require more frequent testing and reporting. These data are reported to the State Water Resources Control Board (State Board) DDW and are publicly available.

Consideration of ILRP drinking water well monitoring data will be incorporated in the Five-Year Assessment Report, when these data are available. Additional groundwater quality data collected at regulated facilities and from other wells are also updated to the publicly accessible GeoTracker database. Most of the public supply wells and wells with data in GeoTracker are located within the Central Valley Floor of the CVGMC region.

Additional non-Coalition groundwater quality data acquired as part of the CVGMC Five-Year Assessment Report will be reviewed for quality (e.g., to identify data inconsistencies and outliers).

7.2.2 Comparison of Regional Groundwater Quality and Trends

Regional trends in groundwater quality relevant to irrigated agriculture are not likely to change rapidly. Therefore, analysis of groundwater quality trends will be conducted every five years and reported accordingly. Trends in all wells for which data are available (GQTM network well data and other publicly available well data) will be analyzed using statistical methods to evaluate the presence and magnitude of groundwater quality trends and investigate relationships with land use conditions and practices. Non-parametric statistical analyses of temporal trends in concentrations (e.g., Mann-Kendall test) and parametric statistical analyses of temporal trends (e.g., linear regression) will be considered as statistical methods to evaluate groundwater quality trends. Non-parametric and parametric statistical analyses utilize different data assumptions and can yield different trend results. The results from these statistical trend analyses will be presented spatially in the form of maps and will be evaluated for regional spatial patterns in trends.

A statistical summary of groundwater quality trends will be tabulated and presented by monitoring subarea or other delineated regional area (pending any spatial patterns in trends evident in the data) for the purpose of analyzing potential relationships between land use conditions and groundwater quality trends. Regional trends in concentrations will be evaluated with respect to land use composition and associated management practices. For example, quantitative comparisons of land uses present in proximity to wells and the associated observed trends in groundwater concentrations may be used to understand how groundwater quality is responding to agricultural management practices. Updated interpretation and mapping of land uses and practices within the Coalition region, particularly as they relate to agricultural lands, will be incorporated into these evaluations. Potential climatic influences on groundwater quality trends will be assessed. Climatic variability can drive changes in groundwater demand (increased groundwater pumping) and the amount of groundwater recharge from water applied as irrigation or falling as precipitation within the region. Such climatic influences could impact groundwater quality conditions and trends and should be considered. Lastly, trends in groundwater quality will also be analyzed by depth zones at selected locations where available well location and construction information allow such comparisons. Comparison of groundwater trends by depth zone may provide useful insights into the rates and paths of groundwater movement. Groundwater level data collected through the GQTM will be evaluated to identify groundwater flow patterns and determine if locations of GQTM network wells are appropriate and sufficient to meet the objectives of the GQTM. This assessment will consider the uncertainty relating to trends and concentrations in areas and the existence of data gaps that limit the ability to evaluate regional trends in relation to agricultural practices.

7.2.2.1 GQTM Network Wells, Other Wells with Groundwater Quality Data and Uncertainty

Well vetting efforts were undertaken by the Coalitions, and have continued after their respective GQTM Workplan submittals, to ensure GQTM well information and sampling agreements with well owners/operators are confirmed prior to the initial sampling event resulting in higher-quality trend monitoring information. Because the CVGMC GQTM network has known construction information, trend analyses will initially emphasize the relationships between land use and groundwater quality trends

using these wells. Other water quality data, that have not yet been linked to well construction information, will be used with caution until the wells have been completely assessed for usability within the program. Regional trend analyses will be used to identify potential data gaps for consideration.

7.2.2.2 Improved Data Certainty in the Future

Through the State Board's efforts to link well construction details to wells with groundwater quality data in GeoTracker (Scott Seyfried, personal communication), more informative data will be publicly available in the future. Similarly, as monitoring networks are designed, and programs are implemented for SGMA purposes, this will also result in more meaningful data. Member Coalitions will benefit from: 1) integration of GQTM/SGMA/SAMP well networks as appropriate to meet similar monitoring program objectives; 2) streamlining data collection, management and analysis efforts; and 3) utilizing network wells that provide more meaningful data and understanding of trends and conditions.

7.3 Report Discussion

Both the Annual GQTM Report and Five-Year Assessment Report will include discussion of results and findings from the individual Coalition GQTM networks. As described above, the Annual GQTM Report will focus on graphical and tabulated presentation of monitoring results. The Five-Year Assessment Report will incorporate additional data acquisition beyond the sample data collected from GQTM network wells and these data will be analyzed statistically for trends. Findings related to groundwater quality trends, spatial patterns in trends, and statistical associations between trends and land use composition and management practices will be the focus of discussion in the Five-Year Assessment Report. A discussion of findings related to data gaps will be included and recommendations regarding addressing data gaps will be provided. The need for refinements to the design of the individual Coalition GQTM networks will be assessed and discussed in the report and associated recommendations on modifications to the program design will be provided. Individual Coalitions will be responsible for implementing updates to their respective GQTM networks.

7.4 CVGMC Regional Monitoring, Central Valley Groundwater Monitoring Program and ILRP Five-Year GAR Update

Within one year of the effective date of the Central Valley Salinity and Nitrate Control Program (i.e., following adoption of the Central Valley Basin Plan amendment), requirements will be triggered for all dischargers of salt and nitrate to participate in other existing groundwater quality monitoring programs that will contribute data to the Central Valley Salt and Nitrate Monitoring Program. The purpose of the Salt and Nitrate Groundwater Monitoring Program (Central Valley Groundwater Monitoring Program [also referred to as the SAMP]) is to evaluate ambient water quality and trends in groundwater basins in the floor of the Central Valley Region, including the CVGMC region.

An assessment of ambient groundwater quality and trends is to be completed for all required groundwater basins/subbasins at least once every five years. To complete this assessment and to the extent practicable, the Central Valley Groundwater Monitoring Program will utilize data collected by existing Regional Board water quality monitoring programs to be cost-effective and establish

consistency in how groundwater quality data are collected, managed, assessed, and reported. Consistent with this purpose, the ILRP CVGMC GQTM is anticipated to provide the foundation for the development of the Central Valley Groundwater Monitoring Program.

Data developed under the ILRP will be supplemented, as needed, to ensure that the periodic (Five-Year) report is completed on schedule. Sources of supplemental data include data from numerous other existing groundwater monitoring programs. As part of the ILRP requirements, individual Coalitions are currently required to conduct a Five-Year GAR update, which includes the collection and evaluation of available groundwater quality data collected by non-ILRP programs to assess groundwater quality conditions and trends. Since this Five-Year GAR update requirement aligns with the purpose of the CVGMC Five-Year Assessment Report and the Central Valley Groundwater Monitoring Program, it is envisioned that these three programs (CVGMC, SAMP, and Five-Year GAR update) could be integrated into a single, more informative, streamlined, and cost-effective program. **Figure 7-1** illustrates the conceptual integration of these programs.

7.5 Schedule

On March 9, 2020, the Monitoring and Reporting Programs for the General Orders for growers within the Central Valley that are members of a third-party Group were revised to synchronize reporting schedules for the CVGMC individual Coalition Annual GQTM Reports and other five-year reporting requirements. Annual GQTM Reports are to be submitted by the Coalitions to the Regional Board by May 1 of the year following the prior year's sampling event. Five-Year Assessment Reports (which is in-lieu of separate individual third-party GAR updates and five-year groundwater quality trend evaluation reports) are to be submitted beginning November 30, 2021.[7] A separate Annual GQTM Report is not due during years in which a Five-Year Assessment Report is submitted.

[7] Ordinarily, the Five-Year Assessment would have been due in fall of 2023 to coincide with completion of five GQTM sampling events beginning in fall of 2018. However, in an effort to synchronize the Five-Year GAR updates with the CVGMC Five-Year Assessment Report, in July 2019 the CVGMC proposed to accelerate the submittal date for the first Five-Year Assessment Report for most Coalitions. The East San Joaquin Water Quality Coalition had a GAR update due by September 30, 2019.

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TABLES

Table 1-1. Required Technical Elements for Individual GQTM Workplans

GQTM Workplan Items Identified in Monitoring and Reporting Program (Appendix B) of the WDR General Orders		Where Addressed		How Addressed
		Individual Coalition GQTMs	*CVGMC Workplan Update*	
1. Workplan Approach				
Discussion of the rationale for the number of proposed wells to be monitored and their locations		X	X	Rationale for monitoring approach, guidelines for target well depth, and proposed monitoring emphasis and approach are based on numerous factors considered by each Coalition as described in their respective GQTM Workplans. At the CVGMC regional level, monitoring considerations include HVAs, irrigated agriculture and top commodities in CVGMC region, delineation of upper part of groundwater system in CVGMC region, typical depths of completion of domestic wells; distribution and monitoring of Public Water Supply wells completed in upper part of groundwater system.
A.	*Consideration of variety of agricultural commodities produced within the third-party's boundaries*	X	X	
B.	*Consideration of conditions discussed/identified in the GAR related to the vulnerability prioritization*	X	X	
C.	*Consideration of areas identified in GAR as contributing significant recharge to urban and rural communities where groundwater serves as a significant source of supply*	X	X	
2. Well Details				
Details for well proposed for trend monitoring		X		The individual Coalition GQTMs provide specific details (e.g., depth, top and bottom of perforations) for the selected GQTM network wells.
A.	GPS coordinates	X		
B.	Physical address of the property on which the well is situated (if available)	X		
C.	California State well number (if known)	X		
D.	Well depth	X		
E.	Top and bottom perforation depths	X		
F.	Copy of DWR Well Completion Report (water well drillers log), if available	X		
G.	Depth of standing water (static water level), if available (may be obtained after implementing program)	X		
H.	Well seal information (type of material, length of seal)	X		
3. Proposed Sampling Schedule				
Trend monitoring wells to be sampled, at a minimum, annually at the same time of year for indicator parameters (parameters identified in WDRs, Att. B).		X	X	The annual sampling will occur in late spring/summer.

4. Workplan Implementation and Analysis			
Proposed methods to be used to evaluate trends in the groundwater monitoring data over time.	X	X	Discussion of methods proposed to present results and evaluate temporal trends and spatial patterns in trends for the CVGMC region. Annual Reports will be prepared by individual Coalitions and will contain tabular summaries of data and time series plots and other basic presentation of monitoring results. The Five-Year CVGMC report will cover the entire CVGMC region containing a combination of regional analyses of groundwater quality conditions and trends throughout the entire CVGMC region together with contributions of more local analyses by individual Coalitions for their respective areas.

Table 3-1. Crop Category Acreage (2014) for CVGMC Region

Crop Category	Total Acreage	Total ILRP Acreage
Deciduous Fruits and Nuts	1,403,013	1,367,680
Field Crops	615,503	567,910
Idle	575,017	421,168
Vineyard	430,018	413,857
Pasture	387,939	338,343
Truck, Nursery, and Berry Crops	345,402	299,181
Riparian Vegetation (Managed Wetlands)	219,076	217,777
Citrus and Subtropical	200,635	199,308
Grain and Hay Crops	161,627	138,313
Young Perennial	8,794	8,367
Rice	2,542	2,535
Grand Total	4,349,568	3,974,439

Table 5-1. GQTM Water Quality Testing Requirements

Water Quality Constituent	Reporting Units	Testing Frequency	Required or Optional[1]	Field or Laboratory Analysis	Comment
Nitrate as nitrogen	mg/L (as N)	Annual	Required	Laboratory	Should be part of trend monitoring for all wells included as part of the GQTM
Electrical conductivity (EC)	µS/cm	Annual	Required	Field	at 25 °C
pH	pH units	Annual	Required	Field	
Dissolved oxygen (DO)	mg/L	Annual	Required	Field	
Temperature	°C	Annual	Required	Field	
Oxidation-reduction potential (ORP)	mV	Annual	Optional	Field	
Turbidity	NTU	Annual	Optional	Field	
Total dissolved solids (TDS)	mg/L	Five years	Required	Laboratory	Should be part of trend monitoring for all wells included as part of the GQTM
Anions					
Carbonate	mg/L	Five years	Required	Laboratory	
Bicarbonate	mg/L	Five years	Required	Laboratory	
Chloride	mg/L	Five years	Required	Laboratory	
Sulfate	mg/L	Five years	Required	Laboratory	
Cations					
Boron	mg/L	Five years	Required	Laboratory	
Calcium	mg/L	Five years	Required	Laboratory	
Sodium	mg/L	Five years	Required	Laboratory	
Magnesium	mg/L	Five years	Required	Laboratory	
Potassium	mg/L	Five years	Required	Laboratory	

[1] Required water quality constituents will be included in all trend monitoring conducted by the coalitions. Not all required constituents will necessarily be included in trend monitoring conducted through coordination with other monitoring entities.

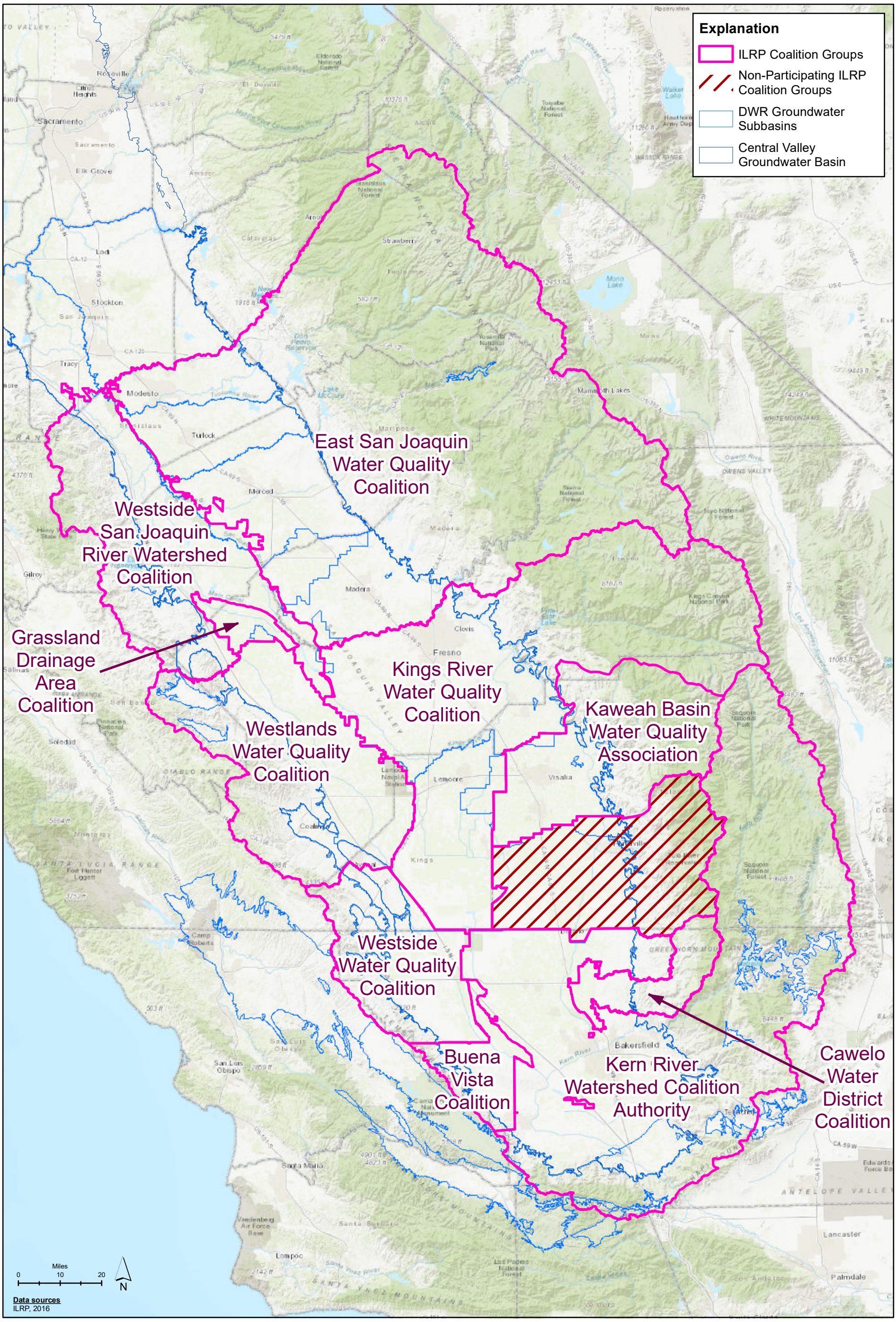
Table 7-1. CVGMC Reporting and Implementation Elements for Annual GQTM and Five-Year Assessment Reports

Reporting Element	Description of Reporting/ Implementation Method	Reporting/ Implementation Frequency	Primary Responsible Party	
			Individual Coalitions	CVGMC
Individual Coalition GQTM data submittal	Upload data to GeoTracker database; submit data to CVGMC DMS administrator in accordance with CVGMC data submittal and update process	Annual	Annual	Annual
CVGMC Data Management System update	CVGMC DMS administrator update DMS and related QA processes	Annual		Annual
Comprehensive Quality Assurance Plan	Review and update as needed	Annual	Annual	Annual
Design of trend monitoring program	Map(s) of monitoring areas	Annual/Five-Year	Annual	Five-Year
	Map(s) of sampled wells	Annual/Five-Year	Annual	Five-Year
Tabulation of results	Summary statistics	Five-Year	Annual	Five-Year
	Complete analytical results	Annual/Five-Year	Annual	Five-Year
	Analytical reports	Annual/Five-Year	Annual	Five-Year
Distribution of nitrate concentrations in groundwater (simplified visualization)	Map of nitrate concentrations for most recent monitoring year (GQTM wells)	Annual	Annual	
Visual presentation and interpretation of results	Map(s) of results and/or trends within aquifer system (e.g., color gradient symbols)	Five-Year	Five-Year	Five-Year
Graphic presentation of time series data	Graphs of series time data illustrating temporal changes; nitrate times series (Annual Reports)	Annual/Five-Year	Annual	Five-Year
Groundwater levels	Map(s) of groundwater elevations (e.g., contours) within select areas as applicable to regional monitoring network	Five-Year*	Five-Year	Five-Year
Update regional groundwater quality characterization (using readily available groundwater quality data)	Map(s) and tabulation of groundwater quality data relevant to irrigated agriculture	Five-Year		Five-Year
	Map(s) and tabulation of DPR groundwater pesticide monitoring data	Five-Year		Five-Year
Comparison of regional groundwater quality trends: *Temporal trends analyses*	Non-parametric statistical analyses of trends (e.g., Mann-Kendall test)	Five-Year		Five-Year
	Parametric statistical analysis of trends (e.g., linear regression)	Five-Year		Five-Year

Reporting Element	Description of Reporting/ Implementation Method	Reporting/ Implementation Frequency	Primary Responsible Party	
			Individual Coalitions	CVGMC
Comparison of regional groundwater quality trends: *Presentation of spatial patterns in trends (i.e., maps showing trends)*	Statistical summary of conditions and trends relative to monitoring areas	Five-Year		Five-Year
	Analyses of groundwater quality trends by depth zone	Five-Year	Five-Year	Five-Year
	Analyses of groundwater quality trends by location and locational characteristics (e.g., land use composition)	Five-Year	Five-Year	Five-Year
Rationale for trend monitoring program design	Discussion of basis for trend monitoring well selection	Annual/Five-Year	Annual	Five-Year
Synthesis of findings	Discussion of findings relating to groundwater quality trends and patterns (brief for Annual; more comprehensive for Five-Year)	Annual/Five-Year	Annual	Five-Year
	Evaluation of relationships between groundwater quality trends and land use	Five-Year	Five-Year	Five-Year
Evaluation of uncertainty and data gaps	Evaluation of representation of CVGMC well network in relation to trends and patterns observed across CVGMC region	Five-Year	Five-Year	Five-Year
Assess need for future monitoring refinements	Provide recommendations regarding monitoring network (brief for Annual; more comprehensive for Five-Year)	Annual/Five-Year	Annual	Five-Year
Address data gaps and monitoring refinements as needed	Implement actions to address Coalition area data gaps and monitoring refinements as needed	Annual/Five-Year	Annual/ Five-Year	
Coordination with education and outreach efforts	Evaluation of CVGMC design in relation to individual Coalition education and outreach efforts (brief for Annual; more comprehensive for Five-Year)	Annual/Five-Year	Annual	Five-Year

* Will include reporting of groundwater elevation contours from DWR or applicable GSPs in first Five-Year Assessment Report; frequency of reporting groundwater elevations after the initial Five-Year Assessment report to be determined in coordination with the Regional Board.

FIGURES



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 2-1 Participating Coalitions.mxd

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FIGURE 2-1

CVGMC Participating Coalitions

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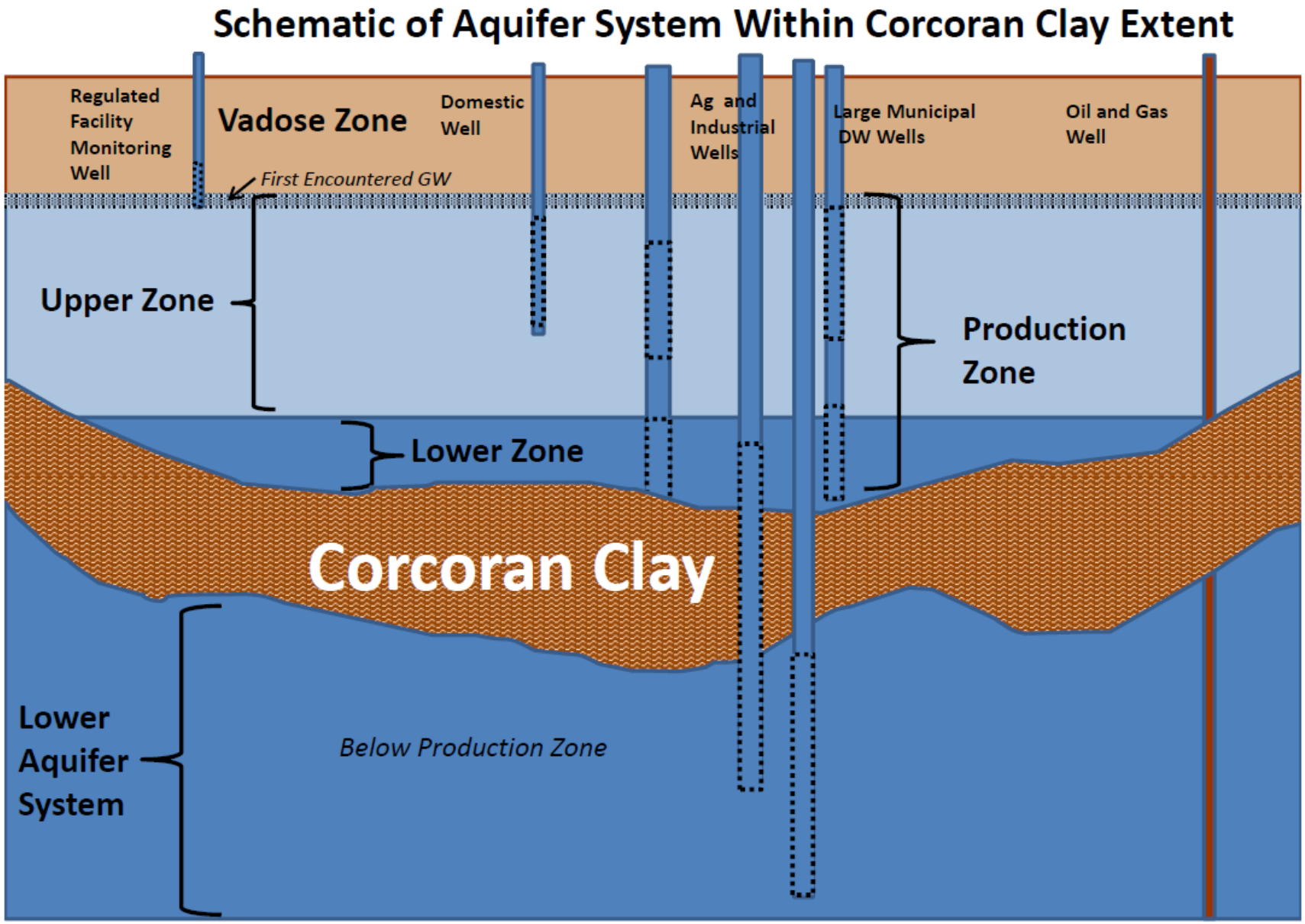

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-1 Schematic of Zone Nomenclature for CV-SALTS.mxd

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FIGURE 3-1

Schematic of Zone Nomenclature for CV-SALTS

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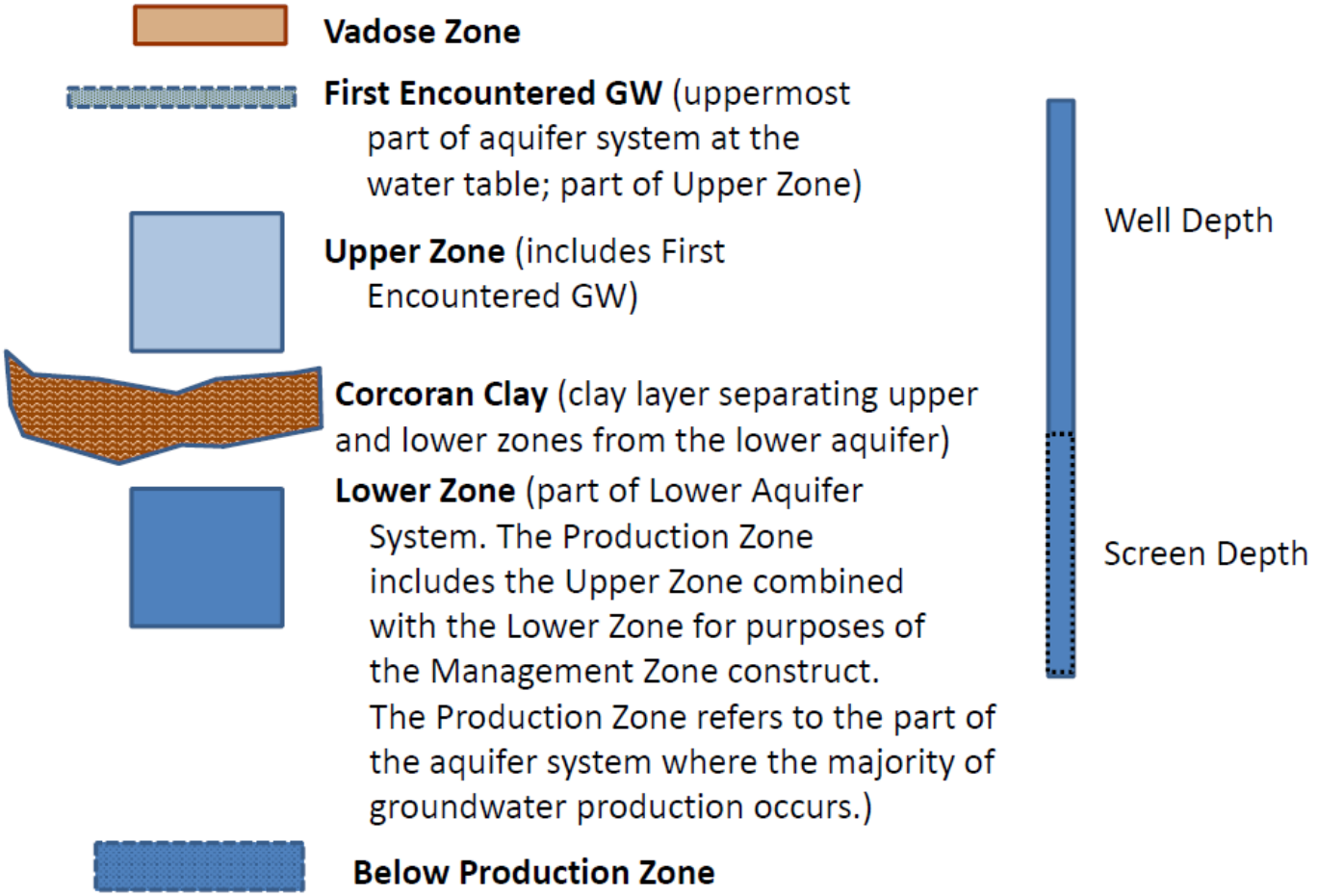
Explanation of Terms



If well depth is unknown, well types are categorized by:
Upper Zone – Regulated Facility Monitoring Wells; Domestic Wells
Lower Zone – Ag Wells, Industrial Wells, Public Supply Wells

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-1 explanation Schematic of Zone Nomenclature for CV-SALTS.mxd

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FIGURE 3-1 (Explanation)

Schematic of Zone Nomenclature for CV-SALTS

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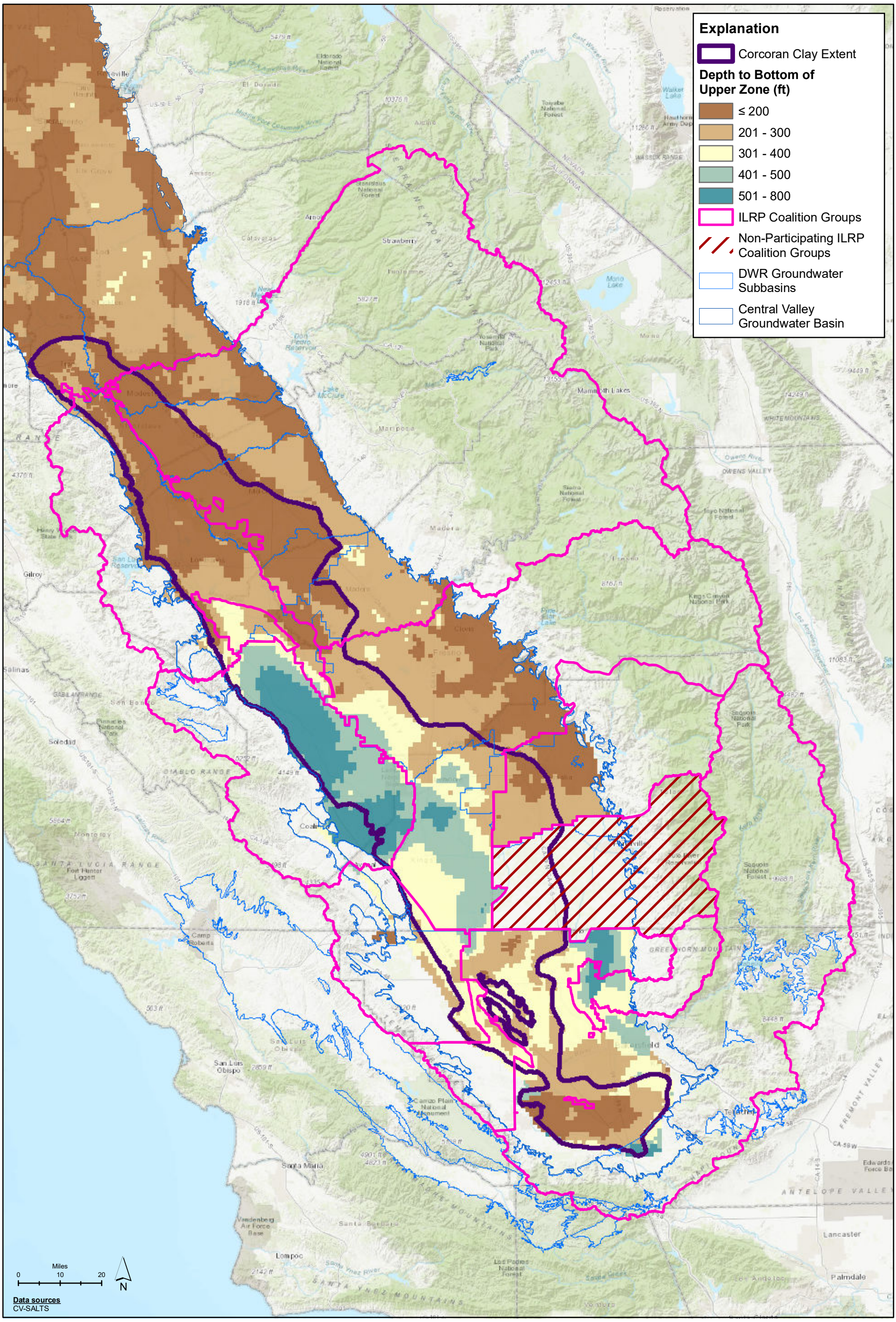
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-2 Depth to the Bottom of the Upper Zone (CV-SALTS).mxd

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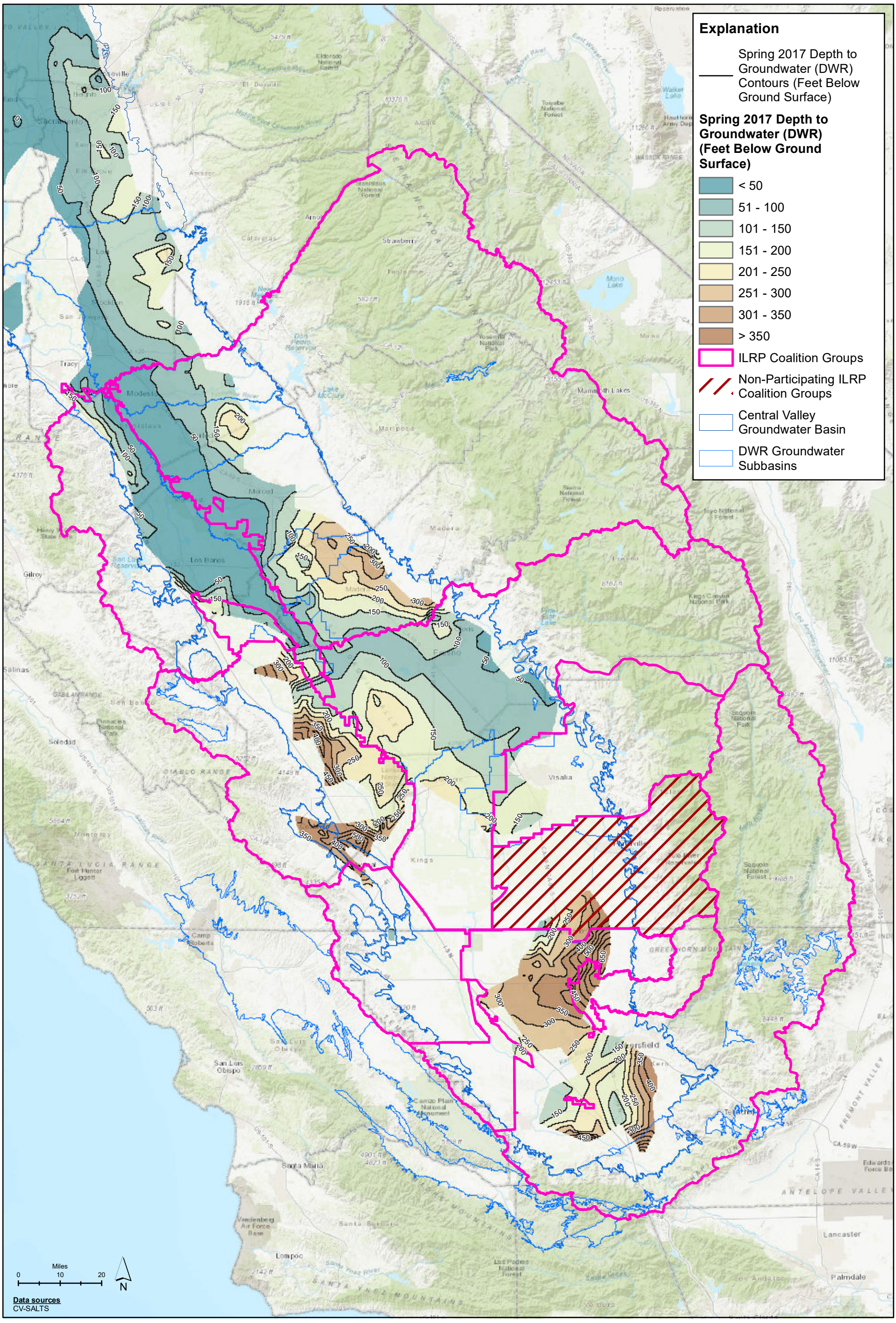
FIGURE 3-2

Depth to the Bottom of the Upper Zone (CV-SALTS)

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-3 Depth to Unconfined or SemiConfined Groundwater.mxd

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FIGURE 3-3
DWR Spring 2017 Depth to Unconfined to Uppermost Semi-Confined Groundwater

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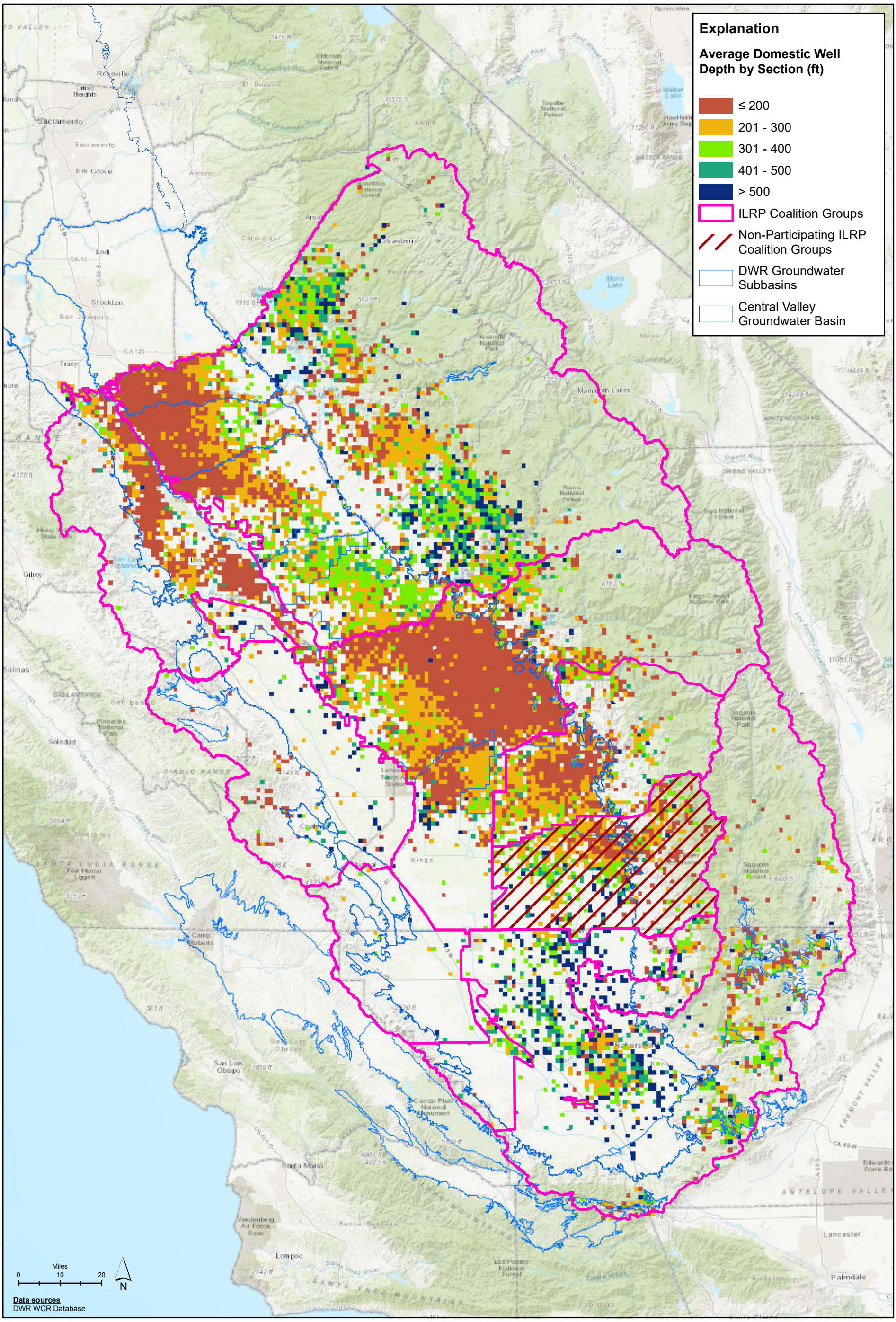
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-4 Average Depth of Domestic Wells.mxd

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FIGURE 3-4

Average Domestic Well Depth by Section

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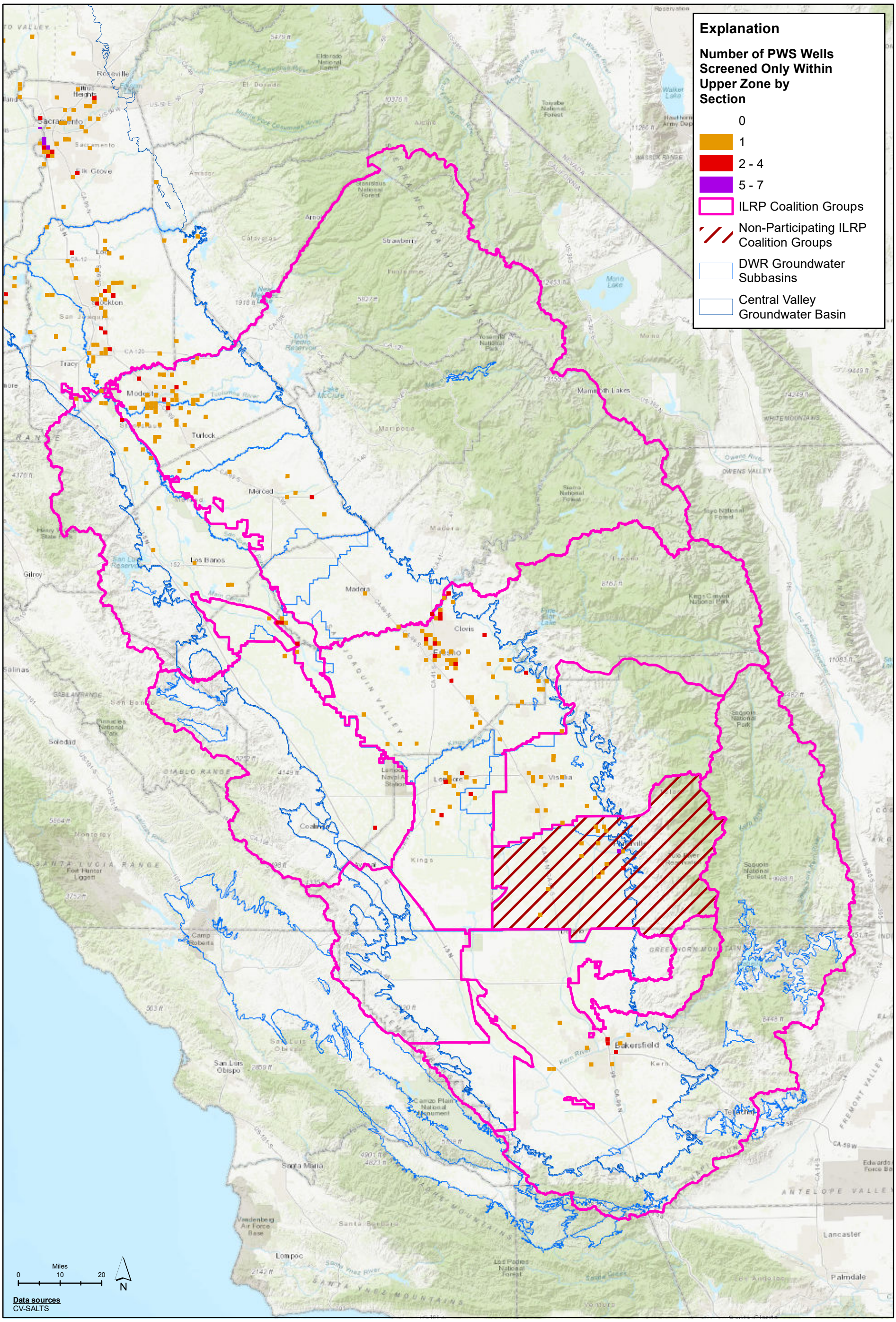

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-5 PWS Well Screened Only Within Upper Zone.mxd

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FIGURE 3-5

Public Water Supply Wells Screened Only Within the Upper Zone

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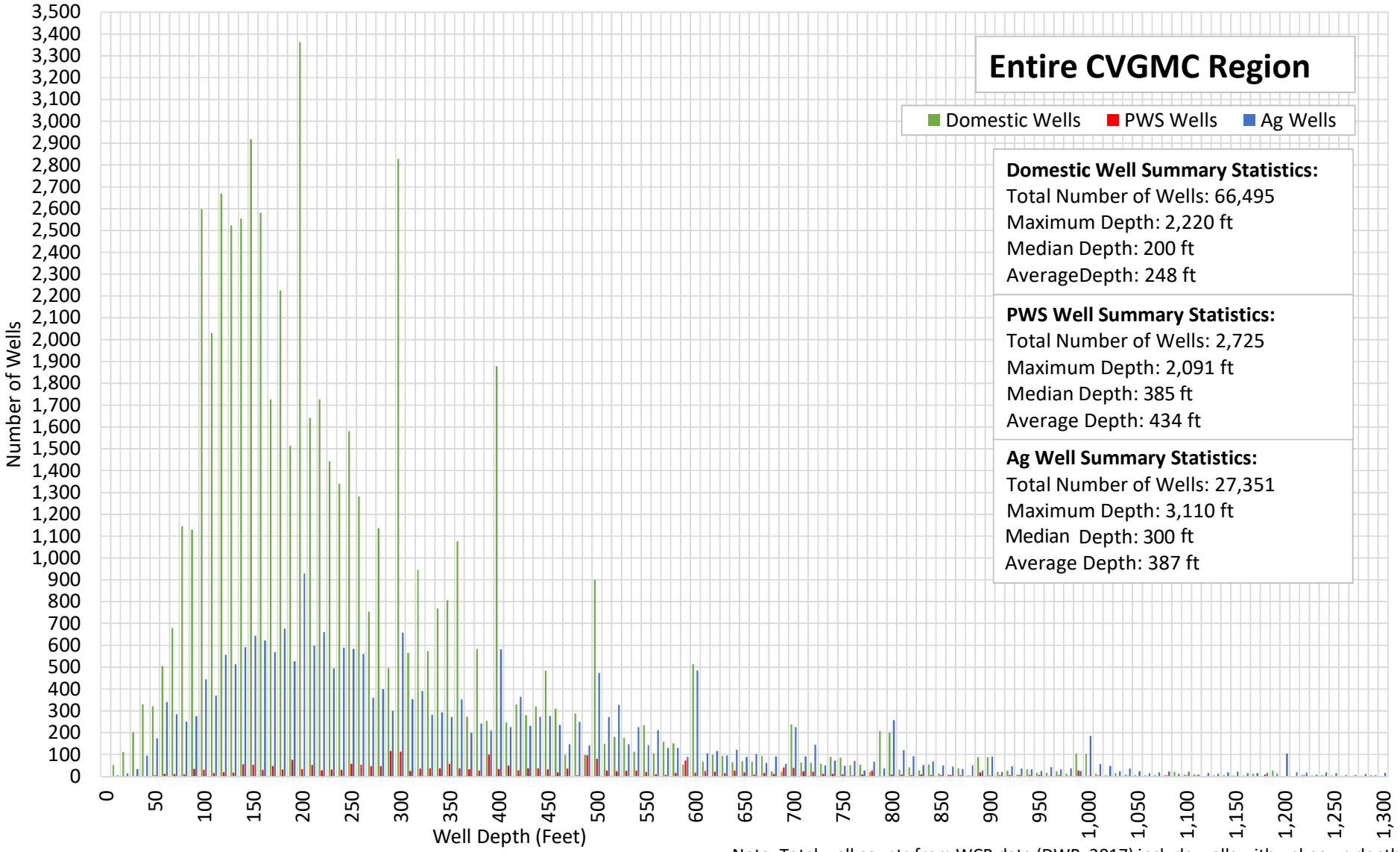
Workplan Update



Note: Total well counts from WCR data (DWR, 2017) include wells with unknown depth

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FIGURE 3-6

Histogram of Well Depths for the Entire CVGMC Region

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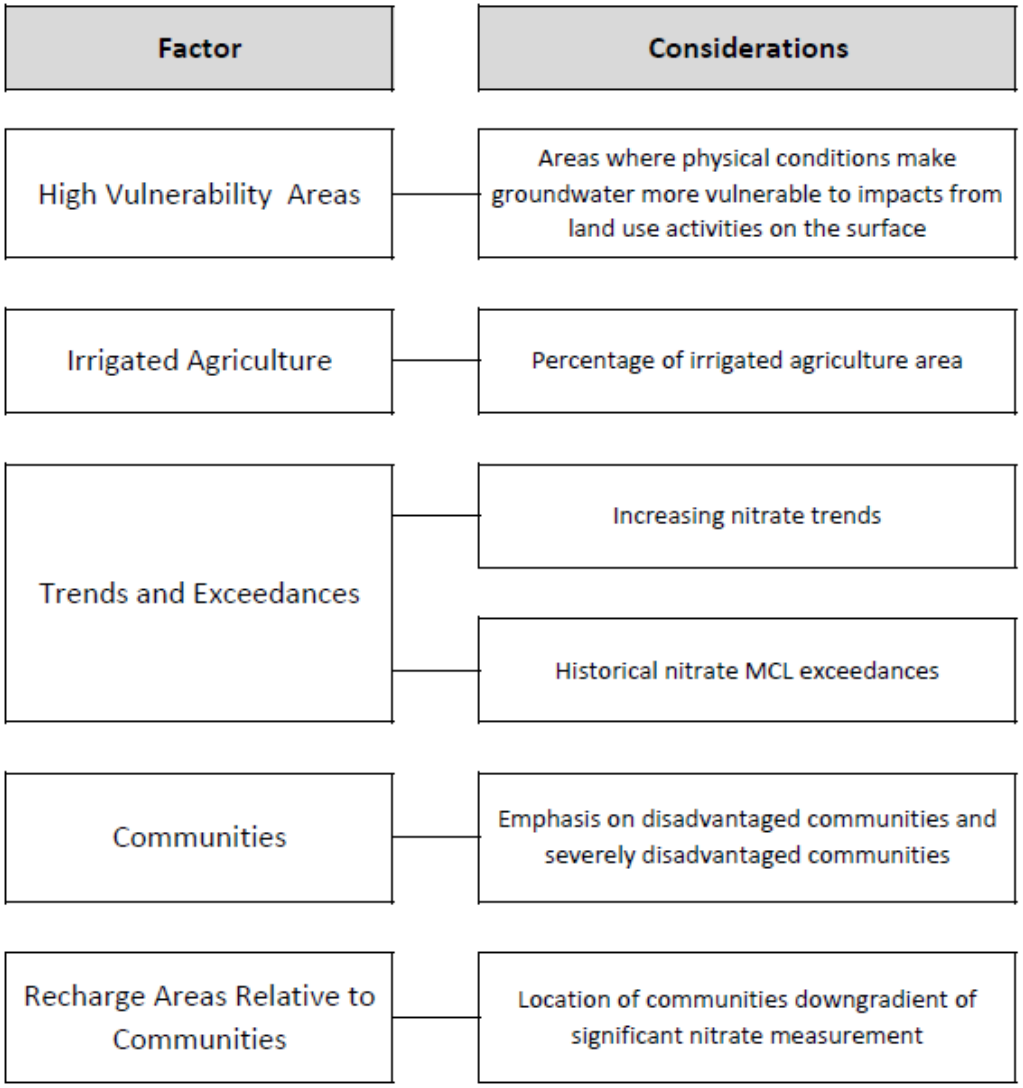

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-17 Key Factors Considered in Prioritization for Monitoring.mxd

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FIGURE 3-7

Key Factors Considered in Prioritization for Monitoring

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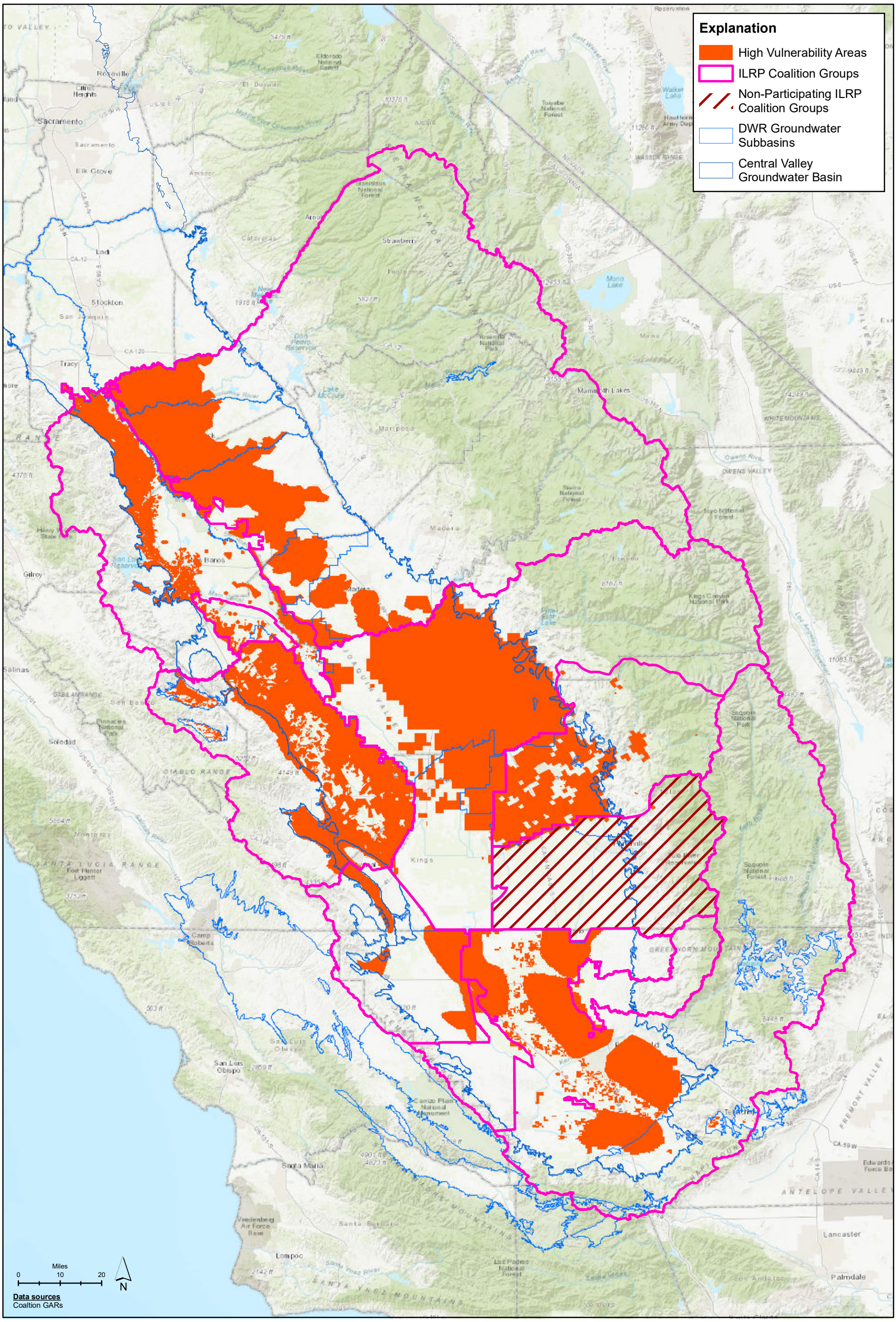

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-18 High Vulnerability Areas.mxd

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FIGURE 3-8

High Vulnerability Areas

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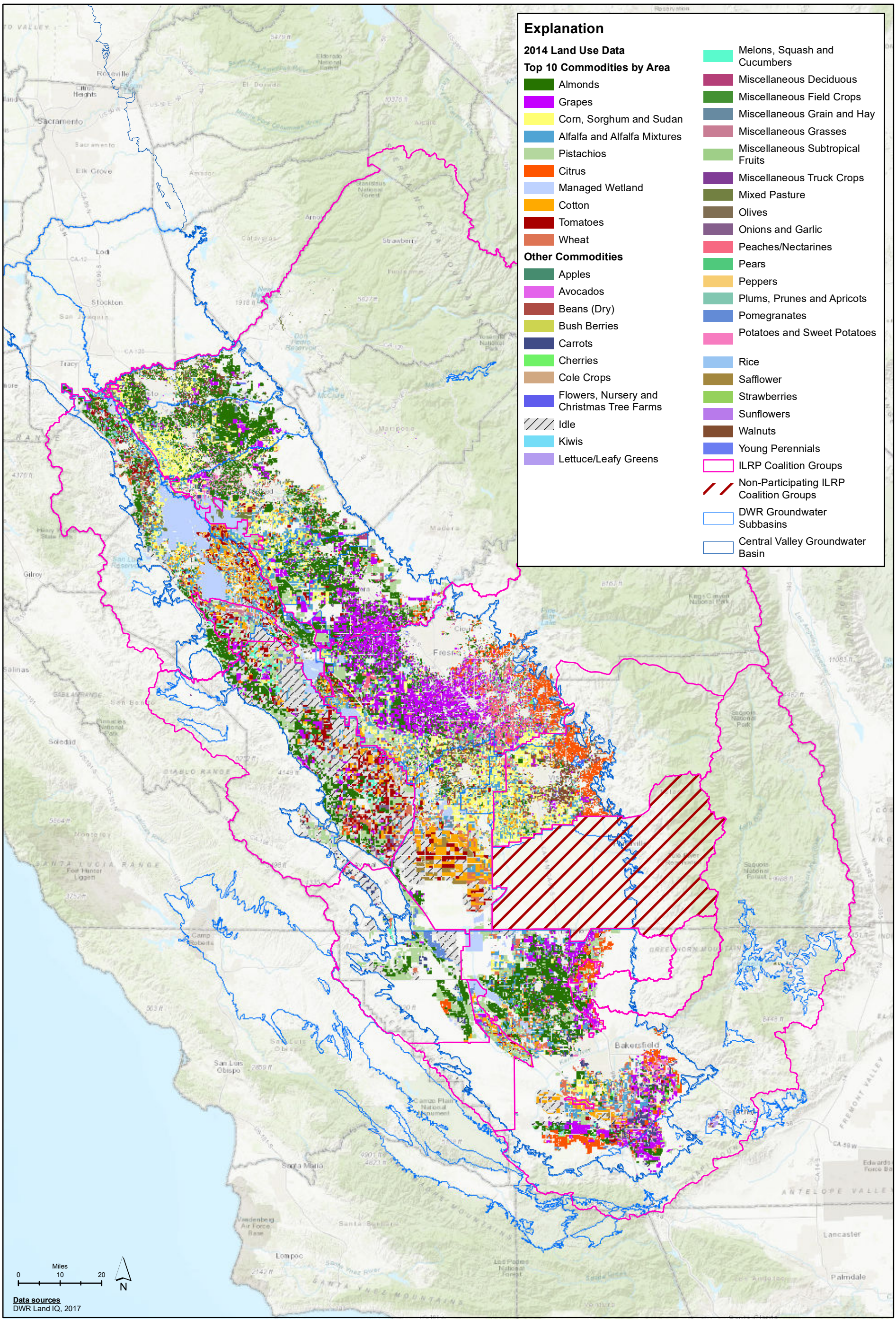

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-19 Irrigated Agriculture - All Commodities.mxd

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FIGURE 3-9

Irrigated Agriculture - All Commodities

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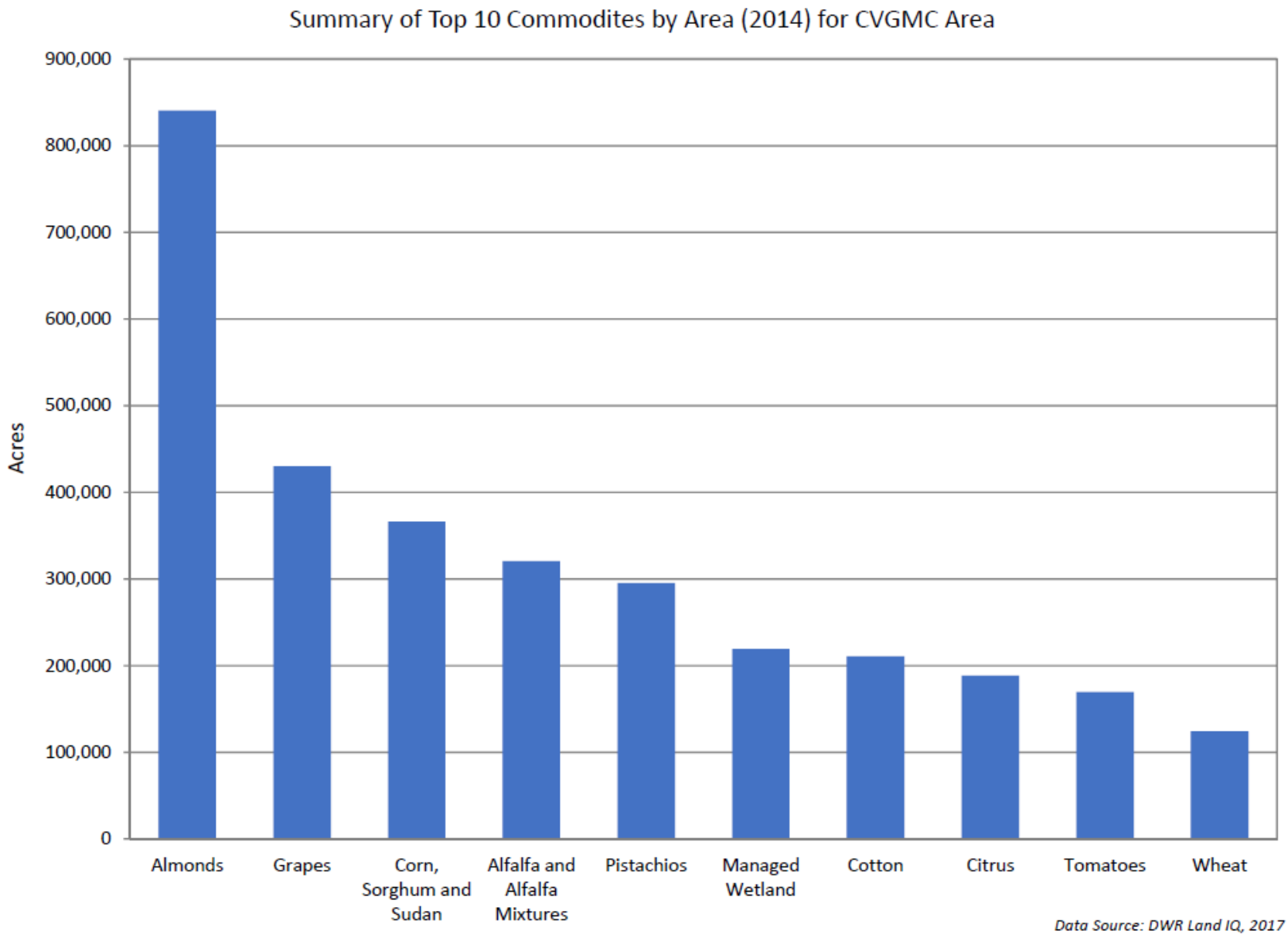
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-20 Summary of Top 10 Commodities by Area for CVGMC.mxd

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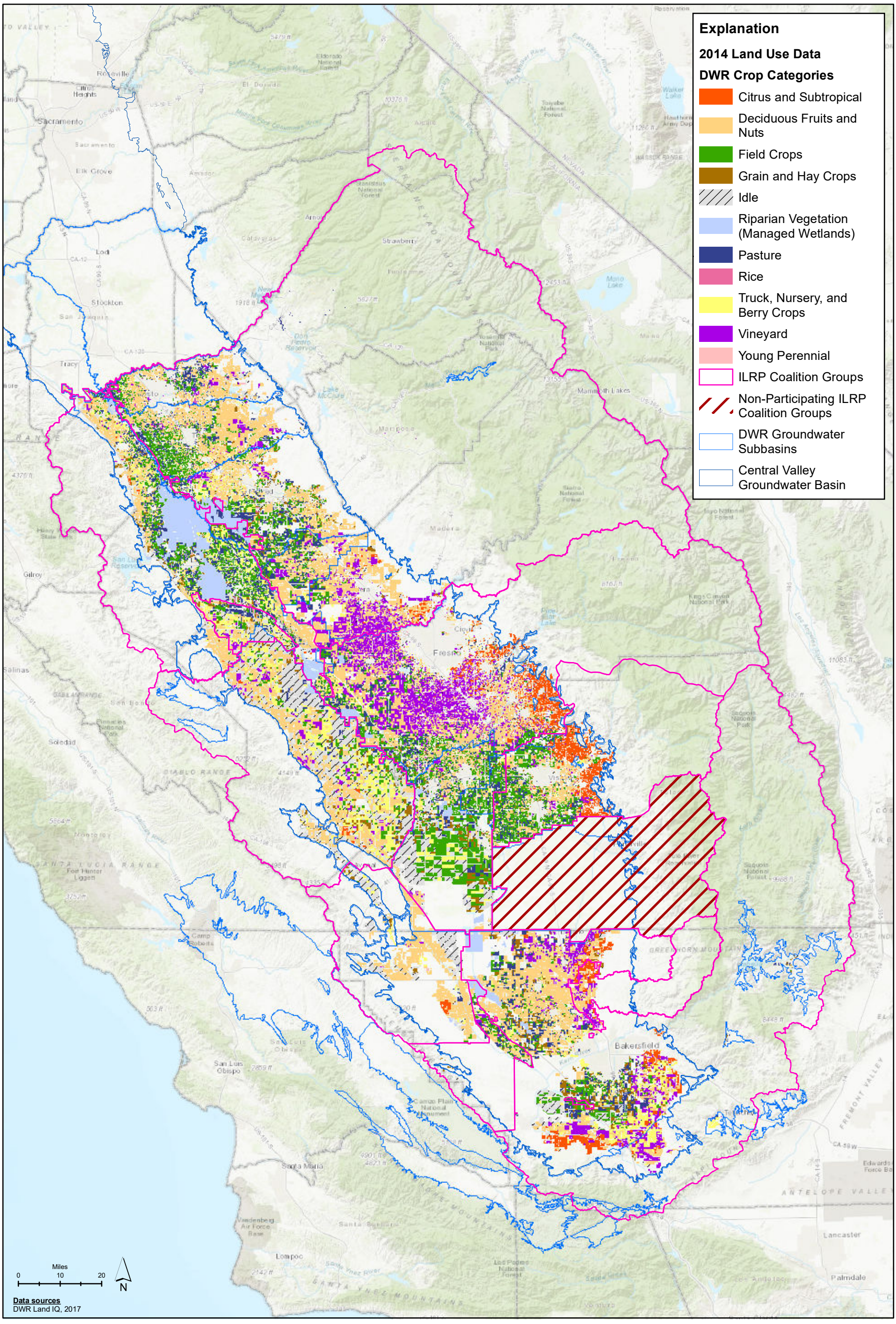
FIGURE 3-10

Summary of Top 10 Commodities by Area for CVGMC

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-21 Irrigated Agriculture - DWR Crop Categories.mxd

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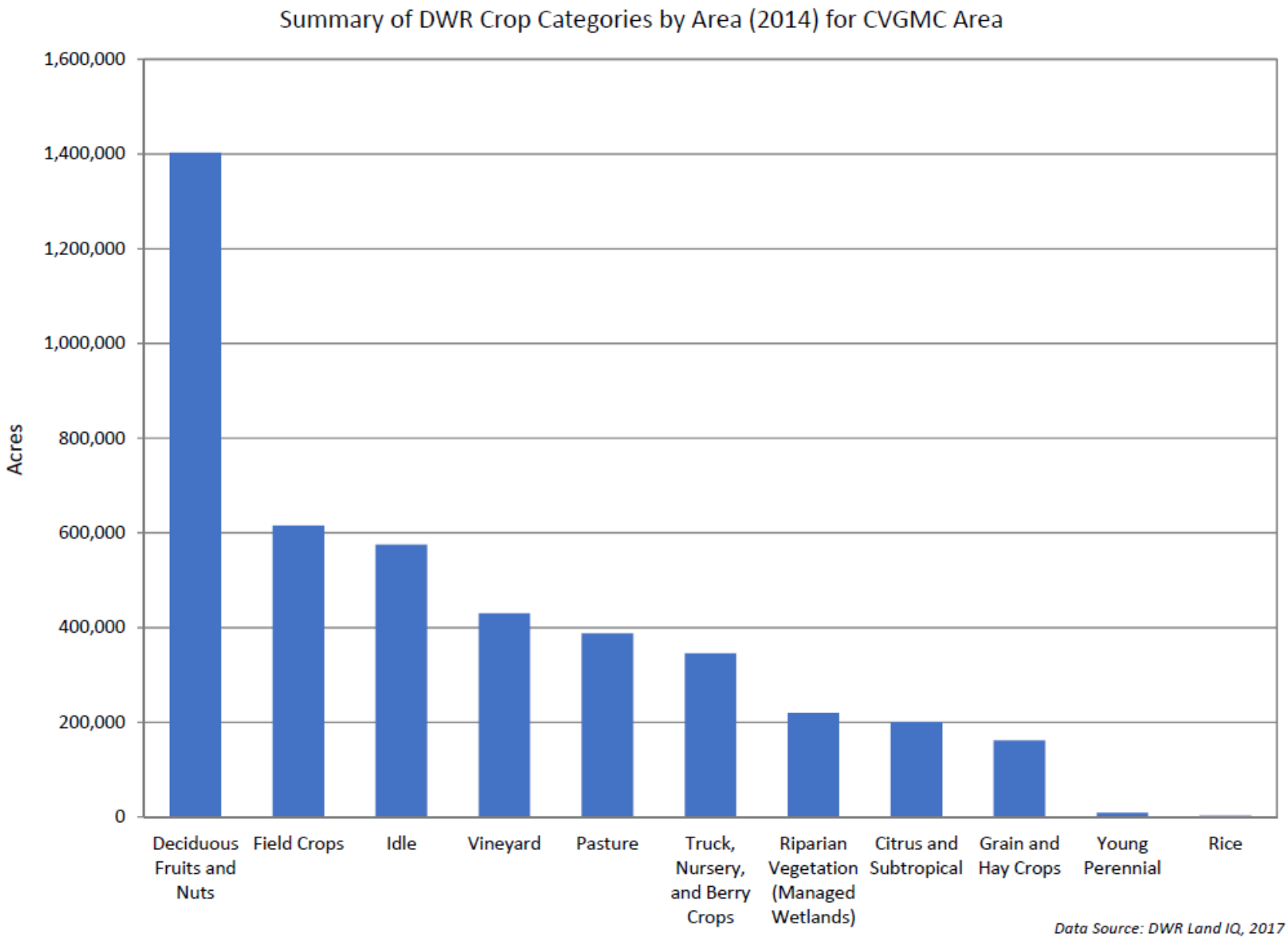
FIGURE 3-11

Irrigated Agriculture - DWR Crop Categories

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-22 Summary of Crop Categories by Area for CVGMC.mxd

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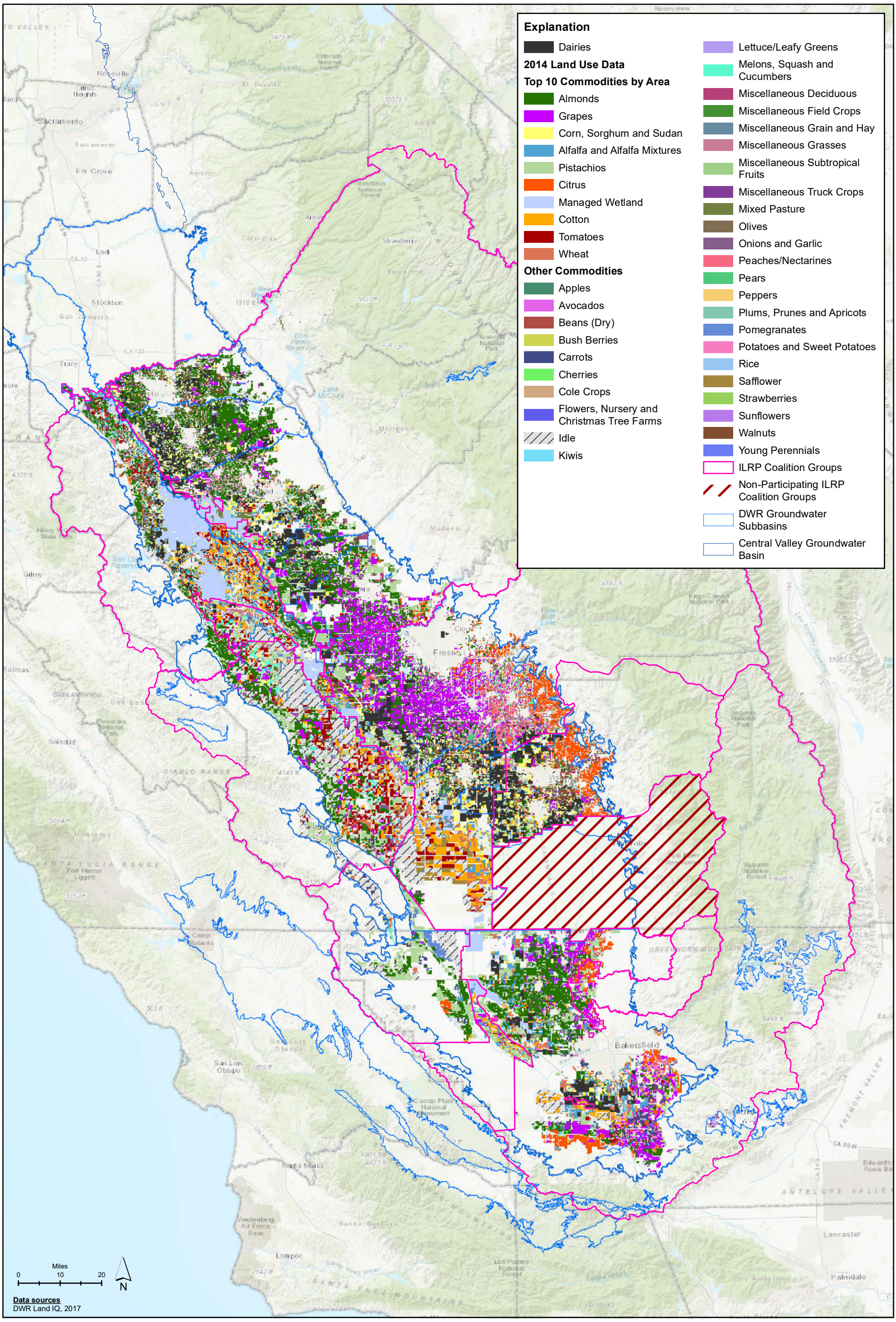
FIGURE 3-12

Summary of Crop Categories by Area for CVGMC

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-23 Irrigated Agriculture - All Commodities (Excluding Dairies).mxd

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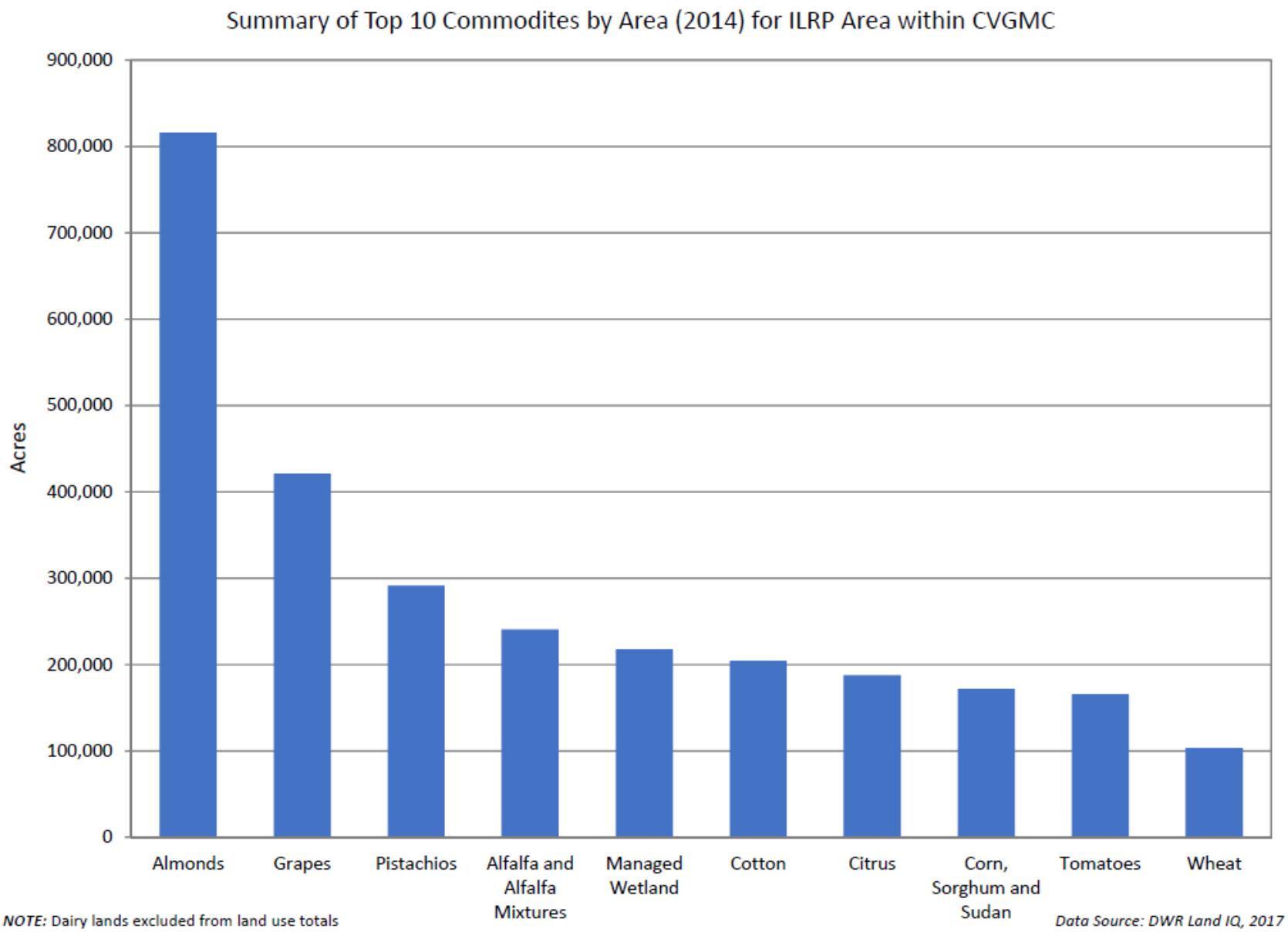
FIGURE 3-13

Irrigated Agriculture within ILRP Area of CVGMC - All Commodities

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-24 Summary of Top 10 Commodities by Area for CVGMC (Excluding Dairies).mxd

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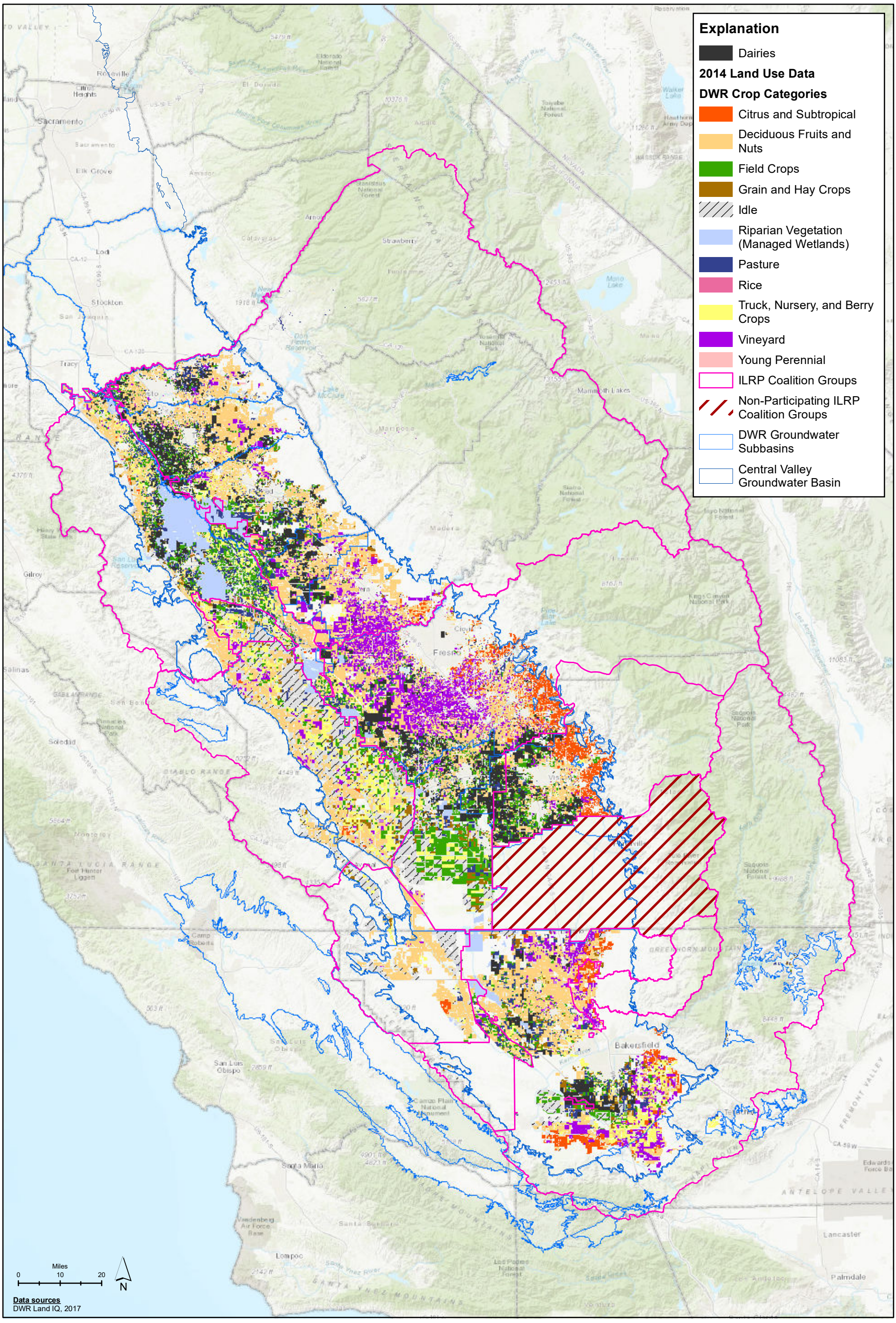
FIGURE 3-14

Summary of Top 10 Commodities by Area for ILRP Area within CVGMC

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-25 Irrigated Agriculture - DWR Crop Categories (Excluding Dairies).mxd

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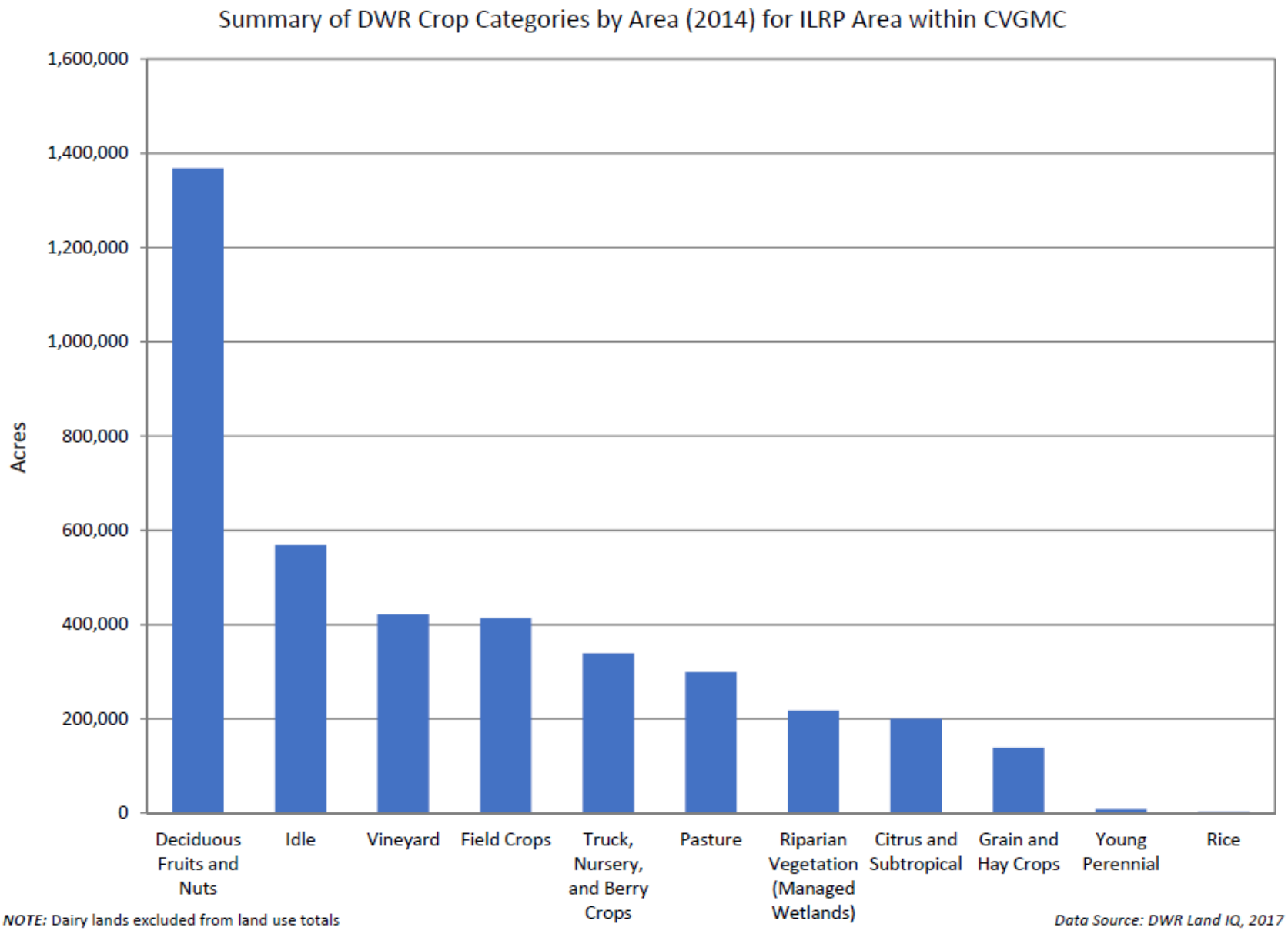
FIGURE 3-15

Irrigated Agriculture within ILRP Area of CVGMC - DWR Crop Categories

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-26 Summary of Crop Categories by Area for CVGMC (Excluding Dairies).mxd

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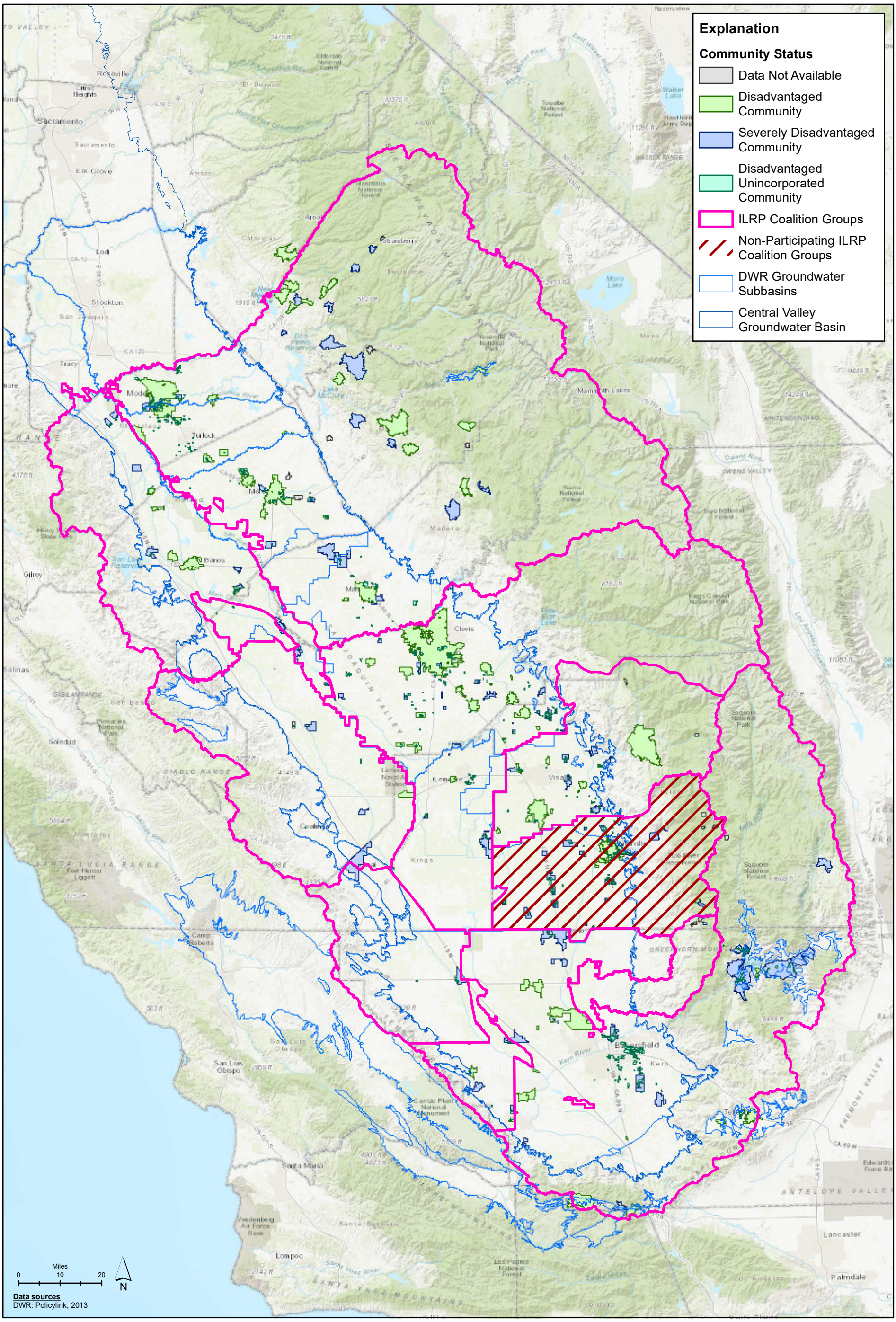
FIGURE 3-16

Summary of Crop Categories by Area for ILRP Area within CVGMC

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-27 Disadvantaged Communities.mxd

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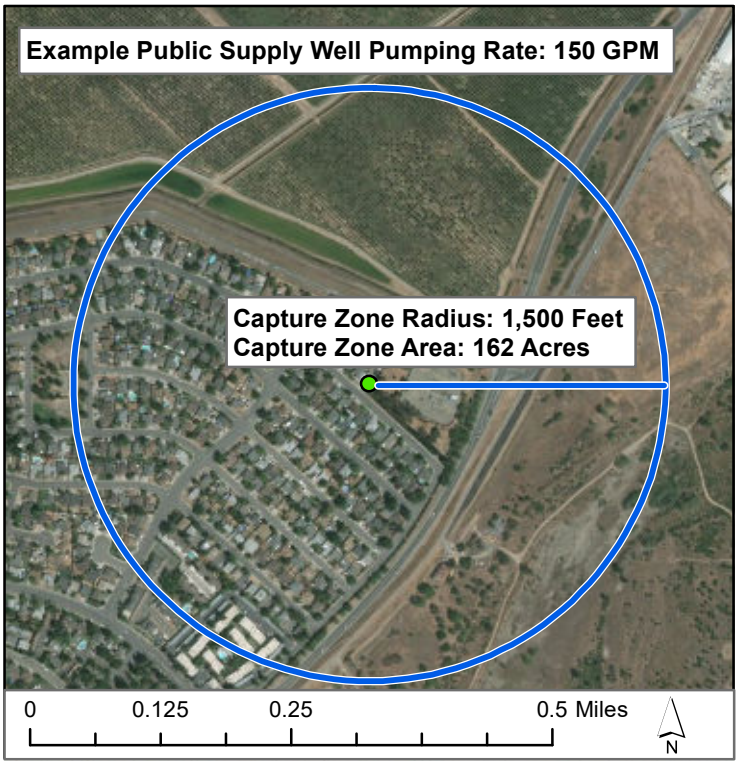
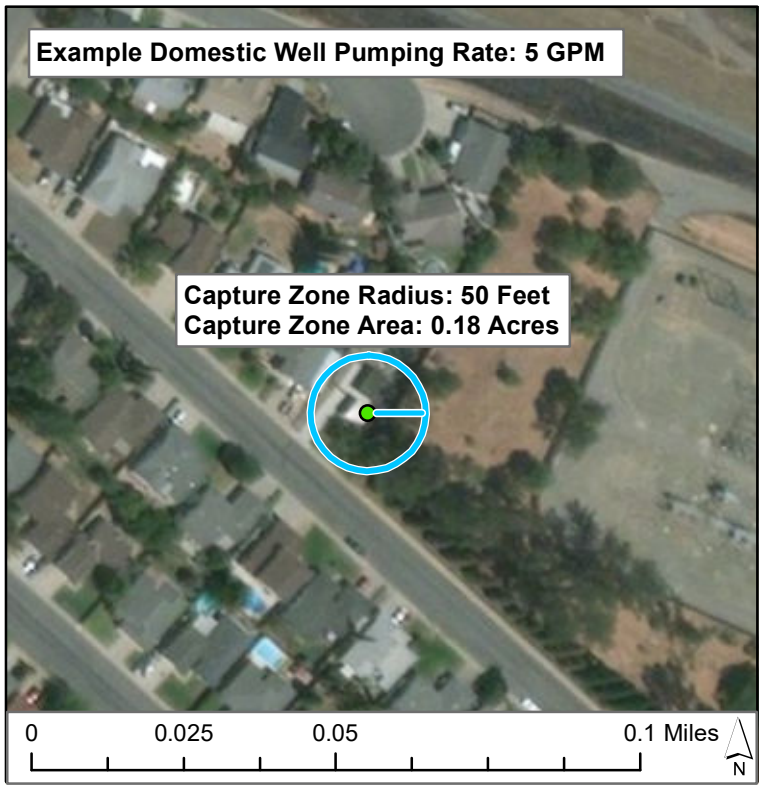
FIGURE 3-17

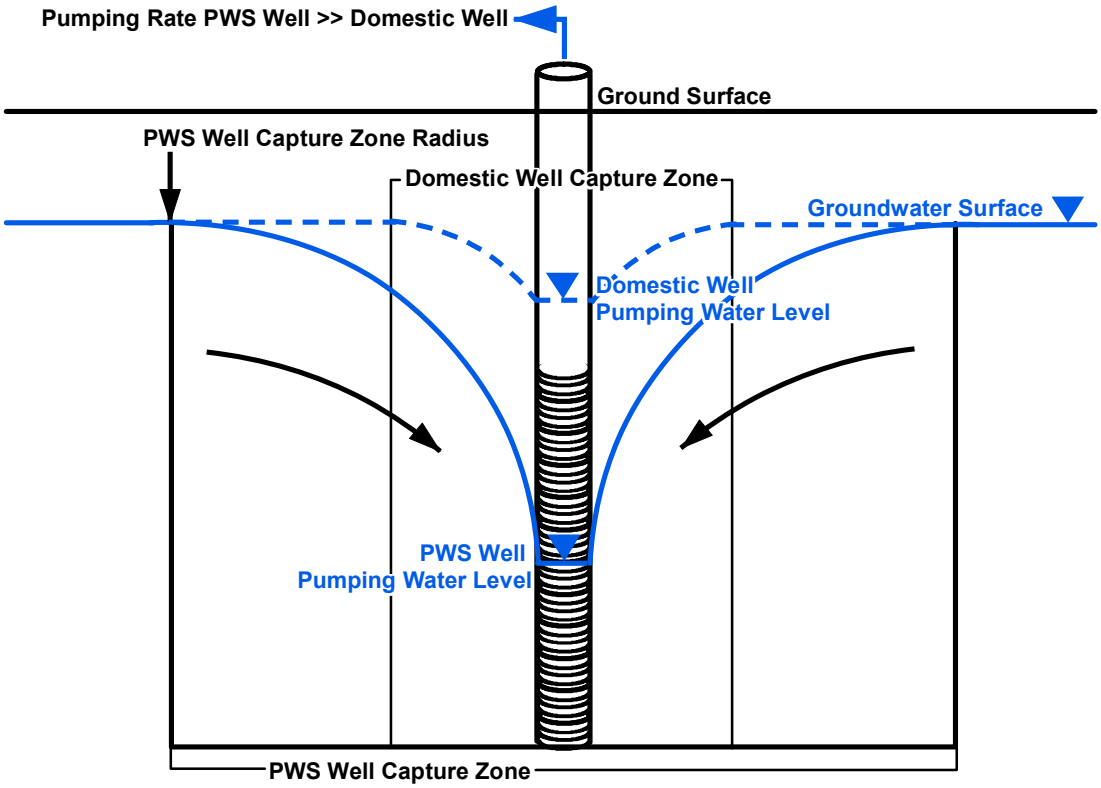
Disadvantaged Communities

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update





Note: Well capture zone scenario results are for illustrative purposes based on distance to stagnation point calculated using Darcy transmissivity method assuming the following properties: aquifer hydraulic conductivity=2 feet/day; saturated thickness=150 feet; hydraulic gradient=0.01.



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-28 Conceptual Schematic of Capture Zone.mxd

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FIGURE 3-18
Conceptual Schematic of Capture Zone Differences for Wells in Hypothetical Unconfined Aquifer

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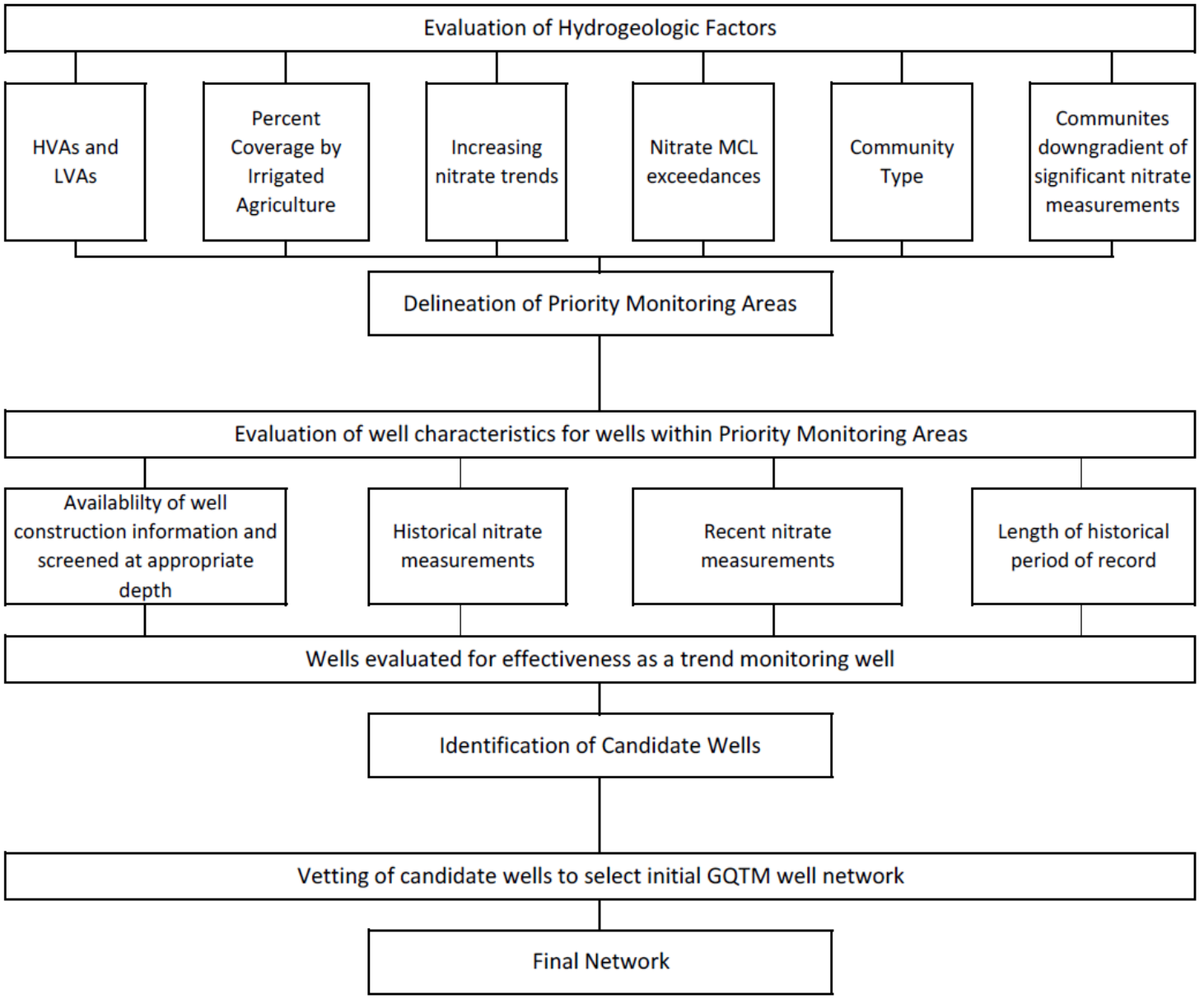

X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 3-29 Concepts and Key Factors for Identification of Candidate Network Wells.mxd

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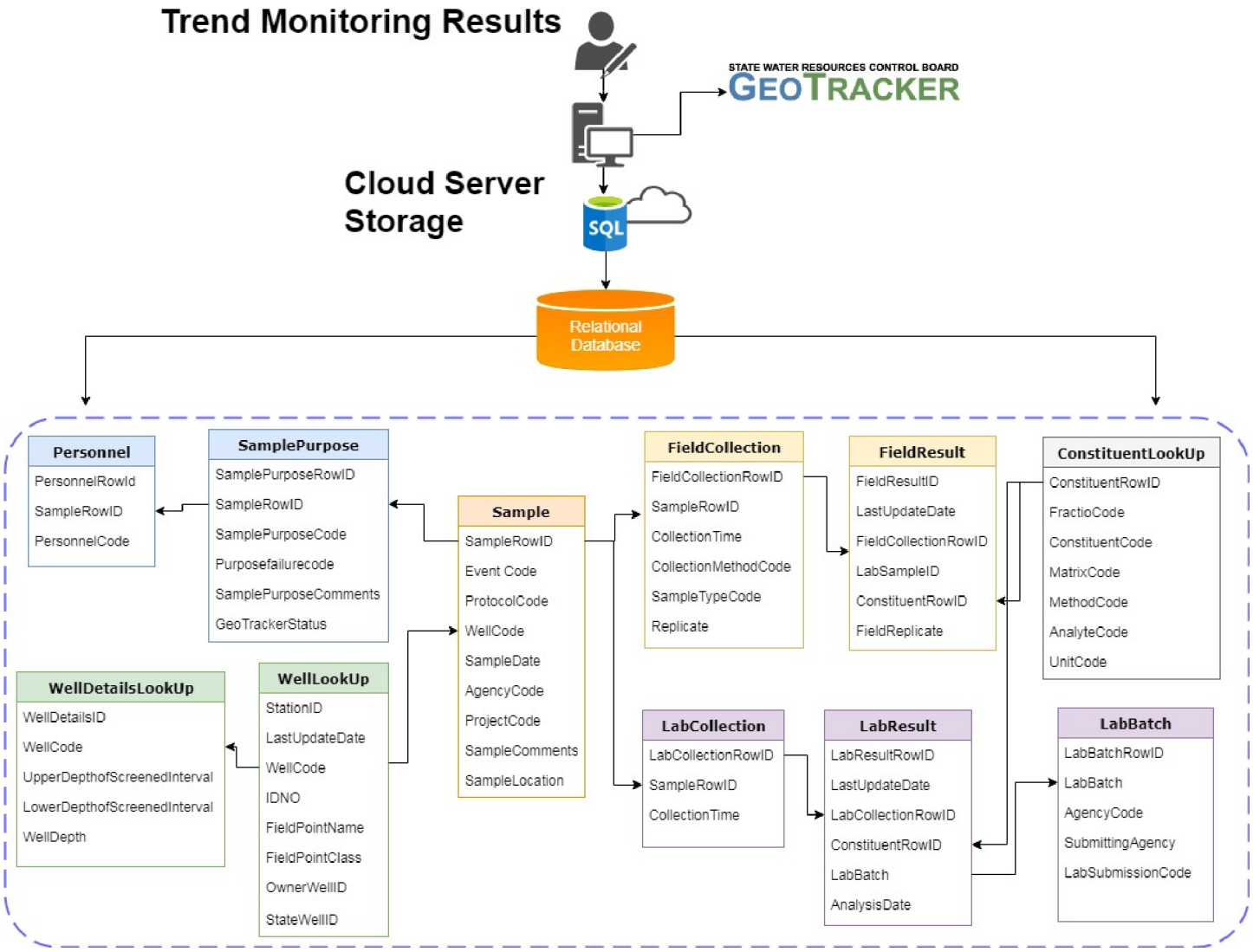
FIGURE 3-19

Concepts and Key Factors for Identification of Candidate Network Wells

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 6-1 CVGMC DMS Relational Database Structure.mxd

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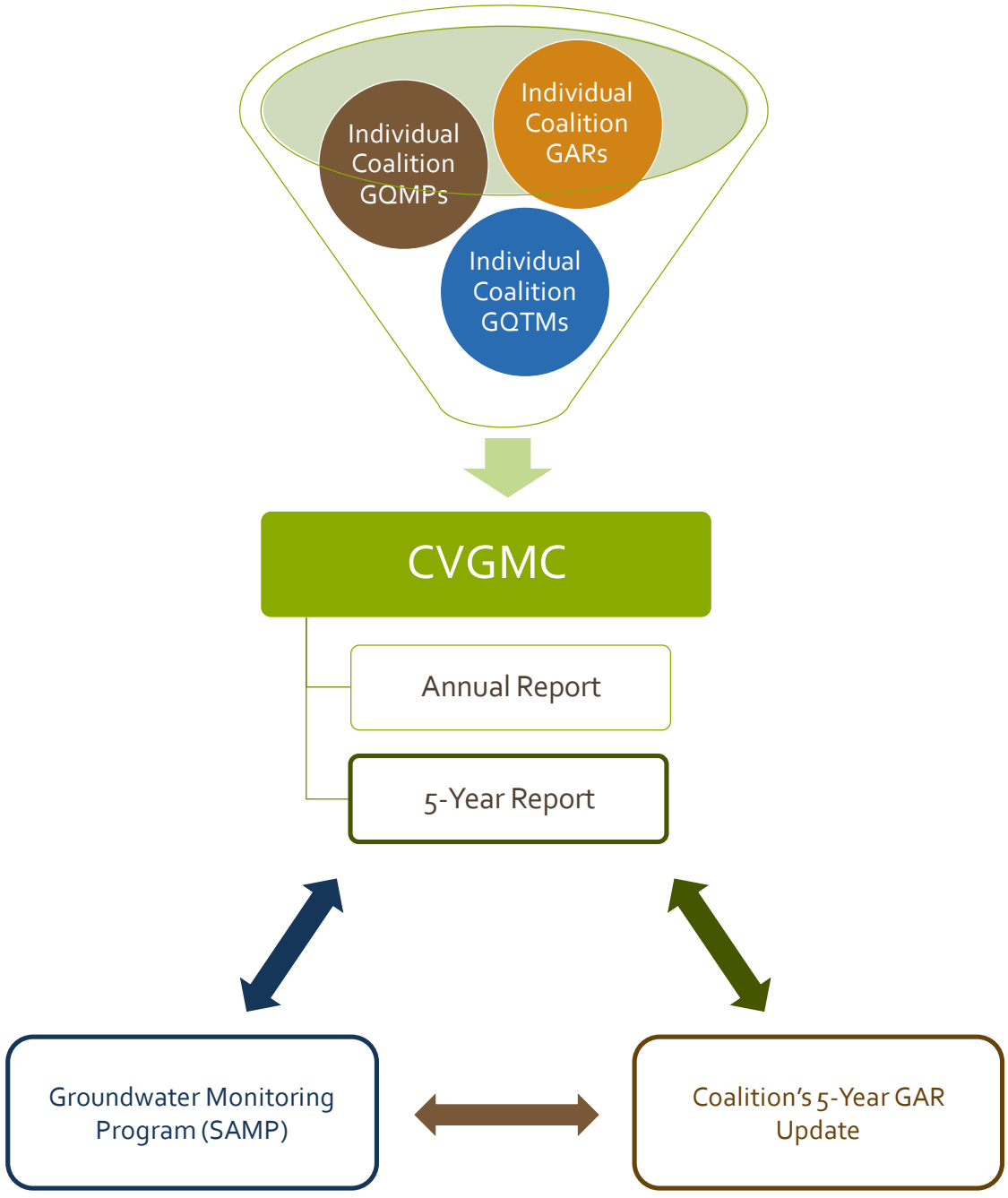
FIGURE 6-1

CVGMC DMS Relational Database Structure

ILRP Groundwater Quality Trend Monitoring Program
Workplan Update



X:\2017\17-145 CVGWMC - Central Valley GW Monitoring Collaborative\GIS\Map Files\Figure 7-1 Conceptual Integration of Monitoring Programs.mxd

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FIGURE 7-1

Conceptual Integration of Monitoring Programs

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