# COMPREHENSIVE GROUNDWATER QUALITY MANAGEMENT PLAN

*Tulare County, California*
*September 20, 2016*

*PREPARED FOR:*

TULE BASIN WATER QUALITY COALITION

2904 W. Main Street, Visalia, CA 93291 • (559) 627-2948 • www.tbwqc.com

# COMPREHENSIVE GROUNDWATER QUALITY MANAGEMENT PLAN

## SEPTEMBER 20, 2016

***Prepared For:***

# TULE BASIN WATER QUALITY COALITION

2904 W. Main Street, Visalia, CA 93291 • (559) 627-2948 • www.tbwqc.com

**CERTIFICATION:**

*I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.*

REGISTERED PROFESSIONAL ENGINEER
DAVID W. DE GROOT
C70992
EXP. 6/30/17
CIVIL
STATE OF CALIFORNIA

**David De Groot, PE**
**Registered Civil Engineer No. 70992**

REGISTERED PROFESSIONAL ENGINEER
RICHARD L. SCHAFER
No. 12,616
03.31.17
CIVIL
STATE OF CALIFORNIA

**Richard L. Schafer, PE**
**Registered Civil Engineer No. 12616**

REGISTERED PROFESSIONAL ENGINEER
MATTHEW D. RAZOR
C81897
EXP. 3/31/18
CIVIL
STATE OF CALIFORNIA

**Matthew Razor, PE**
**Registered Civil Engineer No. 81897**

# TABLE OF CONTENTS

**ATTACHMENTS**



**FIGURES**



**TABLES**



**APPENDIX**

# Abbreviations

| | |
|---|---|
| AGR | Agricultural |
| ASA-CCAs | American Society of Agronomy Certified Crop Advisors |
| CASGEM | California Statewide Groundwater Elevation Monitoring |
| CDFA | California Department of Food and Agriculture |
| CDPH | California Department of Public Health |
| CGQMP | Comprehensive Groundwater Quality Management Plan |
| CIMIS | California Irrigation Management Information Systems |
| Coalition | Tule Basin Water Quality Coalition |
| COC | Constituent of Concern |
| CSU | California State University |
| CVHM | Central Valley Hydrologic Model |
| CV-SALTS | Central Valley Salinity Alternatives for Long-Term Sustainability initiative |
| DAC | Disadvantaged Community |
| Dairy General Order | RWQCB Order R5-2013-0122 Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies |
| DBCP | 1,2-Dibromo-3-chloropropane |
| DCA12 | 1,2-Dichloroethane |
| DPR | California Department of Pesticide Regulation |
| DUC | Disadvantaged Unincorporated Communities |
| DWR | California Department of Water Resources |
| EC | Electrical Conductivity |
| EDB | Dibromoethane |
| ET | Evapotranspiration |
| FEP | Farm Evaluation Plan |
| FMMP | Farmland Mapping and Monitoring Program |
| FREP | Fertilizer Research and Education Program |
| GAMA | Groundwater Ambient Monitoring & Assessment Program |
| GAR | Groundwater Quality Assessment Report |
| General Order | General Order R5-2013-0120 |

| | |
|---|---|
| GIS | Geographic Information Systems |
| GQMP | Groundwater Quality Management Plans |
| GQTM | Groundwater Quality Trend Monitoring |
| HVAs | High Vulnerability Areas |
| ILRP | Irrigated Lands Regulatory Program |
| IND | Industrial |
| ITRC | Cal Poly Irrigation Training and Research Center |
| Ksat | Hydraulic Conductivity |
| Kh | horizontal hydraulic |
| Kv | average vertical |
| MCL | Maximum Contaminant Level |
| Mg/L | Milligrams Per Liter |
| MPEP | Management Practices Evaluation Program |
| MRP | Monitoring and Reporting Program |
| MUN | Municipal |
| NCSS | National Cooperative Soil Survey |
| NMP | Nitrogen Management Plan |
| NO3 | Nitrate |
| NRCS | Natural Resources Conservation Service |
| NWIS | National Water Information System |
| RWQCB | Regional Water Quality Control Board |
| SAR | Sodium Absorption Ratio |
| SSJV | Southern San Joaquin Valley |
| SSURGO | Soil Survey Geographic |
| SWRCB-AEP | State Water Resources Control Board Agricultural Expert Panel |
| SWRCB-DDW | State Water Resources Control Board Division of Drinking Water |
| TAWG | Nitrogen Technical Advisory Workgroup |
| TBWQC | Tule Basin Water Quality Coalition |
| TDS | Total Dissolved Solids |
| Tulare Lake Basin Plan | CVRWQCB Water Quality Control Plan for the Tulare Lake Basin |

| | |
|---|---|
| UCCE | University of California Cooperative Extension |
| UCD | University of California, Davis |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| umhos/cm | micro ohms per centimeter |
| VK | Vertical conductivity |
| WDRs | Waste Discharge Requirements |
| WILD | Wildlife Habitat |

## 1.0 INTRODUCTION

This Comprehensive Groundwater Quality Management Plan (CGQMP) has been prepared on behalf of the Tule Basin Water Quality Coalition (TBWQC or Coalition). The TBWQC serves as the third-party group for the growers within the Tule Basin of the Tulare Lake Basin. A letter from the California Regional Water Quality Control Board (RWQCB), Central Valley Region, dated 18 July 2016 requires the submittal of a CGQMP by 20 September 2016 in conformance with the requirements of the Waste Discharge Requirements of General Order R5-2013-120 (General Order) and the Attachments.

### 1.1 BACKGROUND AND PURPOSE

Groundwater Quality Management Plans are required by the General Order where there are exceedances of water quality objectives that are identified through the required Groundwater Quality Trend Monitoring Program or through periodic updates of the Groundwater Quality Assessment Report that threatens a beneficial use, in the "high vulnerability" groundwater areas identified in the GAR.

The CGQMP follows the requirements outlined in Section VIII.I, (pages 33 - 35) of the General Order, in the Information Sheet, Attachment A, (page 19), and in Attachment B, Monitoring and Reporting Program, Appendix MRP-1 (MRP). The following elements for a CGQMP were identified in the Information Sheet:

- Investigate potential irrigated agricultural sources of waste discharge to groundwater;
- Review physical setting information for the plan area such as geologic factors and existing water quality data;
- Develop a strategy with milestones, and schedules to implement practices to insure discharge from irrigated lands are meeting Groundwater Receiving Water Limitations, III.B;
- Develop a groundwater monitoring strategy to provide feedback on the CGQMP progress;
- Develop methods for evaluating and collecting water quality data; and
- Provide Progress Reports to the Regional Water Quality Control Board, Central Valley Region.

To address the requirements of the General Order, the TBWQC has elected to submit a single comprehensive groundwater management plan, rather than submitting separate groundwater management plans for documented groundwater quality exceedances. This CGQMP outlines a strategy to work with growers to implement protective management practices and a monitoring program to collect data and track trends relating to the CGQMP progress.

The CGQMP relies extensively on the elements of the Management Practices Evaluation Program (MPEP) and the Groundwater Quality Trend Monitoring Program (GQTMW), which are both currently in the process of being developed according to the schedules identified in the General Order.

## 1.2 LOCATION

The TBWQC covers the southern portion of Tulare County along with a small portion of Kern County, all within the Tulare Lake Basin. The TBWQC includes approximately 599,880 acres of the natural water courses of the Tule River, Deer Creek, and White River and contains approximately 365,680-acres of irrigated agriculture, including dairies. Additionally, the TBWQC provides coverage for growers within a supplemental area of the upper watersheds, of the three streams, covering approximately 342,246 acres. The supplemental area includes minimal irrigated agriculture and is predominantly covered by the Sequoia National Forest and the Tule River Indian Reservation, identified in **FIGURE 1. TULARE LAKE BASIN AND TULE BASIN WATER QUALITY COALITION BOUNDARIES.**

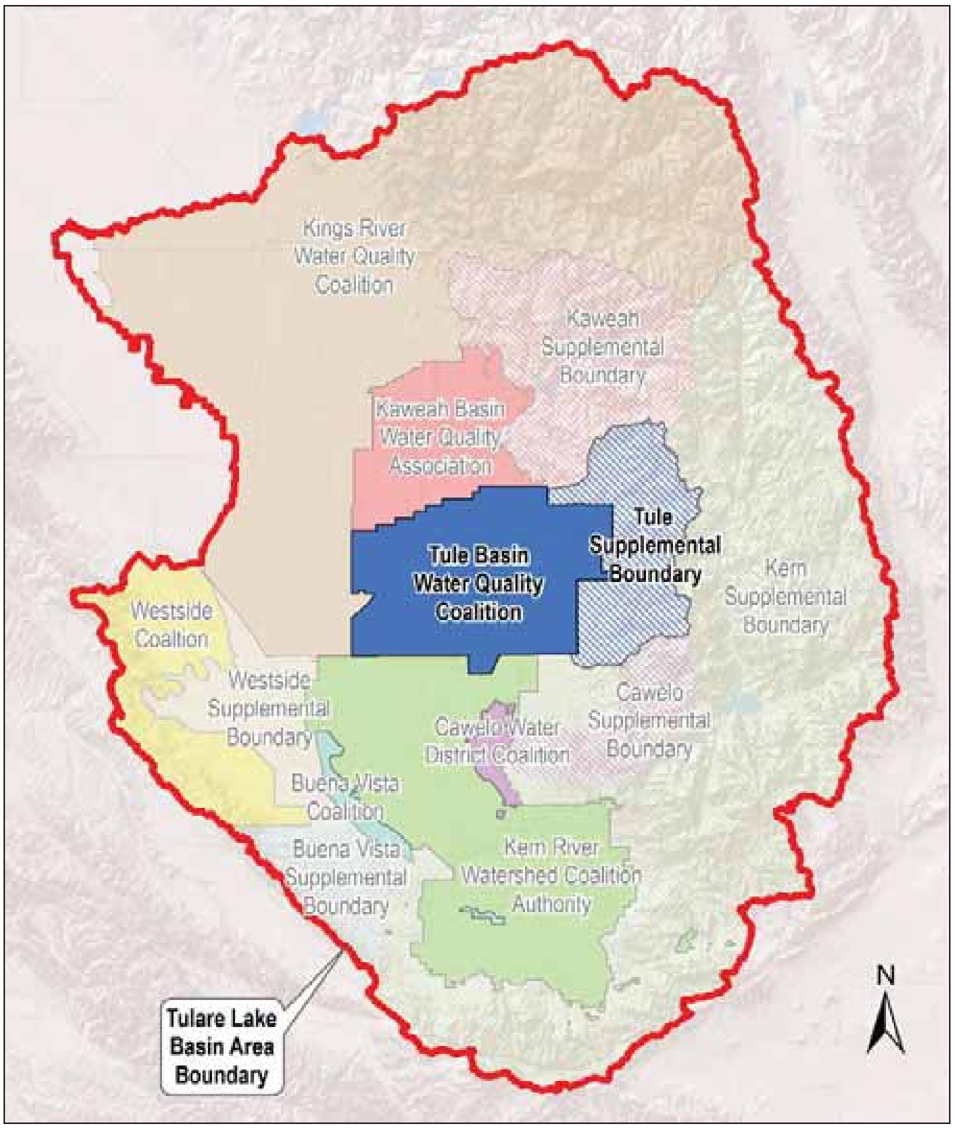



**FIGURE 1: TULARE LAKE BASIN AND TULE BASIN WATER QUALITY COALITION BOUNDARIES**

### 1.3 TULE SUBBASIN

The TBWQC lands overlie the entire Tule Subbasin and the supplemental area extends east into the Sierra Nevada Mountain Range, with a small portion into the Kern Subbasin. DWR Bulletin 118-80, defines the Tule Subbasin as follows:

> *"The Tule Groundwater Subbasin is generally bounded on the west by the Tulare County line, excluding those portions of the Tulare Lake Basin Water Storage District and Sections 29 and 30 of Township 23 South, Range 23 East, that are west of the Homeland Canal. The northern boundary of the basin follows the northern boundaries of Lower Tule Irrigation District and Porterville Irrigation District and the southern boundary of the Lindmore Irrigation District. The eastern boundary is at the edge of the alluvium, and the southern boundary is the Tulare-Kern County line."*

The boundary of Tule Subasin along with identification of the Coalition High Vulnerability Areas are further delineated on **ATTACHMENT A: TBWQC HIGH VULNERABILITY AREA**.

## 2.0 PHYSICAL SETTING

### 2.1 CLIMATE

The climate of the region is semi-arid with mild winters and hot, dry summers. The average annual rainfall within the service area of the Tule Subbasin is approximately 8 inches. The eastern edge of the Basin along the foothills experiences higher amounts of rainfall, while the western edge of the Basin is typically more arid and dry. The average annual precipitation in the Tule River Watershed above Success Reservoir is 31 inches. Precipitation usually occurs from November to May. Snow typically melts during the spring months of April through June. From May through November, the area generally experiences dry summers when little rain occurs.

Within the TBWQC area there are several precipitation stations, maintained and data recorded by the California Irrigation Management Information System (CIMIS) and the Department of Water Resources (DWR). A summary of the average monthly precipitation from the stations within the TBWQC is shown in **TABLE 1: TBWQC AVERAGE PRECIPITATION**.

## TABLE 1: TBWQC AVERAGE PRECIPITATION

| Station Name | Success Reservoir (DWR SCC) | Porterville (CIMIS 169) | Alpaugh (CIMIS 203) | Delano (CIMIS 182) | Lindsay (DWR LND) | Angiola (DWR AGL) | Average Monthly Precipitation |
|---|---|---|---|---|---|---|---|
| **Location within TBWQC** | Eastern | East-Central | South Western | Southern | North Eastern | Western | |
| **January** | 2.00 | 1.96 | 0.70 | 0.86 | 0.43 | 1.41 | **1.49** |
| **February** | 1.97 | 1.72 | 0.72 | 0.86 | 1.30 | 1.37 | **1.41** |
| **March** | 1.83 | 1.76 | 0.55 | 0.88 | 0.80 | 1.16 | **1.32** |
| **April** | 1.13 | 1.03 | 0.32 | 0.78 | 1.17 | 0.71 | **0.84** |
| **May** | 0.36 | 0.44 | 0.11 | 0.29 | 0.26 | 0.27 | **0.31** |
| **June** | 0.08 | 0.07 | 0.05 | 0.04 | 0.00 | 0.06 | **0.06** |
| **July** | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | **0.01** |
| **August** | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | **0.01** |
| **September** | 0.22 | 0.16 | 0.03 | 0.01 | 0.04 | 0.17 | **0.11** |
| **October** | 0.55 | 0.49 | 0.17 | 0.47 | 0.00 | 0.32 | **0.43** |
| **November** | 1.16 | 0.98 | 0.37 | 0.68 | 1.74 | 0.71 | **0.82** |
| **December** | 1.70 | 1.64 | 1.04 | 1.01 | 3.05 | 1.15 | **1.40** |
| **Long Term Annual Average Precipitation:** | **11.05** | **10.26** | **4.07** | **5.88** | **8.79** | **7.35** | **8.01** |
| **Long Term Data Range** | 1961 - 2015 | 1905 - 2015 | 2006 - 2015 | 2002 - 2015 | 1905 - 2015 | 1905-1985 | |

Note: **ATTACHMENT G: TBWQC CLIMATE AND DEMOGRAPHICS MAP** identifies the location of each Precipitation Station.

### 2.2 TOPOGRAPHY

Ground elevations range from approximately 200-feet above mean sea level in the western edge of the Basin to 2,000-feet above mean sea level in the eastern portion of the Basin. The ground surface within the Basin generally slopes to the West, SEE **ATTACHMENT B: UNITED STATES GEOLOGICAL SURVEY QUADRANGLE MAP**.

### 2.3 SOILS

Soil information for the study area was obtained from the National Cooperative Soil Survey (*NCSS*), a joint effort of the United States Department of Agriculture and other federal, state, and local agencies. Soil data for the Tule Basin is presented on soil survey maps that can be used for land-planning programs. The soil survey maps, provided for general reference, contain valuable information regarding soil properties in the TBWQC study area. Soil properties that affect land use are described in the soil survey. The soil survey maps contain predictions of soil behavior for selected land uses, highlight limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment (*USDA, 1982*).

Soils of the Tule Subbasin area were compiled in GIS from three soil surveys downloaded from the USDA-NRCS Soil Data Viewer, the Soil Survey Geographic (*SSURGO*) database, and from soil survey maps entitled, “Tulare County, California, Western Part”, “Tulare County California, Central Part”, and “Kern County, California, Northwestern Part”. Soil units for each of the three surveys were combined and are shown on **ATTACHMENT C: NRCS SOIL SURVEY MAP OF TBWQC**.

The map units delineated on the composite Soil Survey Map represent the soil types or miscellaneous areas (*rock outcrops, dams, water features*) in the study area. A generalized description of each soil type is provided in **ATTACHMENT C.1: NRCS SOIL SURVEY, SOIL TYPE LEGEND**.

## 2.4 GEOLOGY

The geology of the TBWQC area was described by the Department of Water Resources in *DWR Bulletin 118 - Subbasin 5-22.13*, which is one of seven subbasins within the Tulare Lake Basin.

The TBWQC area crosses the geomorphic boundary between the permeable alluvial fan deposits and relatively impermeable crystalline bedrock of the Sierra Nevada Mountain Range. Portions of the southern and northern areas of the TBWQC, and the entire western area of the TBWQC overlie the alluvium of the San Joaquin Valley (*DWR, 2003*). **See ATTACHMENT D: GEOLOGIC MAP OF THE TBWQC AREA**.

The Central Valley is a structural trough about 400 miles long, 20 to 70 miles wide, and extends over 20,000 square miles. The trough was filled with marine and continental sediments, which were the result of inundation by the ocean and erosion of the rocks that form the surrounding mountains (*USGS, 1995*). The base of the Central Valley is comprised of plutonic and metamorphic rocks that are largely impermeable. These basement complex rocks are exposed in the eastern portion of the TBWQC area and are mainly intrusive and extrusive igneous rocks with Paleozoic metavolcanic and Mesozoic, ultramafic, granitic, and gabbroic rocks.

The metavolcanic rocks include latite, dacite, tuff, and greenstone that are commonly schistose. The ultramafic rocks are mostly serpentine with minor peridotite, gabbro, and diabase. The granitic rocks include granite, quartz monzonite, granodiorite, and quartz diorite. The mafic and intermediate rocks include gabbro and diorite. Undivided pre-Cenozoic metasedimentary and metavolcanic rocks in the foothills area are mostly slate, quartzite, hornfels, chert, phyllite, mylonite, schist, gneiss, and minor marble (*Jennings, et.al., 1977*).

The basement complex rocks are buried beneath valley fill deposits that thicken toward the axis of the valley. More than 14,000 feet of Cretaceous, Tertiary, and Quaternary age sediments are buried beneath the Tulare Lake bed. These extensive deposits of marine and mixed marine and continental sediments are the result of erosion from the Coast Ranges, Cascade Range, and Sierra Nevada Mountains. Continental deposits eroded from the Sierra Nevada Mountain Range and Coast Ranges have formed valley sediments that are a heterogeneous mix of gravels, sands, silts, and clays. Unconsolidated deposits overlie the marine and continental deposits and form the floor of the San Joaquin Valley (*Croft, 1972*).

Igneous, metamorphic, and sedimentary rocks and alluvial deposits exposed along the margin of the valley, including those within the TBWQC area, are divided into three main groups: the main freshwater-bearing sediments, nonwater-bearing marine sedimentary rocks that generally contain saline water, and nonwater-bearing basement complex rocks.

Loosely consolidated Miocene to Pleistocene deposits exposed in the western portion of the TBWQC area include sandstone, shale, and gravel. The valley floor is unconsolidated alluvial and flood plain deposits of major rivers, in addition to lacustrine and marsh deposits. The lacustrine and marsh deposits crop out in the San Joaquin Valley beneath the Buena Vista, Kern and Tulare Lake beds. The Tulare Lake bed contains lacustrine and marsh deposits more than 3,600- feet thick (*Page, 1986*). These sediments are relatively flat to gently rolling and generally below an elevation of 500- feet (*USGS, 1995*).

Fractures, joints, and faults within the Pre-Tertiary consolidated basement complex metamorphic and igneous rocks yield relatively small quantities of water. The crystalline rock matrix is relatively impermeable. The Tertiary consolidated sandstone, siltstone, and shale marine rocks overlying the basement complex rocks generally do not yield freshwater.

The Tertiary and Quaternary continental deposits overlying the marine sediments are a maximum of 2,000-feet thick, moderately permeable, semi-confined to confined, from which wells yield large quantities of groundwater. The overlying oxidized deposits are a maximum of 500-feet thick, poorly permeable, semiconfined, and wells generally yield low volumes of water. These deposits consist of sand, silt, and clay with gravel deposits and well developed soils in the oxidized zone.

Quaternary age older alluvial fan deposits overlie the lacustrine and marsh deposits and are a maximum 1,000-feet thick, unweathered, reduced, silty sand, clay, very fine to coarse sand, moderately permeable, semiconfined and confined. Overlying the older reduced deposits are a maximum of 600-feet of oxidized gravels, silt, clay, and very fine to coarse sand. This layer is highly permeable, unconfined and semiconfined. The reduced and oxidized older alluvial deposits yield large quantities of freshwater and are the major aquifer source throughout the Tule Basin.

**TABLE 2: RELATIVE PERMEABILITY OF DEPOSITS AND ROCK UNITS** provides a generalized tabulation of the deposits and relative permeability adapted from Croft and Gordon (*1968*).

**TABLE 2: RELATIVE PERMEABILITY OF DEPOSITS AND ROCK UNITS**

| System | Geologic Unit | Relative Permeability |
|---|---|---|
| Quaternary - Recent | Flood Basin Deposits | Poor |
| Quaternary - Pleistocene to Recent | Younger Alluvium | High |
| Quaternary - Pleistocene to Recent | Older Alluvium | Moderate to High |
| Tertiary and Quaternary - Pliocene and Pleistocene | Lacustrine and Marsh | Poor |
| Tertiary and Quaternary - Pliocene and Pleistocene | Continental Deposits | Poor to Moderate |
| Tertiary | Marine | Mostly brackish water. Least permeable deposits. |
| Pre-Tertiary | Basement Complex | Locally yields small quantities, otherwise virtually impermeable. |

Overlying the older alluvium are recent younger alluvial fan deposits of sand, gravel, silty sand, silt, and clay. These younger deposits are weakly oxidized and reduced with poorly developed soil profiles. This unit is a maximum 55-feet thick, highly permeable, unconfined, and is largely unsaturated and a conduit for recharge to underlying sediments.

Overlying the younger alluvium are surficial poorly permeable recent flood basin deposits of silt, clay, and fine sand that are unconfined. The flood basin deposits are relatively impermeable silt and clay interbedded with some moderately to poorly permeable fine sand layers that interfinger with the younger alluvium.

The alluvial deposits generally increase in permeability from east to west across the TBWQC area. The soil mantle overlying the dissected uplands and crystalline bedrock along the east side of the area are relatively thin and immature. These deposits generally have low groundwater yield with relative low permeability to no permeability.

To the west beneath the communities of Porterville, Poplar-Cotton Center, Woodville, Tipton, Pixley, and Earlimart, the younger alluvial fan and basin rim deposits are permeable to moderately permeable. Basin soils along the west boundary of the study area are poorly permeable to nearly impermeable, especially the confining clays of the Tulare Formation (*Davis et. al., 1959*).

**ATTACHMENT E: TBWQC GEOMORPHIC UNITS MAP** provides a general reference of the geology of the TBWQC area, especially with regard to the boundary between the Sierra Nevada Mountain Range/Foothills provinces and San Joaquin Valley alluvial deposits. The Sierra Nevada granitic block has been tilted slightly westward due to faulting and subsequent uplift of the east edge. The slopes are generally very steep on the east side and gentle on the west side. The dissected uplands, ranging from 550 feet to approximately 1,000 feet above mean sea level, are discontinuous hills of moderate relief between the Sierra Nevada to the East and the alluvial plains and fans to the West. The coalescing low plains and alluvial fans of low relief are located between the dissected uplands and the nearly flat surface of the valley trough. Except near streams, the local relief is less than 10 feet. The unit extends for the entire length of the valley and has an average width of about 21 miles. A majority of irrigated lands within the Tule Basin overlies the alluvial fans and floodplains.

Nearly all groundwater utilized for domestic, municipal, and irrigation water is pumped from the alluvial, flood plain, and continental deposits of the main freshwater-bearing sediments. These deposits are comprised primarily of moderately to highly permeable, largely unsaturated deposits of sand, silt, clay, and gravel.

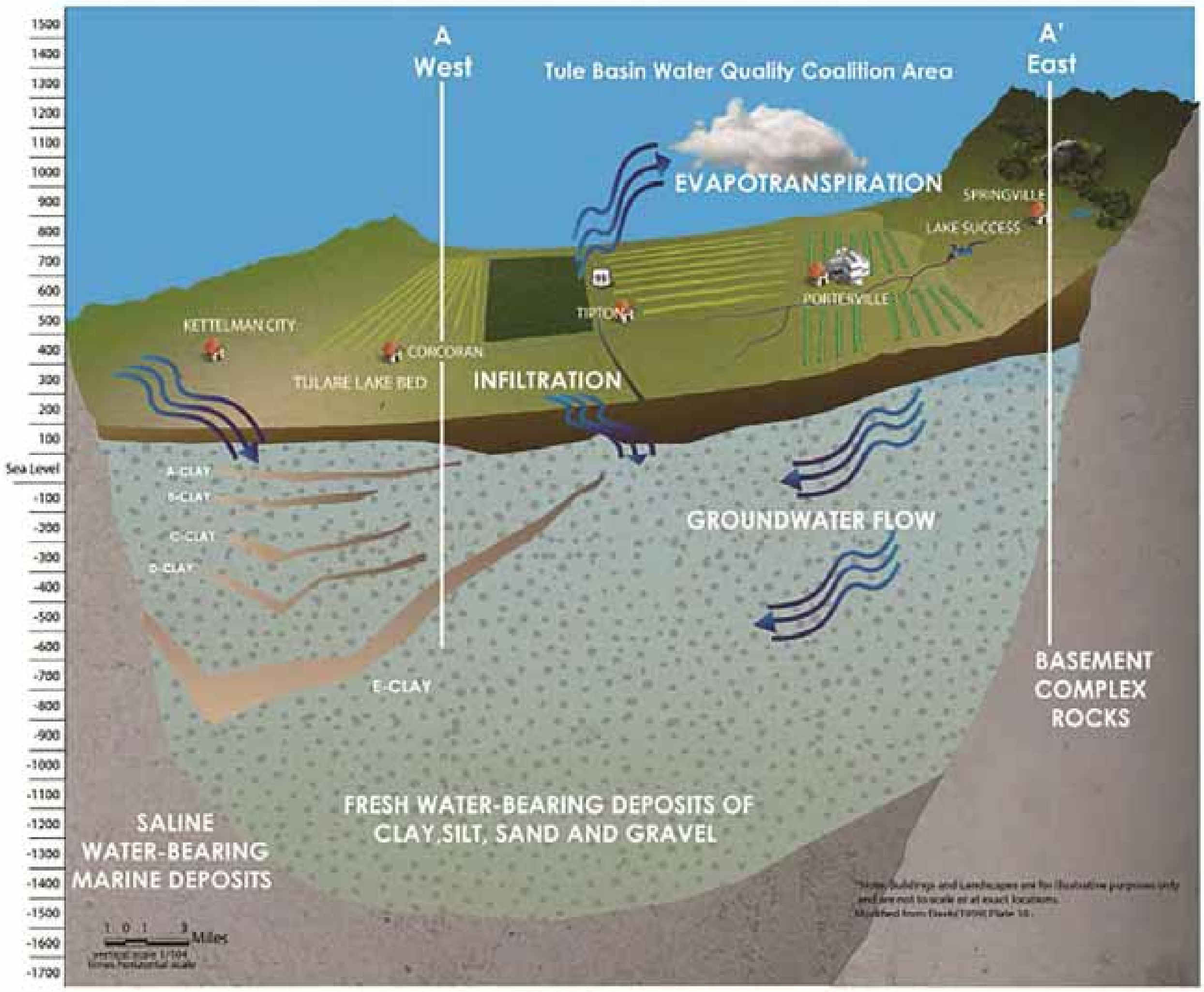
The Tulare Formation, classified as the main freshwater-bearing sediments, are poorly sorted deposits of clay, silt, sand, and gravel derived predominantly from the Coast Range. It contains the E-Clay, which is a major confining unit that stratigraphically pinches out near Highway 99 beneath the western one-third of the TBWQC area as shown on **ATTACHMENT D: GEOLOGIC MAP OF THE TBWQC AREA**.

An additional body of fresh water is confined beneath the E-Clay, which occurs in alluvial and lacustrine deposits of late Pliocene age or older (*Davis, et. al., 1959 and USGS 1995*). In much of the eastern part of the valley, especially in areas of the major streams (*such as within the TBWQC area*), the E-Clay is not present, and groundwater occurs as one freshwater body to considerable depth (*Davis, et. al., 1964*).

The continental deposits are undifferentiated poorly sorted lenticular layers of clay, silt, sand, and gravel derived from the Sierra Nevada Mountain Range. They are moderately permeable, and yield large quantities of groundwater.

There are two non-water bearing rock groups that provide little value in terms of usable groundwater; the marine sedimentary rocks that generally contain saline water of poor quality that underlies freshwater-bearing deposits with few exceptions, and the crystalline basement complex rocks that are similarly of little importance as a groundwater source, although the water contained in fractures or weathered rocks is fresh and is utilized to some extent for domestic and stock water supply (*Davis, et.al., 1959*).

A generalized cross-section of the geologic regime beneath the TBWQC area, identified as Cross Section 'g-g' in the USGS Report 1459 (*Davis, et.al., 1959)* and 'B-B' in the USGS Report 1999-H (*Croft, 1972*), was used used for the development of **FIGURE 2: GENERALIZED GEOLOGIC CROSS-SECTION - TBWQC AREA**




## FIGURE 2: GENERALIZED GEOLOGIC CROSS-SECTION – TBWQC AREA

### 2.5 HYDROGEOLOGY

The hydraulic conductivities of soils throughout the central valley as measured from laboratory samples and estimated average vertical (*Kv*) and horizontal hydraulic (*Kh*) conductivities were reported by Bertoldi, et.al. (*1991*). **TABLE 3: LABORATORY HYDRAULIC CONDUCTIVITY VALUES OF UNCONSOLIDATED SEDIMENTS IN THE CENTRAL VALLEY** contains laboratory values for unconsolidated sediments as reported by Bertoldi, et.al.

**TABLE 3: LABORATORY HYDRAULIC CONDUCTIVITY VALUES OF UNCONSOLIDATED SEDIMENTS IN THE CENTRAL VALLEY**

| Sediment | Average Vertical Hydraulic Conductivity | | Average Horizontal Hydraulic Conductivity | |
|---|---|---|---|---|
| | *ft./day* | *cm/sec* | *ft/day* | *cm/sec* |
| Sand | 11.5 | 4.06E-03 | 14 | 4.94E-03 |
| Clayey Sand | NA | NA | NA | NA |
| Sand-Silt-Clay | 0.02 | 7.06E-06 | 0.02 | 7.06E-06 |
| Clayey Silt | 0.0001 | 3.53E-08 | NA | NA |
| Silty Sand | 0.21 | 7.41E-05 | 0.16 | 5.64E-05 |
| Sandy Silt | 0.02 | 7.06E-06 | 0.13 | 4.59E-05 |
| Silt | 0.0002 | 7.06E-08 | NA | NA |
| Silty Clay | 0.0001 | 3.53E-08 | 0.002 | 7.06E-08 |
| Clay | NA | NA | NA | NA |

The horizontal hydraulic conductivity (*Kh*) averages from 14-feet per day for sand to 0.002 feet per day for silty clay, as determined from laboratory tests of core samples. However, the average horizontal hydraulic conductivity of the entire Central Valley aquifer system is estimated to be 6 feet per day based on calibration of a regional groundwater flow model. This value is somewhat less than the average value for sand but probably reflects the lateral discontinuity of sand beds and more accurately represents the conductivity that controls groundwater flow on a regional scale (*Bertoldi, et. al., 1991*).
The hydrogeologic groundwater conditions beneath the TBWQC area consist of no-flow on [portions] of the northern, southern, and eastern boundaries, and a general-head on the western boundary (*Harter et. al., 2001*).

## 2.6 LAND USE

Land use within the TBWQC boundary is predominantly agriculture with small communities scattered throughout. Agricultural land use within the TBWQC area includes a wide range of field crops, orchards, and vineyards. Land use data from the Department of Water Resources and California Department of Conservation were used to summarize the agricultural use within the TBWQC area.

The State of California, Department of Water Resources (DWR) publishes data on land use by crop type in each county. The general crop land use within the TBWQC area of Tulare County and a portion of Kern County as of 2007 DWR data, excluding the lands within the supplemental area, (data for the supplemental boundary was sparse and unavailable as there is little irrigated agriculture within this area) is summarized in **TABLE 4: DWR CROP LAND USE WITHIN THE TBWQC BOUNDARY 2007**. Based on the 2007 DWR data, approximately 364,000 acres (61%) of the land within the TBWQC Boundary are used for irrigated agricultural purposes. A map identifying the location of the different land uses within the TBWQC per the DWR data is identified in **ATTACHMENT F: TBWQC DWR 2007 LAND USE MAP.**

**TABLE 4: DWR CROP LAND USE WITHIN THE TBWQC BOUNDARY 2007**

| Land Use | Area within TBWQC Boundary (*Excludes Supplemental Area*) acres | Percent of Total Land |
|---|---|---|
| **IRRIGATED AGRICULTURE LAND USE** | | |
| Citrus and Subtropical | 54,779.5 | 9.1% |
| Deciduous Fruits and Nuts | 59,647.0 | 9.9% |
| Field Crops | 53,215.8 | 8.9% |
| Grain and Hay Crops | 84,524.0 | 14.1% |
| Pasture | 49,176.3 | 8.2% |
| Vineyard | 35,892.5 | 6.0% |
| Truck and Berry Crops | 1,749.8 | 0.3% |
| Incidental to Agriculture | 15,350.2 | 2.6% |
| Water Surface | 9,747.5 | 1.6% |
| **Sub-Total (acres):** | **364,082.6** | **60.7%** |
| **NON-IRRIGATED AGRICULTURE LAND USE** | | |
| Idle | 11,578.5 | 1.9% |
| Barren | 49.6 | 0.0% |
| Riparian Vegetation | 1,598.1 | 0.3% |
| Native Vegetation | 186,677.7 | 31.1% |
| Urban, Commercial, Industrial, Residential | 35,892.5 | 6.0% |
| **Sub-Total (acres):** | **235,796.4** | **39.3%** |
| **TOTAL (acres):** | **599,879.0** | |
| **Total Number of Dairy Facilities** | **110** (86,886-Acres) | |

There are 13 developed communities within the TBWQC Boundary area (**ATTACHMENT G: TBWQC CLIMATE AND DEMOGRAPHICS MAP**). The total population within the TBWQC Boundary increased from 71,629 to 91,586 during the decade, year 2001 through year 2010, with an increase of 22%. However, the population within the TBWQC Boundary has decreased from 91,586 to 84,427 from 2011 to 2013, an approximate 8% decrease. Disadvantaged Unincorporated Communities (*DUCs*) within the TBWQC area are shown on **ATTACHMENT G**. DUCs are defined as "*a territory that constitutes all or a portion of a "disadvantaged community*" including 12 or more registered voters or some other standard. A "disadvantaged community" is defined as a community with an annual median household income that is less than 80 percent of the statewide annual median household income (*SB244*).

## 2.7 SURFACE WATER

The TBWQC is located within the Tulare Lake Basin and within the Tule Subbasin, as described in DWR Bulletin 118-80. Within the TBWQC, there are three streams; Tule River, Deer Creek, and White River, which provide surface water for irrigation and recharge. In addition, imported surface water through Central Valley Project contracts is delivered through these channels from the Friant Kern Canal for irrigation and groundwater recharge.

### 2.7.1 SURFACE WATER SUPPLIES

The approximate annual average surface water supply that enters the TBWQC from the Tule River, Deer Creek, White River and the Central Valley Project are as follows:

- Tule River: 139,000 acre feet
- Deer Creek: 22,000 acre feet
- White River: 6,000 acre feet
- Central Valley Project: 343,000 acre feet

The use of the surface water supplies in conjunction with pumped groundwater along with natural precipitation provides the irrigation water for the agricultural lands of the Tule Basin.

### 2.7.2 SURFACE WATER QUALITY

Surface Water Quality of the TBWQC streams, as obtained from the California Environmental Data Exchange Network (CEDEN) record, for the monitoring requirements itemized in **TABLE 2 – MONITORING PARAMETERS** of **ATTACHMENT B; MONITORING AND REPORTING PROGRAM OF THE GENERAL ORDER (page 9)** are summarized in **TABLE 5: SURFACE WATER QUALITY.**

## TABLE 5 – SURFACE WATER QUALITY

| Constituent | Units | Trigger Limit | Tule River Poplar Avenue (2004 - 2005) | Deer Creek Road 248 (2010 - 2013) | White River Road 208 (2011) |
|---|---|---|---|---|---|
| **Electronic Conductivity** | **uS/cm** | *1,000.00* | 67.7 - 157.8 | 148 - 284 | 272 -304 |
| **pH** | **n/a** | *6.5 - 8.3* | 7.02 - 8.94 | 7.7 - 8.9 | 8.18 - 9.03 |
| **Total Dissolved Oxygen** | **mg/L** | *min. 7.0* | 6.3 - 9.4 | 7.0 - 11.1 | 8.94 - 10.64 |
| **E. Coli** | **MPN/100 mL** | *235.00* | - | 81.3 - 2,419 | 980.40 |
| **Total Organic Carbon** | **mg/L** | *n/a* | 0.58 - 6.77 | 1.65 - 7.2 | 6.2 - 8.7 |
| **Hardness (as $CaCO_3$)** | **n/a** | *n/a* | 22.4 - 66.6 | 51.5 - 95.5 | 97.8 - 109.0 |
| **Total Suspended Solids** | **mg/L** | *n/a* | - | 4.75 - 574 | 73.3 - 91.0 |
| **Total Dissolved Solids** | **mg/L** | *450.00* | 50.0 - 120.0 | 99 - 398 | 180 - 211 |
| **Turbidity** | **NTU** | *n/a* | 4.4 - 35 | 1.58 - 12.0 | 55.8 - 86.9 |
| **Arsenic** | **ug/L** | *10* | 1.47 - 2.37 | 1.71 - 2.36 | - |
| **Boron** | **ug/L** | *700.00* | 19 - 38 | 28.6 - 93.7 | - |
| **Cadmium (Total)** | **ug/L** | *5* | 0.011 – 0.050 | 0.03 - 0.2 | - |
| **Copper (Total)** | **ug/L** | *1300.00* | 3.54 - 5.93 | 1.58 - 3.82 | - |
| **Lead (Total)** | **ug/L** | *15.00* | 0.23 - 0.81 | 0.32 - 5.43 | - |
| **Molybdenum (Total)** | **ug/L** | *10 / 35* | - | 0.0044 - 0.0082 | - |
| **Nickel (Total)** | **ug/L** | *100.00* | 0.47 - 2.23 | 0.51 - 3.84 | - |
| **Selenium (Total)** | **ug/L** | *50.00* | 0.36 | 1.0 - 2.0 | - |
| **Zinc (Total)** | **ug/L** | *n/a* | 2.54 - 6.19 | 4.86 - 34.5 | - |
| **Phosphorus as P** | **mg/L** | *n/a* | 21.1 - 64.1 | 0.01 - 0.014 | 0.06 - 0.34 |
| **Ammonia** | **mg/L** | *1.50* | 0.07 | 0.05 - .028 | 0.069 - 0.20 |
| **Nitrate + Nitrite as N** | **mg/L** | *10.00* | 0.07 - 0.30 | 0.03 - 1.00 | 0.70 - 2.90 |
| **Orhthophosphate as P** | **mg/L** | *n/a* | 0.01 - 0.16 | 0.03 - .022 | 0.23 - 0.84 |
| **Phosphorus as P** | **mg/L** | *n/a* | 21.1 - 64.1 | 0.01 - 0.014 | 0.06 - 0.34 |

## 2.8 GROUNDWATER

### 2.8.1 GROUND WATER LEVELS

Regionally, depths to groundwater within the TBWQC increases from east to west. The spring 2015 depth to groundwater within the TBWQC indicates an approximate arithmetical average depth of groundwater of 180 feet, with a range of depths from 10 feet to 480 feet.

**ATTACHMENT H: 2015 SPRING DEPTH TO GROUNDWATER MAP** provides the Spring 2015 Lines of Equal Depth (contours) of Ground Water.

The spring 2015 depths to groundwater are generally less within the northern and southern central portions of the Tule Basin. Groundwater depths are the greatest near Pixley, Alpaugh, and Richgrove with depths from 250 feet to 450 feet.

The groundwater elevations within the TBWQC are shown on **ATTACHMENT I: 2015 SPRING GROUNDWATER ELEVATION MAP.** As demonstrated in **ATTACHMENT I,** the direction of groundwater flow generally follows the surface topography, East to West, however, zones of depression (pockets) are appearing near Pixley and Alpaugh, from over-pumping of the aquifers.

Most of the groundwater recharge occurs within the TBWQC by percolation of natural flow and supplemental imported water within the 166 miles of existing natural streambeds and sloughs, and over-application of irrigation, when available, on farmed fields. In addition, numerous groundwater recharge facilities have been constructed within the TBWQC area that includes approximately 2,100 acres of recharge basins. All as shown on **ATTACHMENT J: RECHARGE BASINS MAP**.

### 2.8.2 GROUNDWATER QUALITY

The existing groundwater quality data for the TBWQC area was obtained from the State Water Resources Control Board Groundwater Ambient Monitoring Program (GAMA), County of Tulare, the Regional Water Resources Control Board, and the Dairy General Order Monitoring Program. This data was organized, analyzed, and presented in the TBWQC Groundwater Assessment Report (GAR) in consideration of the Nitrate Maximum Contaminant Level (MCL) of 45 mg/l and of the maximum Electronic Conductivity (EC) MCL of 1,000 μmhos/cm and used to identify COC impacted groundwater in the TBWQC boundary, for which Nitrate was identified as the primary COC.

**ATTACHMENT K. NITRATE CONCENTRATIONS IN WELLS FROM 1945-2014, 45-MG/L LIMIT** provides identification of those areas of the TBWQC wherein the existing date indicates exceedances of the 45 mg/l MCL.

**ATTACHMENT L. ELECTRICAL CONDUCTIVITY IN WELLS 1950-2014, 1000 UMHOS/CM LIMIT** similarly provides identification of those areas of the TBWQC wherein the existing data indicates exceedances of the 1,000 umhos/cm desired limit.

Groundwater quality of the TBWQC is set forth in **TABLE 6 GROUNDWATER QUALITY**.

**TABLE 6 – GROUNDWATER QUALITY**

| Constituent | Range of Sample Dates | Trigger Limit | Units | No. of Wells Measured | No. of Measurements | Max Value | Min. Value | Average |
|---|---|---|---|---|---|---|---|---|
| pH - Minimum | 1940-2015 | 6.5 | Units | 495 | 705 | 9.80 | 6.10 | 8.02 |
| pH - Maximum | 1940-2016 | 8.3 | Units | 495 | 705 | 9.80 | 6.10 | 8.02 |
| Boron (B) | 1948-2015 | 1.0 | mg/L | 445 | 574 | 5.0 | 0.00 | 0.20 |
| Copper (Cu) | 1978-2015 | 1.3 | mg/L | 66 | 68 | 0.02 | 0.00 | 0.00 |
| Dissolved Oxygen | 2005-2011 | 7 | mg/L | 7 | 10 | 4.6 | 0.64 | 3.02 |
| Lead (Pb) | 1978-2015 | 15 | µg/L | 66 | 68 | 5.0 | 0.00 | 0.33 |
| Molybdenum (Mo) | 2005-2015 | 10 / 35 | µg/L | 48 | 49 | 129 | 0.14 | 11.45 |
| Selenium (Se) | 2005-2015 | 50 | µg/L | 49 | 50 | 6 | 0.04 | 0.63 |
| Zinc (Zn) | 1978-2015 | 5 | mg/L | 59 | 60 | 0.51 | 0.00 | 0.04 |
| Simazine | 1986-2014 | 4 | µg/L | 320 | 484 | 0.95 | 0.00 | 0.07 |
| Total Dissolved Solids (TDS) | 1945-2015 | 450 | mg/L | 287 | 330 | 3,600 | 93.00 | 350.36 |
| Nitrate ($NO_3$) | 1945-2015 | 45 | mg/L | 491 | 739 | 657 | 0.00 | 26.64 |
| Electrical Conductivity (EC) | 1940-2015 | 1000 | umhos/cm | 546 | 860 | 6,200 | 40.00 | 527.26 |

## 2.9 CONSTITUENTS OF CONCERN

Nitrate is the primary constituent of concern (COC) in the TBWQC area. Salts and Pesticides also represent additional COCs, although very few pesticides have been detected in groundwater within the Coalition area.

### 2.9.1 NITRATES

Irrigated agriculture is a well-documented source of nitrate loading in groundwater throughout the State of California. Nitrogen applied to crops as fertilizer may be introduced into groundwater aquifers via deep percolation as water travels through the unsaturated zone during irrigation. The timing and method of irrigation application are key factors influencing nitrate impacts. Deep percolation is vital to sustain agricultural production on crop lands as it leaches excess salts through the root zone. The proper irrigation techniques for nitrogen application is an important factor for the reduction of the mitigation of nitrogen entrainment to groundwater.

Other sources of nitrogen entering groundwater include; feedlots, dairies, animal corrals, animal manure, wastewater percolation, wastewater treatment plants, food processors, septic systems, and sewer lines (Harter, 2012). According to the Central Valley Regional Water Quality Control Board (RWQCB) Dairy General Order 2014 Annual Report, 87,768 acres were identified as dairy lands in the Tule Basin, comparable to the DWR 2007 data that indicated 86,886 acres. The Dairy Facilities and lands are not covered by the Irrigated Lands Regulatory Program General Order but are managed under the Dairy General Order Monitoring Program.

Many of the Disadvantaged Communities in the Basin rely on septic systems and relatively small wastewater treatment facilities as the primary method of wastewater disposal and are a major source of nitrate in groundwater in those areas.

### 2.9.2 SALINITY

The application of irrigation water to support agriculture leads to an increase in concentration of salt solutes in the root zone. It is critical to apply sufficient water to leach salts from the root zone to maintain soils of agronomic viability; which potentially elevates salinity in groundwater. Generally, improper drainage can also result in increased levels of salt leaching into groundwater. However, the extent of elevated salinity throughout the TBWQC is not only attributed to irrigated agriculture but may also be from the natural geology.

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is an initiative to identify salinity management strategies that will achieve a salt balance and keep agriculture economically viable. The TBWQC has contributed to the Central Valley Salinity Coalition and the CV-SALTS process since 2013 and will remain actively involved in this important stakeholder process.

### 2.9.3 PESTICIDES

Pesticides are chemicals used to control populations of a variety of pests of vectors. Pesticides are commonly used for residential, commercial, and agriculture applications on vegetation (herbicides), insects (insecticides), and fungi (fungicides). Pesticides are widely utilized in production agriculture, residential homes and gardens, golf courses, commercial landscaping, and weed control in public right of ways. The exact use of the non-naturally occurring chemicals fluctuate based on the practice and the targeted pest. Pesticides may remain in the soil, and leach over time into groundwater. The Department of Pesticide Regulation (DPR), the Groundwater Ambient Monitoring and Assessment (GAMA), and the Tulare County Ag Commissioner's Office provide sources for determination of pesticide application data which will be utilized for the identification of the cause for an exceedance associated with a pesticide.

## 2.10 BENEFICIAL USES

The Tulare Lake Basin Water Quality Control Plan designates that groundwater shall not contain chemical constituents in concentrations that adversely affect beneficial uses. The Plan provides water quality objectives to protect the beneficial uses of groundwater. The Tule Basin and that portion of the Kern Basin in the TBWQC have designated beneficial uses of Municipal (MUN), Agricultural (ARG), Industrial Process Supply (PRO), Wildlife Habitat (WILD), and Industrial (IND).

## 2.11 BASELINE INVENTORY OF MANAGEMENT PRACTICES

The Department of Water Resources provides data detailing results of a survey to identify California Irrigation Methods by crop category. To obtain the data, variables are inputted into the DWR database, such as year (*1991, 2001, or 2010*), data type (*percentage or acreage*), and hydrologic region.

DWR states that approximately every 10 years, a one-page irrigation survey form is mailed to California growers to update their records on irrigation system methods. A statewide survey of current irrigation methods was conducted during 2011 to determine which irrigation methods were used in California during calendar year 2010. The study was conducted by mailing questionnaires to approximately 58,000 growers who were randomly selected from a list of growers, as a sample set. Any farmer that only farms rice, not irrigated, and only has livestock was excluded from the list. Growers were asked to state the main County in which they farm and the acreages planted between 2001 and 2010. For each crop category, the farmer chose one of a possible 20 crop categories by irrigation method.

The irrigation practices categories of gravity methods, sprinkler, and low-volume such as drip and micro sprinkler, were made available for selection by the growers within the Central Valley of California. Although, a small amount of subsurface irrigation is utilized, it is insignificant as compared to other methods.

For the Tulare Lake Hydrologic Region, 48% of the irrigation practices were by gravity, 8% by sprinkler, 42% by low volume such as drip irrigation, and 2% by other means. Sugar beets, safflower, tomatoes, potatoes, turfgrass & landscape, cucurbits, beans (dry), pasture, onions and garlic, other field crops and other truck crops account for approximately 54,000 acres. Cotton, other deciduous, grains, alfalfa, almonds & pistachios, vineyard, and subtropical trees account for approximately 350,000 acres. The complete dataset is available in the conditionally approved GAR.

Further refinement of the actual management practices currently being utilized by the TBWQC members will occur as data is collected and compiled from the Farm Evaluation Plans and Nitrogen Management Plan Summary Reports. Once this data has been collected, audited, and compiled, the baseline management practices will be summarized and included in the Annual Report to the RWQCB as required by the General Order. Management Practices that are initially identified as protective of groundwater quality through initial research completed by the SSJV MPEP are included in **SECTION 3.4.2**.

## 3.0 MANAGEMENT PLAN STRATEGY

The successful implementation of the CGQMP relies on the implementation of various but coordinated monitoring elements as outlined in the General Order. These elements include the Groundwater Quality Assessment Report (GAR), required member reports such as the Farm Evaluation Plan (FEP) and Nitrogen Management Plan (NMP) Summary Reports, the Management Practices Evaluation Program (MPEP), and the Groundwater Quality Trend Monitoring Workplan (GQTMW). The implementation timelines for these different elements vary, but as the results of each become available, the CGQMP will update or include or reference to these results. The following section highlights the significance and application of each of these items in the ongoing management plan strategy.

### 3.1 APPROACH AND PRIORITIZATION

The TBWQC has delineated a high vulnerability area within the coverage area as a part of the Conditionally Approved GAR, which is defined as the management plan area for the CGQMP. The COCs identified within the GAR were Nitrogen, Pesticides, and Salts, with the Nitrogen identified as the primary COC. The CGQMP will focus on ensuring that appropriate agricultural management practices are implemented by Coalition members to address these COCs.

#### 3.1.1 CGQMP MANAGEMENT PLAN STRATEGY AND MPEP IMPLEMENTATION:

The implementation of the CGQMP is linked with the MPEP throughout the General Order. The General Order requires CGQMPs to address high vulnerability areas as identified in the GAR through the implementation of protective practices. The MPEP identifies, promotes implementation of, and monitors implementation and benefits of protective management practices. The General Order explains that the purpose of the MPEP is to determine the effects, if any, of irrigated agricultural practices on first encountered groundwater under varied conditions (e.g., soil type, depth to groundwater, irrigation practice, crop type, nutrient management practices). Some MPEP Workplan elements and their relevance to the CGQMP are described in the following sections. Virtually all of the management practice aspects of the CGQMP are embodied in the SSJV MPEP Committee's Workplan.

The CGQMP management plan strategy and MPEP implementation is outlined in **Appendix A: *"Identification, Extension, and Implementation of Management Practices to Minimize Nitrate Leaching from Crop Root Zones to Satisfy Groundwater Quality Management Plan Requirements."*** The following is an excerpt from Appendix A with minor edits:

The TBWQC has joined with six other coalitions to form the South San Joaquin Valley (SSJV) MPEP Committee, and hired and collaborates actively with a technical team (SSJV MPEP Team) to develop and implement a Workplan. This process and the Discussion Draft Workplan (2016; Workplan) further advanced the understanding of what the MPEP entails and the timeline to complete program requirements and produce results. The TBWQC can now draw on this work being completed to more clearly articulate how management practices will be identified, communicated to members, implemented, and assessed.

The CGQMPs are identified for high vulnerability areas. The Workplan outlines how the MPEP will interface with individual coalitions and their CGQMPs. Section 2.1.3 of the SSJV MPEP Workplan ("Exchanging Data with Coalitions and Informing Groundwater Quality Analyses") reads as follows:

> "*As mentioned previously, individual ILRP coalitions are engaged in complementary activities that can inform the MPEP and allow for more rapid, effective work. Examples of data and work products from the coalitions that are potentially relevant to the MPEP include the following:*
>
> > *Coalitions' data about the type and location of practices are fundamental to assessing the effects of irrigated agriculture on underlying groundwater. These data might arise from the following sources:*
> > *- Farm Evaluation Plans*
> > *- Nitrogen Management Plan Summary Reports*
> > *- GARs*
> > *- Groundwater Quality Trend Monitoring Reports*
> > *- Methodology and results (e.g., surface loading, loading to groundwater) from the MPEP can inform Comprehensive Groundwater Quality Management Plans (CGQMPs) and other groundwater analyses undertaken by coalitions."*

The SSJV MPEP was developed to be an efficient, collective effort to identify, evaluate, and increase implementation of protective management practices to address requirements that pertain to both the MPEP and CGQMP. **TABLE 7: CROSS REFERENCE OF CGQMP REQUIREMENTS IN GENERAL ORDER** outlines the sections of the CGQMP and the SSJV MPEP Workplan which jointly address CGQMP requirements.

## TABLE 7: CROSS REFERENCE OF CGQMP REQUIREMENTS IN GENERAL ORDER

| MPEP vs. CGQMP Requirements | | | |
|---|---|---|---|
| **General Order Requirements** | | **TBWQC CGQMP** | **SSJV MPEP Workplan** |
| **I.A. Introduction and Background Section** | | | |
| | The introduction portion of the management plan shall include a discussion of the COCs that are the subject of the plan and the water quality objective(s) or trigger(s) requiring preparation of the management plan. The introduction shall also include an identification (both narrative and in map form) of the boundaries (geographic and surface water/ groundwater basin[s] or portion of a basin) to be covered by the management plan including how the boundaries were delineated | Section 1.0 Introduction, Section 2.9 Constituents of Concern | N/A |
| **I.B.1. Physical Setting and Information** | | | |
| I.B.1.a | Land use maps which identify the crops being grown in the SQMP watershed or GQMP area. For groundwater, these maps may already be presented in the Groundwater Assessment Report (GAR) and may be referenced and/or updated as appropriate. Map(s) must be in electronic format using standard Arc-geographic information system (ArcGIS shapefiles). | Section 2.6: Land Use | Section 3.5.1.1, Cropping |
| I.B.1.b | Identification of the potential irrigated agricultural sources of the COC(s) for which the management plan is being developed. If the potential sources are not known, a study may be designed and implemented to determine the source(s) or to eliminate irrigated lands as a potential source. | Section 2.9: Identification of Constituent of Concern (COC) Sources | Section 3.6, Source Quantification |
| I.B.1.c | A list of the designated beneficial uses as identified in the applicable Basin Plan. | Section 2.10: Beneficial Uses | N/A |
| I.B.1.d | A baseline inventory of identified existing management practices in use within the management plan area that could be affecting the concentrations of the COCs in surface water and/or groundwater (as applicable) and locations of the various practices. | Section 2.11: Management Practices Baseline, Section 3.4.2: Existing Protective Management Practices | Section 3.6.3, Benchmark Existing Level of BMP Adoption |

| | | | |
|---|---|---|---|
| I.B.1.e | A summary, discussion, and compilation of available surface water and/or groundwater quality data (as applicable) for the parameters addressed by the management plan. Available data from existing water quality programs may be used…The GAR developed for the third-party's geographic area, and groundwater quality data compiled in that document, may serve as a reference for these data. | Section 2:7: Surface Water, Section 2.8: Groundwater | Section 3.5.2.2, Groundwater Conditions |
| **I.B.3. Groundwater – Additional Requirements** | | | |
| I.B.3.a | Soil types and other relevant soils data as described by the appropriate Natural Resources Conservation Service (NRCS) soil survey or other applicable studies. The soil unit descriptions and a map of their areal extent within the study area must be included. The GAR developed for the third-party's geographic area, and the soils mapping contained in that document, may satisfy this requirement. | Section 2.3: Soils | 3.5.1.2, Soil Characteristics |
| I.B.3.b | A description of the geology and hydrogeology for the area covered by the GQMP. The description shall include: | Section 2.4: Geology | Section 3.5.2 Characterizations of Sub-Root Zone Process Factors |
| **I.C. Management Plan Strategy** | | | |
| I.C.1 | A description of the approach to be utilized by the management plan (e.g., multiple COC's addressed in a scheduled priority fashion, multiple areas covered by the plan with a single area chosen for initial study, or all areas addressed simultaneously [area wide]). Any prioritization included in the management plan must be consistent with the requirements in section XII of the Order, Time Schedule for Compliance. | Section 3.1: Approach and Prioritization | Section 3.1, Master Schedule; Section 3.7, Initial Prioritization of Investigations; and Section 3.13, Regulatory Deliverables |
| I.C.2 | The plan must include actions to meet the following goals and objectives:<br>a. Compliance with the Order's receiving water limitations (section III of the Order).<br>b. Educate Members about the sources of the water quality exceedances in order to promote prevention, protection, and remediation efforts that can maintain and improve water quality. | Section 3.2.1: Education and Outreach, Section 3.4.6: Management Practice Implementation Schedule, Section 3.4: Implementation Strategy | Section 2.4, Outreach Approach and Section 3.11, Sharing Findings with Coalition Members (Outreach), Section 3.6.3, Benchmark Existing Levels of BMP Adoption; 3.8, Focused Field Studies; Section 3.9, A Multi-Pronged Approach to Assessing the Influence of Irrigated Lands |

| | | | |
|---|---|---|---|
| | c. Identify, validate, and implement management practices to reduce loading of COC's to surface water or groundwater, as applicable, thereby improving water quality. | | on Groundwater Quality; Section 3.10, Landscape-level Performance Assessment; Section 3.12, Assessing Adoption, Data Exchange with Coalitions , Section 3.9.4, Summary Rationale for a Multi-Pronged Approach |
| I.C.3 | Identify the duties and responsibilities of the individuals or groups implementing the management plan. This section should include:<br><br>-Identification of key individuals involved in major aspects of the project (e.g., project lead, data manager, sample collection lead, lead for stakeholder involvement, quality assurance manager).<br><br>-Discussion of each individual's responsibilities<br><br>-An organizational chart with identified lines of authority. | Section 3.3: Duties and Responsiblities | Section 2.2, Institutional Approach |
| I.C.4 | Strategies to implement the management plan tasks. | **Section 3.4: Implementation Strategy** | Entire Management Practices Evaluation Workplan |
| I.C.4.a | Identify the entities or agencies that will be contacted to obtain data and assistance. | Section 3.4.1: Partner Agencies and Entities | Section 2.2, Institutional Approach |
| I.C.4.b | Identify management practices used to control sources of COCs from irrigated lands that are 1) technically feasible; 2) economically feasible; 3) proven to be effective at protecting water quality, and **4) will comply with sections** III.A and B of the Order. Practices that growers will implement must be discussed, along with an estimate of their effectiveness or any known limitations on the effectiveness of the chosen practice(s). | Section 3.4.3: Additional Practices to Address COCs | Section 2.1.4, Demonstrating Progress (**partial);** Section 3.8, Focused Field Studies; and Section 3.10, Landscape-level Performance Assessment |
| I.C.4.c | Identify outreach that will be used to disseminate information to participating growers. This discussion shall include: the strategy for informing growers of the water quality problems that need to be addressed, method for disseminating information on relevant management practices to be implemented, and a description of how the effectiveness of the outreach efforts will be evaluated. The third-party may conduct outreach efforts or work with the assistance of the County Agricultural Commissioners, U.C. Cooperative Extension, Natural Resources Conservation Service, Resource Conservation District, California Department of Food and Agriculture, or other appropriate groups or agencies. | Section 3.2.1: Education and Outreach, Section 4.6: Outreach and Education | Section 2.4, Outreach Approach and Section 3.11, Sharing Findings with Coalition Members (Outreach) |

| | | | |
|---|---|---|---|
| I.C.4.d | A specific schedule and milestones for the implementation of management practices and tasks outlined in the management plan. Items to be included in the schedule include: time estimated to identify new management practices as necessary to meet the Order's surface and groundwater receiving water limitations (section III of the Order); a timetable for implementation of identified management practices (e.g., at least 25% of growers identified must implement management practices by year 1; at least 50% by year 2). | Section 3.4.6.1: Timetable to Identify and Implement Management Practices | Section 3.1, Master Schedule |
| I.C.4.e | Establish measureable performance goals that are aligned with the elements of the management plan strategy. Performance goals include specific targets that identify the expected progress towards meeting a desired outcome. | Section 3.5: Performance Goals | Section 3.1, Master Schedule and Section 3.12, Assessing Adoption, Data Exchange with Coalitions |
| **I.D. Monitoring Methods** | | | |
| I.D.1 | The monitoring system must be designed to measure effectiveness at achieving the goals and objectives of the SQMP or GQMP and capable of determining whether management practice changes made in response to the management plan are effective and can comply with the terms of the Order.<br><br>Management practice-specific or commodity-specific field studies may be used to approximate the contribution of irrigated lands operations. Where the third-party determines that field studies are appropriate or the Executive Officer requires a technical report under CWC 13267 for a field study, the third-party must identify a reasonable number and variety of field study sites that are representative of the particular management practice being evaluated. | Section 4: Monitoring Methods | Section 3.8, Field Studies and Section 3.10, Landscape-level Performance Assessment |

| | | | |
|---|---|---|---|
| I.D.3 | The third-party's Management Practice Evaluation Program and Groundwater Quality Trend Monitoring shall be evaluated to determine whether additional monitoring is needed in conjunction with the proposed management strategy(ies) to evaluate the effectiveness of the strategy(ies). This may include commodity-based representative monitoring that is conducted to determine the effectiveness of management practices implemented under the GQMP. Refer to section IV of the MRP for groundwater monitoring requirements. | Section 4: Monitoring Methods | Section 3.7, Initial Prioritization of Events and Section 3.9, A Multi-pronged Approach to Assessing the Influence of Irrigated Lands on Groundwater Quality |
| **I.E. Data Evaluation** | | | |
| I.E | Methods to be used to evaluate the data generated by SQMP/GQMP monitoring and to evaluate the effectiveness of the implemented management practices must be described. The discussion should include at a minimum, the following: 1. Methods to be utilized to perform data analysis (graphical, statistics, modeling, index computation, or some combination thereof). 2. Identify the information necessary to quantify program effectiveness going forward, including the tracking of management practice implementation. The approach for determining the effectiveness of the management practices implemented must be described. Acceptable approaches include field studies of management practices at representative sites and modeling or assessment to associate the degree of management practice implementation to changes in water quality. The process for tracking implementation of management practices must also be described. The process must include a description of how the information will be collected from growers, the type of information being collected, how the information will be verified, and how the information will be reported. | Section 5: Data Evaluation and Reporting | Section 3.7, Initial Prioritization of Events; Section 3.8, Focused Field Studies; Section 3.9, A Multi-pronged Approach to Assessing the Influence of Irrigated Lands on Groundwater Quality; Section 3.10, Landscape-level Performance Assessment; Section 3.11, Sharing Findings with Coalition Members (Outreach); and Section 3.12, Assessing Adoption, Data Exchange with Coalitions |

### 3.1.2 PRIORITIZATION OF HIGH VULNERABILITY AREAS

To facilitate and focus the CGQMP, and due to practical and economic constraints, prioritization is given to Nitrogen, using a matrix of factors that influence the potential for nitrogen impacts from irrigated agriculture.

The high vulnerability areas identified within the GAR will be prioritized for planning of future monitoring and management efforts. The prioritization of the high vulnerability areas may include, but not limited to, the following:

- Identified exceedances of water quality objectives;
- Proximity to communities reliant on drinking water;
- Trends in most recent groundwater quality;
- Existing land uses;
- Irrigation methods;
- Crop types;
- Recent Depth to Groundwater and groundwater flow;
- Legacy or Ambient groundwater conditions; and
- Hydrogeological vulnerability factors.

#### 3.1.2.1 SSJV MPEP CROP PRIORITIZATION

In addition to prioritization of high vulnerability areas within the TBWQC boundaries, the SSJV MPEP Team developed a prioritization scheme for the SSJV to guide MPEP implementation. This is described in *Section 3.7* of the SSJV MPEP Workplan.

> *"The following criteria are proposed as the basis for selection of in-depth sampling and field studies:*
>
> 1. *Crops that represent the largest land area and economic value.*
> 2. *Crops and cropping systems with the largest N surplus and/or largest depth of leaching water applied.*
> 3. *Crops and cropping systems preferentially grown on coarse soils (e.g. sweet potatoes).*
> 4. *Crops and cropping systems in areas with shallow depth to groundwater (i.e., hydrogeologic sensitivity).*
> 5. *Regions of the MPEP area classified as disadvantaged communities (i.e., proximity to public groundwater supply wells).*
>
> *Initial modeling results, along with assessments of soil, vadose zone, and groundwater properties, as well as crop area distribution, will provide a basis for prioritizing effort relative to these criteria. Magnitudes of crop production area and value of the major commodities (presented in Section 3.5.1.1) will inform decisions about crop selection for more detailed study and data collection. Included among the most important crops in terms of area and value are fruit and nut crops (almond, citrus, pistachios), field crops (cotton, alfalfa, silage corn [exclusive of dairy], wheat), and vegetable crops."*

## 3.2 ACTIONS TO MEET OBJECTIVES

The actions that will be taken to address groundwater impacts through the implementation and validation of protective practices include: outreach and education, implementation of the SSJV MPEP Workplan to identify and validate protective practices, and ongoing monitoring through various General Order elements to demonstrate progress in protecting groundwater by evaluation of long term trends. Monitoring methods are described in **SECTION 4: Monitoring Methods**, which will include actions to track responses to required member reports, analysis of trends of various data collected, and long-term groundwater quality trend monitoring. Groundwater quality data from required monitoring will be analyzed by the SSJV MPEP Team alongside regional and site-specific Soil & Water Assessment Tool (SWAT) model estimates of potential groundwater impacts to support the objectives of the MPEP and the CGQMP.

### 3.2.1 EDUCATION AND OUTREACH

Since the establishment of the Coalition, the TBWQC has worked to support growers in meeting requirements of the ILRP. This includes the completion of required third-party reports and associated research, such as Annual Monitoring Reports, the GAR, the development of the SSJV MPEP Workplan, and development of the GQTM Workplan. The TBWQC has also worked diligently to develop a strong relationship of trust with growers through extensive outreach and one-on-one support for required member reports.

TBWQC conducted extensive member outreach sessions to discuss the findings of the GAR and the development of the high vulnerability areas. This outreach provides growers with a foundational understanding of the areas of potential vulnerability to groundwater impacts from COCs within their farms and adjacent communities. Outreach and education to members, focusing on ongoing groundwater quality conditions and trends, will continue to be conducted as additional data are collected and interpreted under various reports as required by the General Order.

The TBWQC also devoted significant effort in training grower-members and consultants in how to correctly complete Farm Evaluation Plans and NMPs throughout 2015 and in early 2016. The TBWQC also has helped facilitate NMP self-certification training for its members.

#### 3.2.1.1 TBWQC CGQMP & SSJV MPEP OUTREACH APPROACH

Ongoing education will provide feedback regarding monitoring results (analysis of member surveys including relevant performance metrics such as nitrogen ratios and Farm Evaluation Plans), and the findings of the SSJV MPEP regarding protective practices. The TBWQC will coordinate with the SSJV MPEP to define outreach curricula reflecting protective management practices throughout the CGQMP area. See SSJV MPEP Workplan, Appendix C for additional description of the CGQMP & MPEP outreach strategy.

As discussed in the SSJV MPEP Workplan Section 2.4, “Outreach Approach”, a multi-pronged effort will leverage current resources to reduce duplication of effort and to effectively support growers.

*“The main themes of information that the SSJV MPEP will focus on include the following:*

- *Early outreach to rapidly expand implementation of known, protective practices.*

- *Program and process information, explaining regulatory obligations and how to meet them, schedules, meetings, and where to find information on protective practices.*

- *Referrals to technical advisors who can assist growers in fitting suites of protective practices to growers' specific settings and needs.*

- *New and highly relevant information on protective practices and environmental performance, as it is collected and generated.*

- *Information from growers regarding crop selection, location, and management, mainly obtained through coalitions.*

*Growers have historically obtained information to guide management decisions from a variety of sources, including the following:*

- *Information from public-sector experts housed within UCCE, USDA-NRCS, United States Department of Agriculture Agricultural Research Service, CDFA, CSU Fresno, California Polytechnic State University San Luis Obispo, out-of-state cooperative extension services, irrigation and drainage districts, and occasionally other public agencies (e.g., county departments, DWR, California Departments of Fish and Wildlife and Pesticide Regulation, County Agricultural Commissioners, State and Regional Water Boards, Bureau of Reclamation, and the United States Geological Survey (USGS) and Fish and Wildlife Service.*

- *Private-sector experts housed within commodities groups, Certified Crop Advisers (CCAs), Pest Control Advisers, private institutes (e.g., International Plant Nutrition Institute, Western Growers Association), input manufacturers and vendors, and production cooperatives.*

- *Social networks including other growers, friends, neighbors, and family members.*

- *Growers' experiential knowledge bases, which tend to be the most site-specific and best informed about field and management history.*

*The formats of information exchange among growers vary widely, and include the following:*

- *One-on-one, word of mouth, or written communication.*

- *Presentations at grower (often winter) meetings, technical workshops, and training sessions.*

- *Online tools and databases, including a Grower/Advisor Webpage, to promote and accelerate understanding and implementation of protective management practices.*

- *Targeted mailings to memberships of various groups.*

- *Online and printed newsletters, and online repositories of scientific literature, extension circulars, handbooks, soil surveys, and other references.*

- *GARs, trend monitoring programs, groundwater quality management plans, and annual reports produced by member coalitions.*

- *Surveys relating to growers' crop selections, practices, needs, and preferences (e.g., surveys conducted by coalitions to meet Farm Evaluation and Nitrogen Summary Report requirements of the General Order).*

*… The success of outreach will therefore depend on prioritizing practices that growers can use and that have potential to increase levels of groundwater quality protection, and on leveraging the broad range of existing outreach resources through collaboration and partnership."*

#### 3.2.1.2 OUTREACH ACTIVITIES AND TOOLS

CGQMP outreach activities will include the efforts ongoing outreach programs conducted by partner groups (UCCE, USDA/NRCS, CSU, CDFA, and commodity groups), and Central Valley coalitions, all in coordination with the SSJV MPEP. This network of cooperating partners will assist in the development and delivery of CGQMP relevant curricula, ensuring optimal use of resources. TBWQC outreach events are planned to occur a minimum of once per year and will include presentations of applicable grower feedback, and early implementation curricula from the SSJV MPEP.

TBWQC growers currently participate in the many agricultural outreach programs conducted by CGQMP implementation partners, which provide growers information on protective management practices. The SSJV MPEP will help to coordinate partner meetings where information on protective management practices will be provided The TBWQC will seek to document growers' participation in these events. The SSJV MPEP maintains a database of outreach and outreach-related activities. Events may be hosted by coalitions and/or cooperating partners. This allows the MPEP and member coalitions to track grower participation in outreach activities. Additional description of these tools is provided in SSJV MPEP Workplan, as identified in Appendix A.

A timetable for outreach events associated with the SSJV MPEP is provided in the Workplan master schedule **(SSJV MPEP Workplan, Figure 23 and Figure 24).** The SSJV MPEP Team will develop the outreach curricula pertaining to the initial inventory of management practices, including relevant meeting materials, videos, fliers, and online tools. Resources will be organized into a Grower/Advisor webpage to increase accessibility to coalition members and consultants. Additional tools to support outreach are described in Section 3.11 of the SSJV MPEP Workplan.

- *Helpful information for growers and their advisors to efficiently derive maximum benefit from required Nitrogen Management Planning processes can be provided.*
- *Tools to facilitate second-language growers to understand and comply with LTILRP requirements and derive maximum water quality and production advantages.*
- *Query-able management practice databases to assist growers in evaluating the potential cost and benefits (production, water quality, labor) benefits of various suites of management practices, applied at their specific management block locations and planting dates.*

The TBWQC considers grower outreach and education to be a critical component of the ILRP. As required by the General Order, outreach products and activities will be summarized and reported to the RWQCB annually as part of the Management Plan Status Report and Annual Monitoring Report.

### 3.3 DUTIES AND RESPONSIBILITIES

David De Groot, PE is the Technical Lead for the TBWQC and will be responsible for administering the Comprehensive Groundwater Quality Management Plan under the direction of the TBWQC Board of Directors, who have authority to change project administration duties from time to time. The coalition will then be responsible for gathering data, facilitating training programs, conduct outreach, educate members on findings, and report to the Regional Board.

Following is a list of the individuals a part of the TBWQC team to implement the CGQMP:

- R.L. Schafer, PE: TBWQC Coordinator, Quality Control
- David De Groot, PE: TBWQC Overall Technical Lead
- Matthew Razor, PE: CGQMP Lead
- Michael Tharp: Field Monitoring
- Michelle Parker: Administration
- Kelsey Leyendekker: Grower Outreach and Education
- Bradley Meadows, BSK Laboratories: Water quality analysis
- John Dickey: SSJV MPEP Coordinator

### 3.4 IMPLEMENTATION STRATEGY

CGQMP implementation will be integrated with SSJV MPEP activities and other ILRP program elements to address groundwater quality impacts. The TBWQC will leverage the joint SSJV MPEP to compile background information for management practices, facilitate training programs, and produce outreach and educational materials appropriate to protective management practices.

#### 3.4.1 PARTNER AGENCIES AND ENTITIES

Various entities, including those listed below, will be used as resources for data during the implementation of the CGQMP. Specifically, the TBWQC will leverage the ongoing efforts of the SSJV MPEP Committee to compile background information for management practices, facilitate training programs, and produce outreach and educational materials appropriate to various aspects of farm management and growers that are involved in the identified priority cropping scenarios. Partners available to support development of these resources include, but are not limited to:

- California Department of Food and Agriculture (**CDFA**);
- Fertilizer Research and Education Program (**FREP**);
- Tulare County Agricultural Commissioner;
- NRCS;
- Cal Poly Irrigation Training and Research Center (**ITRC**);
- UCCE;
- Central Valley Third Party Coalitions; and

- SSJV MPEP Committee and Technical Team

The missions of institutions and programs such as the UCCE, ITRC, and FREP make them ideal partner organizations to help accomplish the objectives of the CGQMP. Existing training programs and outreach materials developed by these partners will be utilized to the greatest extent possible. This will allow TBWQC to benefit from the knowledge and expertise of these existing programs, while contributing to expansion of the knowledge base through the SSJV MPEP.

### 3.4.2 EXISTING PROTECTIVE MANAGEMENT PRACTICES

There has been extensive research on existing agricultural management practices in California, particularly relative to irrigation and nutrient management, including publications such as Nitrogen Source Reduction to Protect Groundwater Quality (Dzurella et al., 2012). Where there is uncertainty about management practice performance, or where additional knowledge is needed, the SSJV MPEP will help initiate evaluations to close these knowledge gaps or develop additional tools. A selection of practices that may reduce deep percolation of nitrate can be found on **Table 8: Management Practices Documented to Improve Nitrogen Fertilizer Efficiency and Barriers (Dzurella et al., 2012)**.

**Table 8: Management Practices Documented to Improve Nitrogen Fertilizer Efficiency and Barriers (Dzurella et al., 2012)**

| Management Practices Documented to Improve Nitrogen Fertilizer Efficiency and Barriers (Dzurella et al., 2012) | | |
|---|---|---|
| **Management Practice** | | **Barriers to Adoption** |
| **Irrigation and Drainage Design and Operation** | | |
| Irrigation System Evaluation and Monitoring | | |
| 1 | Conduct irrigation system performance evaluation | Operational cost, land tenure, training |
| 2 | Install and use flow meters or other measuring devices to track water volume applied to each field at each irrigation | Capital cost, operational cost, training |
| 3 | Conduct pump performance tests | Operational cost, training |
| Irrigation Scheduling | | |
| 4 | Use weather-based irrigation scheduling | Operational cost, logistics, training, technology |
| 5 | Use plant-based irrigation scheduling | Operational cost, logistics, training |
| 6 | Use soil moisture content to guide irrigation timing and amount | Operational cost, logistics, training |
| 7 | Avoid heavy pre-plant or fallow irrigations for annual crops | Risk to yield or quality, logistics, training |
| Surface Gravity System Design and Operation | | |
| 8 | Convert to surge irrigation | Capital cost, operational cost, logistics, training |
| 9 | Use high flow rates initially, then cut back to finish off the irrigation | Operational cost, logistics, training |
| 10 | Reduce irrigation run distances and decrease set times | Risk to yield or quality, capital cost, operational cost, land tenure, training |
| 11 | Increase flow uniformity among furrows (e.g. by compacting furrows) | Operational cost |
| 12 | Grade fields as uniformly as possible | Operational cost, training |

| | | |
|---|---|---|
| 13 | Where high uniformity and efficiency are not possible, convert to drip, center pivot, or linear move systems | Capital cost, operational cost, land tenure, training |
| Sprinkler System Design and Operation | | |
| 14 | Monitor flow and pressure variation throughout the system | Operational cost |
| 15 | Repair leaks and malfunctioning sprinklers; follow manufacturer recommended replacement intervals | Capital cost, operational cost, training |
| 16 | Operate sprinklers during the least windy periods, when possible | Logistics |
| 17 | Use offset lateral moves | Operational cost, logistics, technology |
| 18 | Use flow-control nozzles when pressure variation is excessive | Capital cost, land tenure, training |
| Drip and Micro-sprinkler System Design and Operation | | |
| 19 | Use appropriate lateral hose lengths to improve uniformity | Training, capital cost |
| 20 | Check for clogging; prevent or correct clogging | Operational cost, capital cost, training |
| Other Irrigation Infrastructure Improvements | | |
| 21 | Installation of sub-surface drains in poorly drained soils[1] | Capital cost, technology |
| 22 | Backflow prevention | Capital cost, training |
| **Crop Management** | | |
| Change Crops to Use Those with Smaller N Requirements and Greater N Efficiency | | |
| 23 | Cover crops to recover residual soil nitrate and immobilize it in soil organic matter | Risk to yield or quality of cash crop, capital cost, operational cost, logistics, training, technology, increased irrigation requirements for the cash crop |
| 24 | Include deep-rooted or N-scavenger crop species in annual crop rotations | Risk to yield or quality, capital cost, operational cost, logistics |
| 25 | Include perennial crop in rotation, e.g. alfalfa or perennial grasses | Capital cost, logistics, land tenure |
| **Nitrogen Fertilizer Management** | | |
| Improve Rate, Timing and Placement of N Fertilizers | | |
| 26 | Adjust N-fertilizer rates based on soil nitrate testing | Operational cost, training |
| 27 | Adjust timing of N fertilization based on plant tissue analysis | Risk to yield or quality, operational cost, training, lack of robust relationships between tissue test and amount of N fertilizer required |
| 28 | Apply N fertilizer in small multiple doses, rather than one or two large doses, to meet crop demand during the growing season without deficiency or excess | Operational cost, training |
| 29 | Know N content of irrigation water and adjust fertilizer rates accordingly | Operational costs, logistics, training |
| 30 | Reduce total N-fertilizer rates by replacing low-uptake-efficiency N-fertilizer applications to soil with high-uptake-efficiency foliar-N applications | Operational costs, training, technology |
| 31 | Vary N-application rates within large fields according to site-specific needs based on heterogeneity in soil N supply and/or crop growth | Operational costs, capital costs, training, technology |
| 32 | Use delayed injection procedure when fertigating in surface gravity systems | Operational costs, logistics, training |

| | | |
|---|---|---|
| 34 | Develop an N budget that includes crop N harvest removal, supply of N from soil and other inputs to guide decisions on N-fertilizer rates and timing | Operational costs, training, technology |
| 35 | Use controlled release fertilizers, nitrification inhibitors, and urease inhibitors | Risk to yield quantity or quality, capital cost, training, technology, benefits depend on soil types and N-fertilizer management practices |
| Improve Rate, Timing, and Placement of Animal Manure and Organic Amendment Applications | | |
| 36 | Apply appropriate rates of manure and compost, taking N mineralization characteristics of these organic N sources into account | Risk to yield quantity or quality, operational cost, logistics, training, technology |
| 37 | Incorporate solid manure immediately to decrease ammonia volatilization loss | Operational costs, training |
| 38 | Use delayed injection to improve application uniformity when applying liquid manure in surface-gravity irrigation systems | Operational cost, logistics, training, technology |
| 39 | Use quick-test methods to monitor dairy lagoon water N content immediately before and during application, and adjust application rate accordingly | Operational costs, training, technology |
| 40 | Calibrate solid manure and compost spreaders | Operational cost, logistics, training |
| Promote Overall Healthier Soil | | |
| 41 | Promote healthy soil to augment water and nutrient holding capacity and retard nutrient loss[1] | Time and knowledge required to integrate organic amendments and other healthy soil promotion (e.g., reduced tillage) into cropping system. |

*[1]Presumably beneficial to N management primarily by promoting more uniform crop growth and N uptake across the field.*

As part of the education and outreach, the SSJV MPEP Team is working with CDFA, UCCE, and other partners to inventory additional known protective management practices. The SSJV MPEP will promote expanded management practice evaluations where information is missing, and continue to work to develop and validate protective management practices. In particular, the early outreach component of the SSJV MPEP Workplan is designed to boost the initial education and outreach for the known protective management practices where they are most applicable. The TBWQC will continue to communicate additional findings relevant to protective practices as they become available through annual monitoring and coordination with SSJV MPEP.

### 3.4.3 ADDITIONAL PRACTICES TO ADDRESS COCS

Additional practices to address transport of COC’s to groundwater include appropriate irrigation well maintenance and destruction of abandoned wells. Abandoned wells may provide a direct conduit of surface level constituents to groundwater. This may be evidenced by the presence of currently un-used, highly labile pesticides in groundwater. The TBWQC will continue to work with growers to direct them to county resources for appropriate well destructions in the case of abandonment. Additionally, the TBWQC will provide information on proper well destruction at outreach events, and feedback from Farm Evaluation Plans on proper wellhead management.
Additionally, COC pesticides considered subject the DPR’s Groundwater Protection Program will be considered to be separate and under the purview of that regulatory program.

### 3.4.4 TECHNICALLY AND ECONOMICALLY FEASIBLE MANAGEMENT PRACTICES

Protective management practices advocated by the TBWQC to growers must be demonstrated to be technically and economically feasible for growers to implement. The barriers to adoption for practices outlined in Table 8 are a focus of exploration and mitigation during grower outreach.

SSJV MPEP Workplan, Appendix C defines the methodology to address barriers to adoption, a revised excerpt is provided as follows.

*"Barriers to adoption will be investigated by discussing individual practices with key resource persons, including growers and those who work closely with them (CCAs, Farm Advisors, and NRCS staff). Once a barrier is identified, means will be sought to lower this barrier to allow beneficial implementation of protective practices. Some examples of barriers and actions that may be taken to alleviate them include the following:*

- *Outreach to supplement training and available information to growers or farmworkers*
- *Simplify complex practices or develop tools to manage complexity*
- *Promote efforts to offset costs of practices with high material resources needs through funding and volume pricing*
- *Produce workable alternatives when practices are ill adapted to certain types of operations or soil/topographic/management settings*
- *Practices will need to be fed back into field research performed by MPEP research partners*"

Site-specific and operational conditions will require different combinations of management practices to protect groundwater quality. The success of the CGQMP is dependent on member growers tailoring the implementation of management practices to suit site conditions. The TBWQC will continue to support grower efforts to implement protective management practices through outreach and support in conjunction with the SSJV MPEP.

### 3.4.5 PRACTICE EFFECTIVENESS AND LIMITATIONS

The agricultural practices defined in Table 8 have been demonstrated to improve nitrogen fertilizer capture by crops, thereby minimizing deep percolation of nitrates. The relationship of these performance changes to underlying groundwater quality will be established by methods spelled out clearly in the SSJV MPEP Workplan.

### 3.4.6 MANAGEMENT PRACTICES IMPLEMENTATION SCHEDULE

Many of the practices listed in Table 8 are currently implemented by growers who strive to minimize fertilizer loss and maximize irrigation water application efficiency. Currently, the Farm Evaluation Survey tracks the implementation of nitrogen efficiency, irrigation efficiency, and sediment and erosion control practices. Seventeen of the practices described by Dzurella et al., (2012) are included in the Farm Evaluation Plans. The initial Farm Evaluation Plans were completed by members in the CGQMP area during the Spring of 2016. Analysis of the Farm Evaluation Plans will provide a management practice baseline for TBWQC members throughout the high vulnerability areas.

#### 3.4.6.1 TIMETABLE TO IDENTIFY & IMPLEMENT MANAGEMENT PRACTICES

The current timetable for the implementation of the CGQMP is reliant with the ongoing implementation of the SSJV MPEP. The initial identification of management practices shown to be protective of groundwater quality will be provided to growers during the initial outreach and education phase. Additional management practices will be evaluated during the implementation phase of the SSJV MPEP Workplan. The outline below specifies the sequence of current activities and deliverables for management practices review and implementation as a part of the CGQMP:

- <u>Year 1 (first year after approval of CGQMP)</u>
    - Define baseline of protective practices currently implemented throughout the high vulnerability areas based on FEP data. Develop summary statistics for the different practices within the FEP.
    - Continue Coordination with the SSJV MPEP Team on research of known protective management practices and schedule the initial outreach curriculum.

- <u>Year 2 (second year after approval of CGQMP)</u>
    - Begin tracking trends and progress in implementation of protective practices over time throughout the high vulnerability areas. Develop summary statistics for the different practices within the FEP.
    - Define baseline analysis for reported Nitrogen Applied versus Crop Yield, calculating nitrogen ratios for crops with available nitrogen removed coefficients. Develop overall summary statistics to identify potential outliers.
    - Provide feedback to members on their relative performance within similar cropping systems based on provided Nitrogen application data and on farm management practices.
    - Initiate outreach specific to individual outliers and provide education on how to implement different management practices on their farm(s).
    - SSJV MPEP Team to initiate investigation of priority cropping scenarios with ongoing refinement of SWAT modeling to evaluate effects of management practice application.

- <u>Year 3 (third year after approval of CGQMP)</u>
    - Continue tracking management practice trends and progress in implementation of protective management practices over time throughout the high vulnerability areas.
    - Begin tracking trends reported in Nitrogen Applied versus Crop Yield, calculating nitrogen Ratios for crops with available Nitrogen removed coefficients. Develop summary statistics to identify outliers.
    - Provide feedback to growers on their relative performance within similar cropping systems based on provided Nitrogen application data and on farm practices.

Initiate outreach specific to outliers to provide additional resources on required member report submissions and certification, potential practices

- Curate outreach and education to growers incorporating SSJV MPEP Team findings for initial modeling results demonstrating impact of implemented practices in priority cropping scenarios.
- SSJV MPEP Team integrates grower reported grower data as modeling parameter inputs to analyze basin wide trends and demonstrate progress alongside long term groundwater monitoring data.

The third year of CGQMP implementation can be considered the steady state of the CGQMP implementation which will progress through the defined ten-year period. Member submittals, MPEP reports, GQTMW, and annual reporting continue to inform CGQMP implementation and support grower outreach efforts. Progress in implementing protective practices will be demonstrated through both the findings of the SSJV MPEP and the feedback provided by growers on the efficacy of outreach.

## 3.5 PERFORMANCE GOALS

TBWQC will work to ensure enrolled high vulnerability growers defined under this CGQMP provide member submittals as required in the timeline of the order. Successful completion of Farm Evaluation Plans and NMP Summary Reports are a foundational indicator of performance. Grower participation in the ILRP Program is a demonstration of the success of the Coalition and an ongoing relationship with members.

Growers will be provided with feedback on their reporting with respect to trends over time and relative to other growers as soon as data are available. This feedback will be expanded to define the effectiveness of practices to mitigate COC's on varying site conditions as defined via the SSJV MPEP. The TBWQC will conduct specialized outreach to members that appear to be outliers with respect to nitrogen reporting and/or management practice implementation.

Performance goals for the implementation of protective practices to limit deep percolation of nitrate are based on baselines of currently adopted protective management practices. For example, in **Section 3.6.3 of the SSJV MPEP Workplan**, "Benchmark Existing Level of BMP Adoption" states:

*"Another important MPEP objective is to provide a quantitative framework to predict how adoption of BMPs can reduce nitrate losses to groundwater. Achieving this objective will require characterizing the current N balances and net N surpluses for the most vulnerable regions, crops, and cropping systems (Section 3.6.2), as well as benchmarking the current degree of adoption of BMPs across the MPEP area. These benchmarks provide a baseline against which increases in BMP adoption levels can be evaluated for their impact on reducing nitrate losses using models and targeted field studies."*

As mentioned previously, certain practices identified as protective are already included within the Farm Evaluation Plan. Additional protective management practice implementation above the established baseline will be defined through the timetable of management practice identification, review of member submittals, SSJV MPEP findings, and scheduled monitoring. As additional protective management practices are identified through research or by work completed by the SSJV MPEP, the TBWQC will reach out to growers to promote and track implementation progress.

Reported member data will also underpin the SSJV MPEP demonstration of program performance. Management parameters will be included among model management parameters to assess landscape-level performance changes over time, and MPEP modeling will demonstrate the influence on underlying groundwater. The following SSJV MPEP Workplan sections highlight this process:

> *"As these data become available, trends in implementation of protective practices can be characterized in greater detail and with greater accuracy. These characterizations will be combined with performance data to illustrate progress in protecting groundwater quality from degradation by irrigated agriculture. Results will be provided to coalitions for inclusion in annual reports, and included in MPEP deliverables, as appropriate (SSJV MPEP Workplan, 2016. Section 3.12 Assessing Adoption, Data Exchange with Coalitions, pg 3-69)."*
>
> *"The Committee will document and demonstrate progress in protecting groundwater from nitrate emanating from irrigated agriculture. Once protective practices for specific irrigated lands settings (unique crop, soil, and management combinations) are identified and implemented under the MPEP, the increasing frequency of those practices on the landscape will be the main evidence of MPEP progress…"*
>
> *"Assessment of landscape-level impact of program. This includes the following:*
>
> - *Development of a verification monitoring framework for landscape-level nitrate loading as a function of management and other factors.*
> - *Refinements to the framework, including refined model inputs characterizing management and driving the landscape-level assessment of pre-MPEP and a series of post-MPEP conditions. These will be based on the following:*
>     - *Comparisons with results of verification monitoring.*
>     - *Results of management practice field monitoring and evaluation.*
> - *Comparison of landscape-level performance trends over time.*
>
> *Collaborative work with coalitions to assess the impact of changing performance on underlying groundwater. (SSJV MPEP Workplan, 2016. Section 2.1.4 pg 2-4/2-5)"*

The performance of the CGQMP strategy will also be assessed with respect to the effectiveness of TBWQC and SSJV MPEP outreach efforts in impacting grower decisions. Grower receptivity and comprehension to management practice outreach topics will be assessed by taking sample groups of participating growers and surveying the benefit of outreach. Results will be employed to adjust and/or supplement outreach curricula and to follow up with participants. Performance will be evaluated by the proportion of members reporting improved understanding and lowered barriers to implementation as a result of outreach activities.

## 4.0 MONITORING METHODS

The monitoring methods of the CGQMP are designed to measure the effectiveness of whether changes in management practices for irrigated agriculture are complying with the General Order requirements (General Order, Attachment B, MRP-1, page 5). The CGQMP monitoring methods within the TBWQC will be obtained from all the monitoring programs required by the General Order, including the Groundwater Quality Trend Monitoring Workplan (GQTMW), Management Practice Evaluation Program (MPEP), Farm Evaluation Plan (FEP), Nitrogen Management Plan (NMP) Summary Reports, and Groundwater Quality Assessment Report (GAR) five year updates. A compilation of that data will provide a means for determination of whether the management practices being implemented are effective, specifically within the high vulnerability areas.

A general overview of the monitoring methods to be collected of farming operations in the TBWQC and utilized for determination of trends in management practices and groundwater quality include the following:

### 4.1 FARM EVALUATION PLANS

Farm Evaluation Plans (FEP) provide the TBWQC with information on grower management practices that are protective of groundwater quality. FEPs were required to be submitted to the TBWQC by March 1, 2016 for all farms in the high vulnerability areas, and by March 1, 2017 for all farms. The management practices being utilized on the farms, as obtained from the FEP's, will be summarized and included in The Annual Report for each reporting period.

Management practice implementation will be tracked through Farm Evaluation Plan data from the initial submission through each subsequent year, allowing for changes and improved trends to be developed over time. As additional management practices are defined to be protective of groundwater quality through analysis completed by the SSJV MPEP, further outreach to members will be conducted to help growers find ways to implement the most effective management practices.

### 4.2 NITROGEN MANAGEMENT SUMMARY PLANS

Members in high vulnerability areas with farms larger than 60 acres are required to submit a Nitrogen Management Plan Summary Report (NMP Summary Report) beginning on March 1, 2017 annually to the Coalition identifying their efficiencies of nitrogen uptake by each crop. This information is crucial to establish different nitrogen efficiencies and determine trends in usage over time. The summaries of the data collected, which includes the applied nitrogen and total crop yield, will be summarized, the crop yield converted to an estimate of nitrogen removed (utilizing information from the Nitrogen Management Plan Technical Advisory Work Group[1]), and submitted within the Annual Report covering the previous NMP crop reporting period.

[1] Nitrogen Management Plan Technical Advisory Workgroup was formed in March 2015 by all Central Valley Water Quality Coalitions (excluding the California Rice Commission) to develop guidelines to identify knowledge gaps that exist in understanding nitrogen removal values. A "Crop Nitrogen Knowledge Gap Study Plan and Guidance Document" report was submitted to the RWQCB on December 18, 2015, and a follow up memo was submitted on February 19, 2016. Additional work is being completed by Dr. Daniel Geisseler, University of California, to identify the yield to removal conversion coefficient for the majority of crops grown in the TBWQC.

The NMP Summary Report data will guide outreach events and education of growers. Feedback to growers, particularly those with less efficient nitrogen use as compared with other growers of the same crop type, will provide a means of assisting growers in minimizing nitrogen leaching past the root zone and offer growers management practices that will allow more efficient fertilizer applications. The NMP Summary Report data will also be tracked from the first submission each year, allowing for changes and trends to be developed over time.

## 4.3 GROUNDWATER QUALITY TREND MONITORING WORKPLAN

A Groundwater Quality Trend Monitoring Workplan (GQTMW) is being prepared by the TBWQC (due January 6, 2017) to identify a long term groundwater monitoring well network of existing shallow wells for the determination of the current water quality of groundwater as affected by irrigated agriculture and to develop long-term groundwater quality data that can be used to evaluate the regional effects of management practices used by irrigated agriculture. The groundwater quality data collected during the annual monitoring will be useful for the determination of where there are current groundwater quality exceedances and for long term groundwater quality trends. Once the GQTMW is approved by the RWQCB, water quality data will begin to be collected and utilized for analysis under the CGQMP.

## 4.4 MANAGEMENT PRACTICE EVALUATION PROGRAM

A Management Practice Evaluation Plan (MPEP) is being prepared collectively among the different Third Party Coalitions within the Tulare Lake Basin through the SSJV MPEP Committee. The purpose of the MPEP is to identify those management practices being used by irrigated agriculture that are protective of groundwater quality and to identify the best management practices for different commodity groups within different hydrogeological areas.

The SSJV MPEP anticipates using Coalition data to characterize the extent and locations of implemented practices. On the basis of these and other data, characterizing crops, soils, climate, and management systems, performance will be assessed for all fields, and aggregated at a landscape scale (since this is the scale that influences groundwater quality). This assessment will occur along with priority investigations to define performance on specific sites. The modeled output will be employed to gauge the performance of implemented practices throughout the Coalition. The end product will be successively more refined versions of calibrated SWAT model output, along with analysis of the influence of land-surface conditions and activities on groundwater.

This process is described in Section 3.10 (page 3-55) of the SSJV MPEP Workplan, "Landscape-Level Performance Assessment."

> *"Because the interactions between water, soil, plants, nitrogen, and the atmosphere are very complex and highly variable over time and space, attempts to quantify nitrate fluxes require a modeling framework that simulates water and N balances across the soil-plant-water-atmosphere continuum. In addition, the modeling framework must also incorporate spatial factors to quantify nitrate fluxes at scales ranging from field to watershed. SWAT (Neitsch et al., 2009) is a modeling framework that integrates crop production and*

*physical data, producing output for the entire landscape, but specific down to relatively small spatial units of analysis (field or sub-field). For these and other reasons, SWAT has been selected as the central analysis tool to evaluate the influence of management practices on N losses and crop production. The use of SWAT does not, however, preclude use of other tools and models for focused investigations and to check SWAT results, as appropriate.*

*A landscape-level performance assessment will be conducted in three primary steps (Figure 2-2):*

1. *Initial SWAT models will be developed to characterize the potential ranges of N loading based upon readily available information.*
2. *SWAT models will be refined by comparison with the results of field studies and benchmark N balance and N surplus data.*
3. *Updated SWAT models will be used to evaluate the effects of actual and hypothetical levels of BMP implementation across the MPEP area."*

## 4.5 GROUNDWATER QUALITY ASSESSMENT REPORT

The Groundwater Quality Assessment Report (GAR) was conditionally approved by the RWQCB for the TBWQC on January 6, 2016. The GAR identified the high vulnerability areas of the TBWQC, utilizing readily available information regarding geology, hydrogeology, soil types, and existing groundwater quality data. The GAR is required to be updated at five year intervals for re-assessment of existing groundwater quality in the high vulnerability areas based on additional groundwater quality data used to characterize groundwater quality conditions and trends of the TBWQC. The high vulnerability areas identified in the most recent approved GAR update will remain the focus of the CGQMP.

## 4.6 OUTREACH AND EDUCATION

As a part of implementing an effective monitoring program, outreach to the members of the TBWQC with summarized results of the monitoring program and management practices will be coordinated by the TBWQC. In addition, coordination with the SSJV MPEP committee, other coalitions, and other technical partners, outreach meetings and education training seminars will be provided to the members. The effectiveness of the grower outreach and education will be used to compare the trends in groundwater quality and the trends in the implementation of effective management practices over time. Further detail of the Outreach and Education is summarized in Section 3.4.1, Section 3.4.2, and Section 3.4.3 of this report.

In summary, the monitoring methods and evaluation of data include a multi-faceted approach which will utilize the annual reporting of the FEP and NMP Summary reports to determine current management practices being used and to track trends on whether the management practices identified under the SSJV MPEP are being implemented. Parallel to tracking the management plans, the GQTMW program will identify the current groundwater quality conditions and trends in groundwater quality over time. Updates of the GAR will identify the areas of focus for the

CGQMP. By comparing long term management practices trends to long term groundwater quality trends, the effectiveness of the management practices will be measured alongside the effectiveness of the education and outreach that has been conducted for education of members of the effective management practices.

## 5.0 DATA EVALUATION AND REPORTING

Methods used to evaluate the data generated by the CGQMP and other related monitoring programs of the General Order including the evaluation of the effectiveness of the implemented management practices, the reports required to be submitted to the RWQCB as a part of the CGQMP, and the process for approving and completing the CGQMP are described below:

### 5.1 DATA EVALUATION METHODS

Data collected under the various ongoing monitoring programs associated with the General Order (GQTMW, FEP, NMP Summary Report, MPEP, Annual Reports) will be organized, compiled, and evaluated to track the effectiveness of the implemented management practices. Following is the data that will be collected:

- Management practices used by growers reported through the FEP Reports;
- Nitrogen Management Plan Summary Reports (after submitted) to calculate nitrogen ratios and efficiencies;
- Pesticide use information from the County Agricultural commissioners;
- Groundwater Quality collected annually from the GQTMW (after approval), in conjunction with additional data collected to update the GAR (every five years), such as additional groundwater quality data from SWRCB Division of Drinking Water (DDW), Geotracker, USGS, and pesticide data from DPR.
- Management Practices identified through the SSJV MPEP that are effective of protecting groundwater for different crops and different geology.
- Results of SSJV MPEP SWAT Modeling to provide a landscape-level performance assessment of practices as they evolve over time.

Utilizing these data sets, an evaluation of the effectiveness of the implemented management practices along with recommendations for growers are as follows:

- Long-term forecast of changes in groundwater quality conditions, on a regional scale, as related to the aggregated effect of changes in agricultural management practices;
- Identification of effective management practices for growers through meetings, online videos, and written materials;
- Continuation of outreach and education training for growers, tracking attendance and offering training materials at each event;
- Evaluation of the constituents of concern, considering natural causes and groundwater migration.

These data sets will be used to assess the implementation of Best Management Practices and changes in groundwater quality over time. Data collection, monitoring, and evaluation will be coordinated and conducted in accordance with the procedures developed as a part of both the CGQMP, GQTMW, and MPEP.

## 5.2 RECORDS AND REPORTING

By May 1 of each year (beginning after the approval of the CGQMP), the TBWQC will submit a Management Plan Status Report that summarizes the progress of the implementation of the CGQMP. The Management Plan Status Report will summarize the progress with comparison to the previous reporting period covering the calendar year January 1 through December 31. The Management Plan Status Report will include the requirements identified within the General Order, Attachment B, MRP-1, pages 6-7:

a. Title Page
b. Table of Contents
c. Executive Summary
d. Location Map(s) and a brief summary of the CGQMP high vulnerability areas
e. Update table that tallies all groundwater quality exceedances for the management plan areas.
f. A list of new groundwater quality parameters that were identified since the previous report.
g. Status update on preparation of new management plans
h. A summary and assessment of management plan monitoring data collected during the reporting period
i. A summary of management plan grower outreach conducted
j. A summary of the degree of implementation of management practices
k. Results from evaluation of management practice effectiveness
l. An evaluation of progress in meeting performance goals and schedules
m. Any recommendations for changes to the CGQMP (min. evaluation every 5 years)

## 5.3 SOURCE IDENTIFICATION STUDIES

A Source Identification Study may be prepared to identify and locate the source(s) of a groundwater constituent exceedance, but the study will not be prepared if the TBWQC elects to use a comprehensive approach to address exceedances of groundwater quality thresholds. Previous efforts to define the relative contribution of various nitrate producing activities to groundwater have yielded inconclusive results, especially in defining or explaining legacy impacts. As such, the cost and effort required to thoroughly conduct a source identification study is considered to have little benefit and would be duplicative of other efforts previously made by the RWQCB and others (*Harter T., et al. 2012*).

The SSJV MPEP Group has prepared a Discussion Draft Workplan identifying the approach to evaluate management practices in the field and through SWAT modeling efforts. The SSJV MPEP Group is evaluating the feasibility of field studies as a part of that approach, and are identifying locations where field studies are deemed most appropriate. In areas where field studies are not completed, the MPEP proposes to utilize the data from the field studies and other research documents to prepare a SWAT model to predict contributions from irrigated agricultural operations to groundwater quality problems identified under the CGQMP rather than implementing site specific Source Identification Studies.

### 5.4 MANAGEMENT PLAN APPROVAL AND COMPLETION

The review and approval process for the Draft CGQMP, as stated in the General Order, Attachment B, MRP-1, pages 7-9, includes the following:

- Prior to the Executive Officer approval, the Draft CGQMP will be posted on the RWQCB website for review and comment of stakeholders. After consideration of the stakeholder comments, the Executive Officer will approve the CGQMP, conditionally approve the CGQMP, or not approve the CGQMP. The action of the Executive Officer will be based upon the findings as to whether the plan meets the program requirements and goals contained within the General Order.

- Periodic review of the CGQMP will be conducted at least once every five years to determine whether the approved plan is resulting in groundwater quality improvements. Based upon the review and results, the Executive Officer may require the plan be updated based on the new information and progress in achieving compliance with the General Order. The Executive Officer may also require revision to the plan if other areas not currently within the CGQMP boundary indicate degradation of groundwater. It is anticipated by the TBWQC that during each five year update of the GAR, re-evaluation of the High Vulnerability Areas will be conducted and the CGQMP will be revised to be consistent with the most current GAR.

- The Executive Officer will make a finding as to whether the CGQMP is making adequate progress or inadequate progress. If inadequate progress is being made, additional management practice field monitoring studies, independent on-site verification of implementation of management practices and evaluation of their adequacy, and/or individual waste discharge requirements may be required by the Executive Officer.

Since the TBWQC is proposing to utilize a Comprehensive Groundwater Quality Management Plan, rather than individual management plans, Source Identification Studies will not be prepared, therefore, the process for implementing the CGQMP will involve the use of improved management practices for the resolution of groundwater quality problems, with submittal of credible evidence that the management practices being implemented are effective for the protection of groundwater quality. It is anticipated that such evidence will be provided during the activities of the MPEP. The following key components will be provided for evidence:

- Demonstration through evaluation of monitoring data that the groundwater quality problem is no longer occurring over three or more years;

- Documentation that the TBWQC education and outreach of members has improved or eliminated the groundwater quality issue;
- Documentation of member implementation of management practices that has resolved the groundwater quality exceedance; and
- Demonstration that the management practices implemented by the members are effective in protecting groundwater quality.

After approval of the CGQMP, the regular, ongoing monitoring requirements described in the General Order shall continue, which includes the GQTMW, further identification and analysis of management practices through the SSJV MPEP, and tracking management practices through the FEP and NMP Summary reports.

## SECTION 6.0 REFERENCES

Bertoldi, G.L., Johnston, R.H., and Evenson, K.D., 1991, Ground Water in the Central Valley, California – A Summary Report, Regional Aquifer-System Analysis-Central Valley, California, United States Geological Survey Professional Paper 1401-A, United States Government Printing Office, Washington, 55p.

Bertoldi, G.L., Johnston, R.H., and Evenson, K.D. [1991], Ground water in the Central Valley, California- a summary report: U.S. Geological Survey Professional Paper 1401-A.

Burton, C.A., and Belitz, K., 2008, Ground-water quality data in the southeast San Joaquin Valley, 2005-2006 - Results from the California GAMA Program: U.S. Geological Survey Data Series 351, 103 p.

Croft, M.G., 1972, Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California, United States Geological Survey Water-Supply Paper 1999-H, United States Government Printing Office, Washington.

Croft, M.G., and Gordon, G.V., 1968, Geology, Hydrology, and Quality of Water in the Hanford-Visalia Area San Joaquin Valley, California, United States Department of the Interior Geological Survey, Water Resources Division, Open-File Report 68-67, 68p.

Davis, G.H, Green, J.H., Olmsted, F.H, and Brown, D.W., 1959, Ground-Water Conditions and Storage Capacity in the San Joaquin Valley California, Water-Supply Paper 1469, United States Geological Survey prepared in cooperation with California Department of Water Resources, 324p.

Davis, G.H, Lofgren, B. E., and Mack, S.,1964, Use of Ground-Water Reservoirs for Storage of Surface Water in the San Joaquin Valley California, Water-Supply Paper 1618, United States Geological Survey prepared in cooperation with California Department of Water Resources, 134p.

DWR, 1980, Department of Water Resources, Groundwater Basins in California, Bulletin 118-80, 73p.

DWR, 1986, Crop Water Use in California, Department of Water Resources, Bulletin 113-4, 122p.

DWR, 2003, Department of Water Resources, Update 2003, California Groundwater Bulletin 118, Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Tule Subbasin, 265p.

DWR, 2009, California Water Plan, Update 2009, Integrated Water Management, Volume 3 Regional Reports, Tulare Lake, Department of Water Resources Bulletin 160-09, 68p.

Dzurella, et al., 2012. Nitrogen Source Reduction to Protect Groundwater Quality. Technical Report 3, 174p., in: Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature. Center for Watershed Sciences, University of California, Davis, 174p.

Faunt, C. C., ed., 2009, Groundwater availability of the Central Valley aquifer, California: U.S. Geological Survey Professional Paper 1766, 225 p.

Fogelman, R.P., 1982, Compilation of selected ground-water-quality data from the San Joaquin Valley, California: U.S. Geological Survey Open-File Report 82-335.

Fujii, R., and Swain, W.C., 1995, Areal distribution of selected trace elements, salinity, and major ions in shallow ground water, Tulare Basin, southern San Joaquin Valley, California: U.S. Geological Survey Water Resources Investigations Report 95-4048.

Gurdak, J.J., and Sharon, L.Q., 2012, Vulnerability of recently recharged groundwater in principle aquifers of the United States to nitrate contamination: Environmental Science &Technology, v. 46, p. 6004-6012.

Harter, T., Ruud. N., and Naugle, A., 2001, A Conjunctive Use Model for the Tule River Groundwater Basin in the San Joaquin Valley, California, Integrated Water Resources Management, Proceedings of a Symposium held at Davis, California, 82p.

Harter, T., Lund, J. R. et.al., 2012, Addressing Nitrate in California's Drinking Water With a Focus on Tulare Lake Basin and Salinas Valley Groundwater, Report for the State Water Resources Control Board Report to the Legislature, Center for Watershed Sciences, University of California, Davis, Groundwater Nitrate Project, Implementation of Senate Bill X2 1, Prepared for California State Water Resources Control Board, January, 2012. 92p.

Jennings, C.W., Strand, R.G., and Rogers, T.H., 1977, Geologic map of California, California Division of Mines and Geology, scale 1:750,000.

Mullen, J.R., and Nady, P., 1985, Water budgets for major streams in the Central Valley, California, 1961-77: U.S. Geological Survey Open-File Report 85-401, 87 p.

Nolan, B.T., Hitt, K.J. , and Ruddy, B.C. , 2002, Probability of nitrate contamination of recently recharged groundwaters in the conterminous United States: Environmental Science & Technology, v. 36, no. 10.

Page, R.W., 1986, Geology of the Fresh Ground-Water Basin of the Central Valley, California, with Texture Maps and Sections, Regional Aquifer System Analysis, United States Geological Survey Professional Paper 1401-C, United States Government Printing Office, Washington.

Rosenstock, T.S., and others, 2014, Agriculture's contribution to nitrate contamination of Californian groundwater (1945-2005): Journal of Environmental Quality, v.43, n. 3, p. 895-907.

Rosenstock, T.S., Liptzin, D., Six, J., and Tomich, T.P., 2013, Nitrogen Fetrilizer use in California: Assessing the Data, Trends, and a Way Forward, California Agriculture v067n01p68-79. On the worldwide web at: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.E.v067n01p68&fulltext=yes

RWQCB, 1995, California Regional Water Quality Control Board-Central Valley Region, (Revised 2004 with Approved Amendments), Water Quality Control Plan for the Tulare Lake Basin Second Edition, 202 p.

RWQCB, 2011, California State Water Resources Control Board, 1999/2011, Hydrogeologically vulnerable areas map (references appear to be 1999 or earlier; map noted as updated March 10, 2011).

RWQCB, 2012, Central Valley Regional Valley Water Quality Control Board, Irrigated Lands Regulatory Program, http://www.swrcb.ca.gov/rwqcb5/water_issues/irrigated_lands/index.shtml.

RWQCB, 2013, California Regional Water Quality Control Board-Central Valley Region, Order Number R5-2013-0120, *Waste Discharge Requirements General Order for Growers within the Tulare Lake Basin Area that are Members of a Third Party Group*, 202 p.

Schafer, R.L., 2014, “Annual Report, 2013 Water Year, Tule River Association”.

Schmidt Kenneth D. & Associates, 2001, Analysis of groundwater resources southern Tulare and northern Kern county, CVP Districts: Fresno, CA, Schmidt Kenneth D. & Associates.

Schmidt, K.D., 2009, Groundwater Conditions within the City of Porterville Urban Area Boundary, Kenneth D. Schmidt and Associates, Prepared for the City of Porterville, Porterville, CA, 67p.

Sokol, D., 1954, “Porterville Irrigation District, Geology, Chapter III”, U.S. Bureau of Reclamation, Fresno Operations Office, Fresno, CA, 24p.

USDA, 1982, United States Department of Agriculture Soil Conservation Service, Soil Survey of Tulare County, California, Central Part, 165p.

USDA, 2003, United States Department of Agriculture Soil Conservation Service, Soil Survey of Tulare County, California, Western Part, 299p.

USDA, 1988, United States Department of Agriculture Soil Conservation Service, Soil Survey of Kern County, California, Northwestern Part, 304p.

USDA, 1999, United States Department of Agriculture Natural Resources Conservation Service, Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys, Second Edition, Agricultural Handbook Number 436, 871p.

USDA, 2014, United States Department of Agriculture Natural Resources Conservation Service, Geospatial Data Gateway; http://datagateway.nrcs.usda.gov/GDGOrder.aspx

USGS, 1959, Groundwater Conditions and Storage Capacity in the San Joaquin Valley, California, Davis, G. H.; Green, J. H.; Olmsted F. H.; Brown, D. W., USGS Water Supply Paper: 1469, 246p.

USGS, 1964, Use of Groundwater Reservoirs for Storage of Surface Waters in the San Joaquin Valley, California, G.H. Davis, B.E. Lufgren and Semour Mack, USGS Water Supply Paper 1618, 125p.

USGS, 1989, Groundwater Flow in the Central Valley, California, Regional Aquifer Systems Analysis, Central Valley California, Williamson, A.K.; Prudic, D.E.; Swain, L.A., USGS Geological Survey Professional Paper 1401-D, 136p.

USGS, 1995, Groundwater Atlas of the United States, California, Nevada, United States Geological Survey Hydrologic Investigations Atlas HA-730-B

USGS, 2009, Groundwater Availability of the Central Valley Aquifer, California, United States Geological Survey Groundwater Resources Program, Professional Paper 1776, 246p.

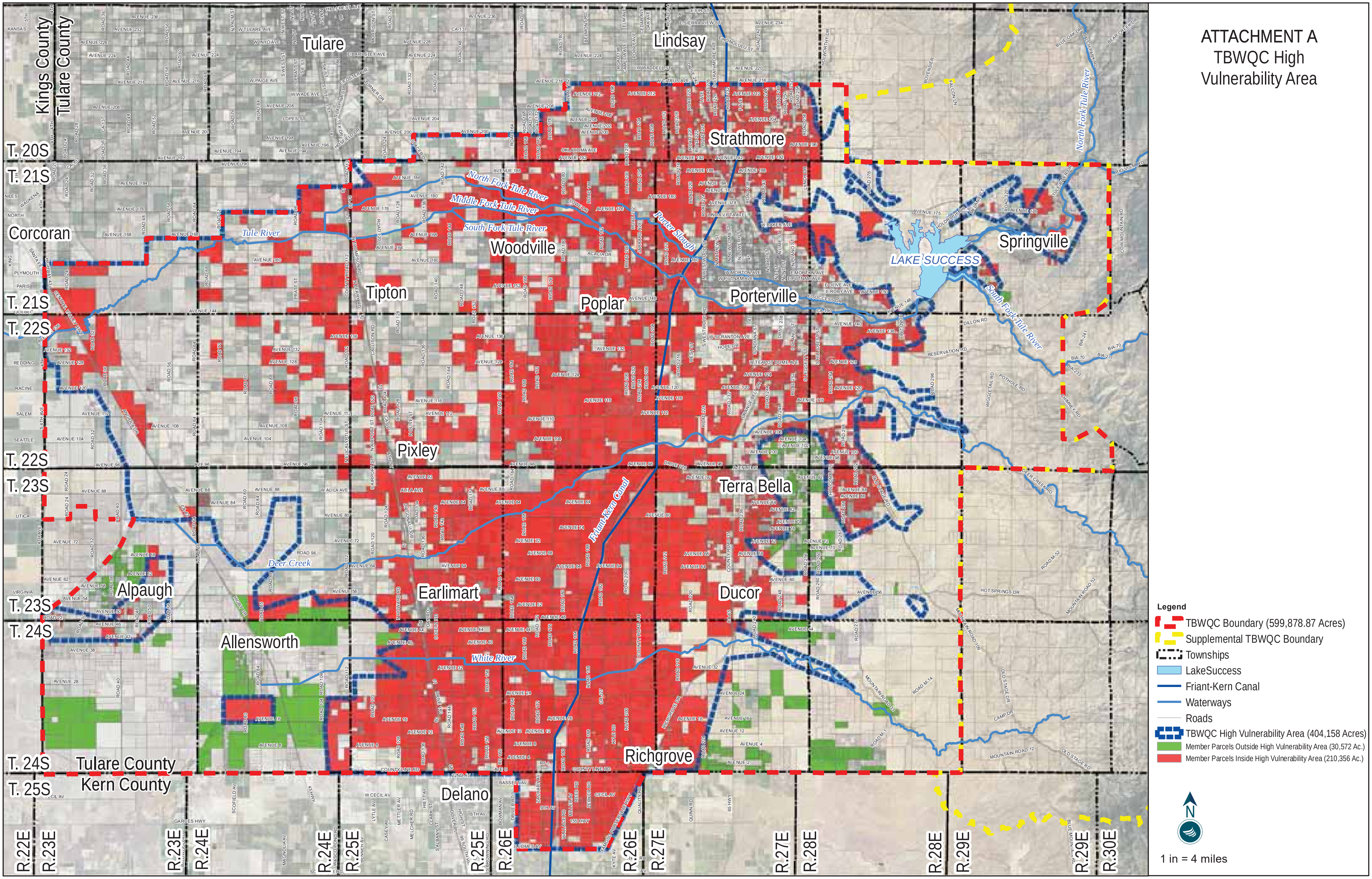
Williamson, A.K., Prudic, D.E., and Swain, L.A., 1989, Ground-Water Flow in the Central Valley, California, Regional Aquifer-System Analysis Central Valley, California, United States Geological Survey, Professional Paper 1401-D, 136p.

Zhang, M., and others, 1997, Pesticide occurrence in groundwater in Tulare County, California: Environmental Monitoring and Assessment, v. 45, p. 101-127.

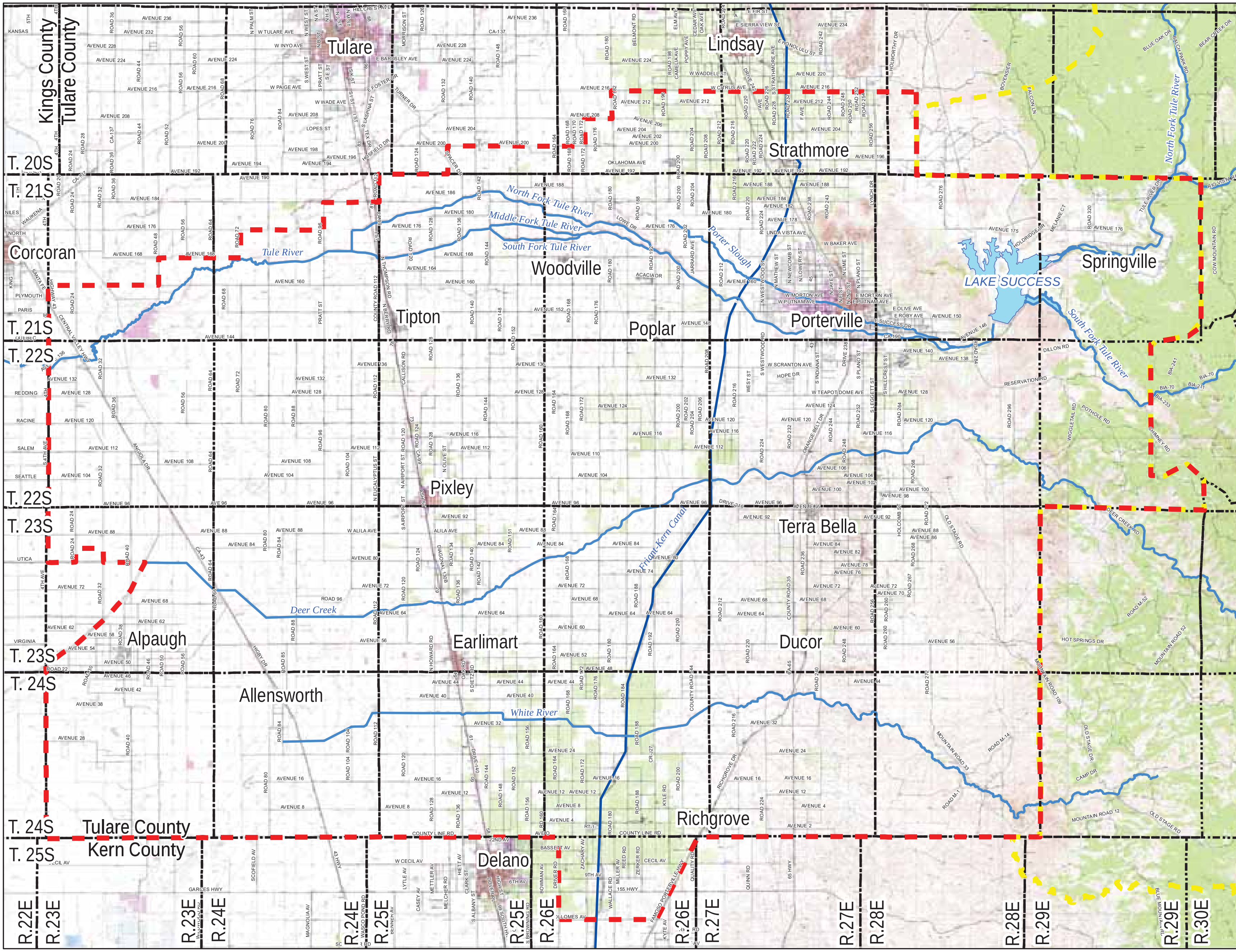
4Creeks, Inc., 2012, Groundwater Management Plan Update, prepared for Deer Creek and Tule River Authority, 122p.

# ATTACHMENTS

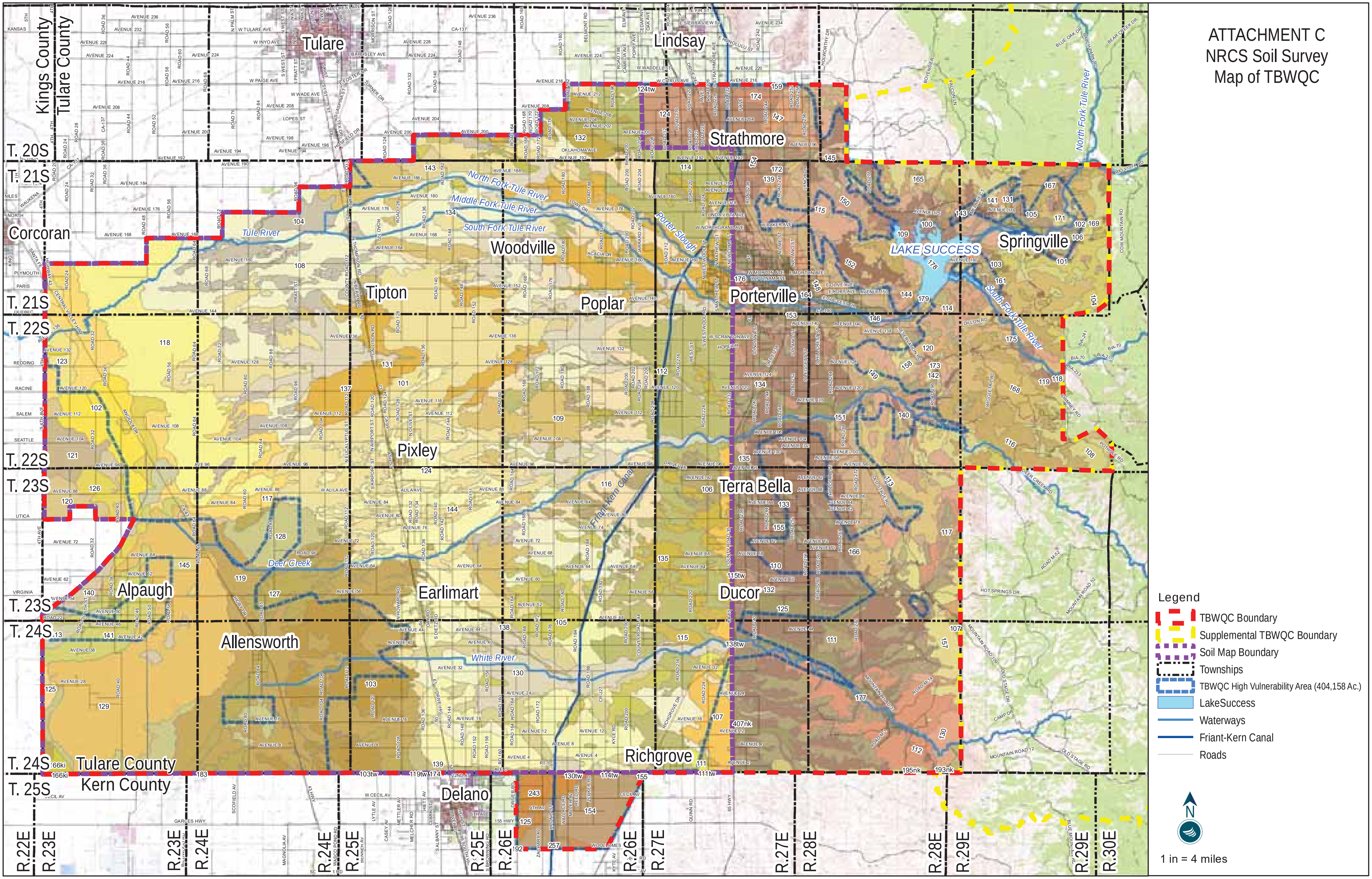
# ATTACHMENT A
TBWQC High Vulnerability Area



# ATTACHMENT B
United States
Geographical Survey
Quadrangle Map



# ATTACHMENT C
# NRCS Soil Survey Map of TBWQC



# ATTACHMENT C.1
# NRCS Soil Survey
# Soil Type Legend

## Map Units-Central Tulare County

- 100 - Auberry sandy loam, 5 to 9 percent slopes
- 101 - Auberry sandy loam, 9 to 15 percent slopes
- 102 - Auberry sandy loam, 15 to 30 percent slopes
- 103 - Auberry sandy loam, 30 to 50 percent slopes
- 104 - Auberry-Rock outcrop complex, 9 to 50 perce*
- 105 - Blasingame sandy loam, 9 to 15 percent slop*
- 106 - Blasingame sandy loam, 15 to 30 percent slo*
- 107 - Blasingame sandy loam, 30 to 50 percent slo*
- 108 - Blasingame-Rock outcrop complex, 9 to 50 pe*
- 109 - Centerville clay, 0 to 2 percent slopes
- 110 - Centerville clay, 2 to 9 percent slopes
- 111 - Centerville clay, 9 to 15 percent slopes
- 112 - Centerville clay, 15 to 30 percent slopes
- 113 - Cibo clay, 15 to 30 percent slopes
- 114 - Cibo clay, 30 to 50 percent slopes
- 115 - Cibo-Rock outcrop complex, 15 to 50 percent*
- 115tw - Exeter loam, 2 to 5 percent slopes
- 116 - Cieneba-Rock outcrop complex, 15 to 75 perc*
- 117 - Clear Lake clay, drained
- 118 - Coarsegold loam, 15 to 30 percent slope
- 119 - Coarsegold loam, 30 to 50 percent slopes
- 120 - Coarsegold-Rock outcrop complex, 15 to 50 p*
- 124 - Exeter loam, 0 to 2 percent slopes
- 124tw - Hanford sandy loam, 0 to 2 percent slopes
- 125 - Exeter loam, 2 to 9 percent slopes
- 130 - Friant-Rock outcrop complex, 15 to 75 perce*
- 131 - Grangeville silt loam, drained
- 132 - Greenfield sandy loam, 0 to 2 percent slopes
- 133 - Greenfield sandy loam, 2 to 5 percent slopes
- 134 - Havala loam, 0 to 2 percent slopes
- 135 - Havala loam, 2 to 5 percent slopes
- 138tw - Tujunga loamy sand, 0 to 2 percent slopes
- 139 - Honcut sandy loam, 0 to 2 percent slopes
- 140 - Honcut sandy loam, 2 to 5 percent slopes
- 141 - Las Posas loam, 9 to 15 percent slopes
- 142 - Las Posas loam, 15 to 30 percent slopes
- 143 - Las Posas loam, 30 to 50 percent slopes
- 144 - Las Posas-Rock outcrop complex, 9 to 50 per*
- 145 - Lewis clay loam
- 146 - Pits
- 147 - Porterville clay, 0 to 2 percent slopes
- 148 - Porterville clay, 2 to 9 percent slopes
- 149 - Porterville clay, 9 to 15 percent slopes
- 150 - Porterville cobbly clay, 2 to 15 percent sl*
- 151 - Riverwash
- 152 - Rock outcrop
- 153 - San Emigdio loam
- 154 - San Joaquin loam, 0 to 2 percent slopes
- 155 - San Joaquin loam, 2 to 9 percent slopes
- 157 - Sesame sandy loam, 15 to 30 percent slopes
- 158 - Sesame sandy loam, 30 to 50 percent slopes
- 159 - Seville clay
- 161 - Trabuco loam, 15 to 30 percent slopes
- 164 - Tujunga sand
- 165 - Vista coarse sandy loam, 9 to 15 percent sl*
- 166 - Vista coarse sandy loam, 15 to 30 percent s*
- 167 - Vista coarse sandy loam, 30 to 50 percent s*
- 168 - Vista-Rock outcrop complex, 9 to 50 percent*
- 169 - Walong sandy loam, 15 to 30 percent slopes
- 171 - Walong-Rock outcrop complex, 15 to 50 perce*
- 172 - Wyman loam, 0 to 2 percent slopes
- 173 - Wyman loam, 2 to 5 percent slopes
- 174 - Wyman gravelly loam, 0 to 2 percent slopes
- 175 - Xerofluvents, flooded
- 176 - Yettem sandy loam, 0 to 2 percent slopes
- 177 - Yettem sandy loam, 2 to 5 percent slopes
- 178 - Water
- 179 - Dam
- 193nk - Chanac-Pleito complex, 2 to 5 percent slo*
- 195nk - Centerville-Delvar complex, 9 to 30 perce*
- 407nk - Centerville clay, 2 to 5 percent slopes

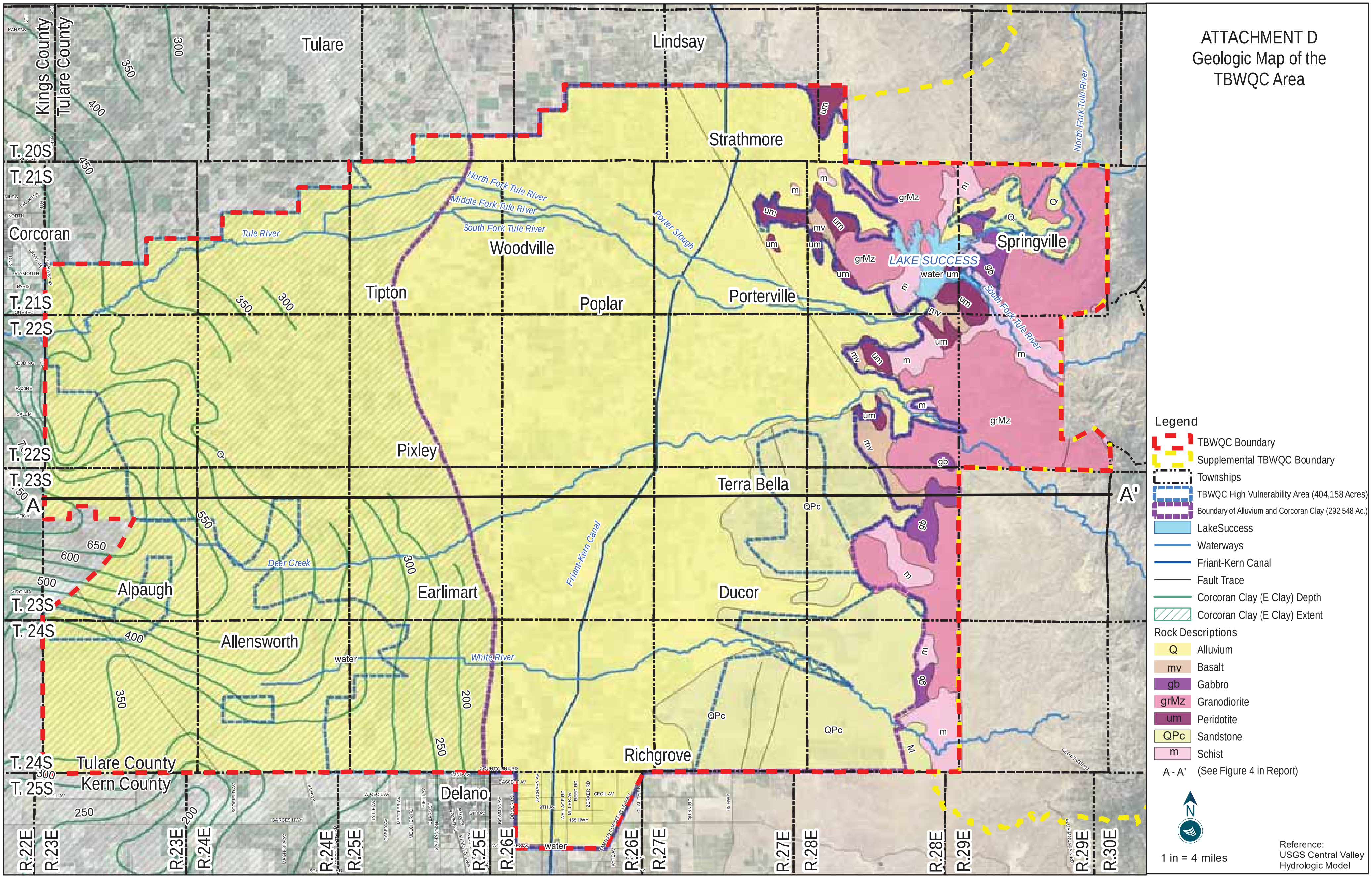
## Map Units-Western Tulare County

- 101 - Akers-Akers, saline-Sodic, complex, 0 to 2 percent slopes
- 102 - Armona sandy loam, partially drained, 0 to 1 percent slopes
- 103 - Atesh-Jerryslu association, 0 to 2 percent slopes
- 104 - Biggriz-Biggriz, saline-Sodic, complex, 0 to 2 percent slopes
- 105 - Calgro-Calgro, saline-Sodic, complex, 0 to 2 percent slopes
- 106 - Centerville clay, 0 to 2 percent slopes
- 107 - Centerville clay, 2 to 5 percent slopes
- 108 - Colpien loam, 0 to 2 percent slopes
- 109 - Crosscreek-Kai association, 0 to 2 percent slopes
- 111 - Delvar clay loam, 2 to 9 percent slopes
- 112 - Dumps
- 113 - Excelsior fine sandy loam, 0 to 1 percent slopes
- 114 - Exeter loam, 0 to 2 percent slopes
- 115 - Exeter loam, 2 to 5 percent slopes
- 116 - Flamen loam, 0 to 2 percent slopes
- 117 - Gambogy loam, drained, 0 to 1 percent slopes
- 118 - Gambogy-Biggriz, saline-Sodic, association, drained, 0 to 2 percent slopes
- 119 - Gareck-Garces association, 0 to 2 percent slopes
- 120 - Gepford silty clay, partially drained, 0 to 1 percent slopes
- 121 - Gepford silty clay, partially drained, sandy substratum , 0 to 1 percent slopes
- 123 - Grangeville fine sandy loam, saline-sodic, 0 to 1 percent slopes
- 124 - Hanford sandy loam, 0 to 2 percent slopes
- 125 - Houser fine sandy loam, drained, 0 to 1 percent slopes
- 126 - Houser silty clay, drained, 0 to 1 percent slopes
- 127 - Kimberlina fine sandy loam, 0 to 2 percent slopes MLRA 17
- 128 - Lethent silt loam, 0 to 1 percent slopes
- 129 - Nahrub silt loam, overwashed, 0 to 1 percent slopes
- 130 - Nord fine sandy loam, 0 to 2 percent slopes
- 131 - Pits
- 132 - Quonal-Lewis association, 0 to 2 percent slopes
- 134 - Riverwash
- 135 - San Joaquin loam, 0 to 2 percent slopes
- 137 - Tagus loam, 0 to 2 percent slopes
- 138 - Tujunga loamy sand, 0 to 2 percent slopes
- 139 - Wasco sandy loam, 0 to 2 percent slopes
- 140 - Westcamp silt loam, partially drained, 0 to 2 percent slopes
- 141 - Posochanet silt loam, 0 to 2 percent slopes
- 143 - Yettem sandy loam, 0 to 2 percent slopes
- 144 - Youd loam, 0 to 1 percent slopes
- 145 - Water-perennial
- 166ki - Twisselman silty clay, saline-alkali

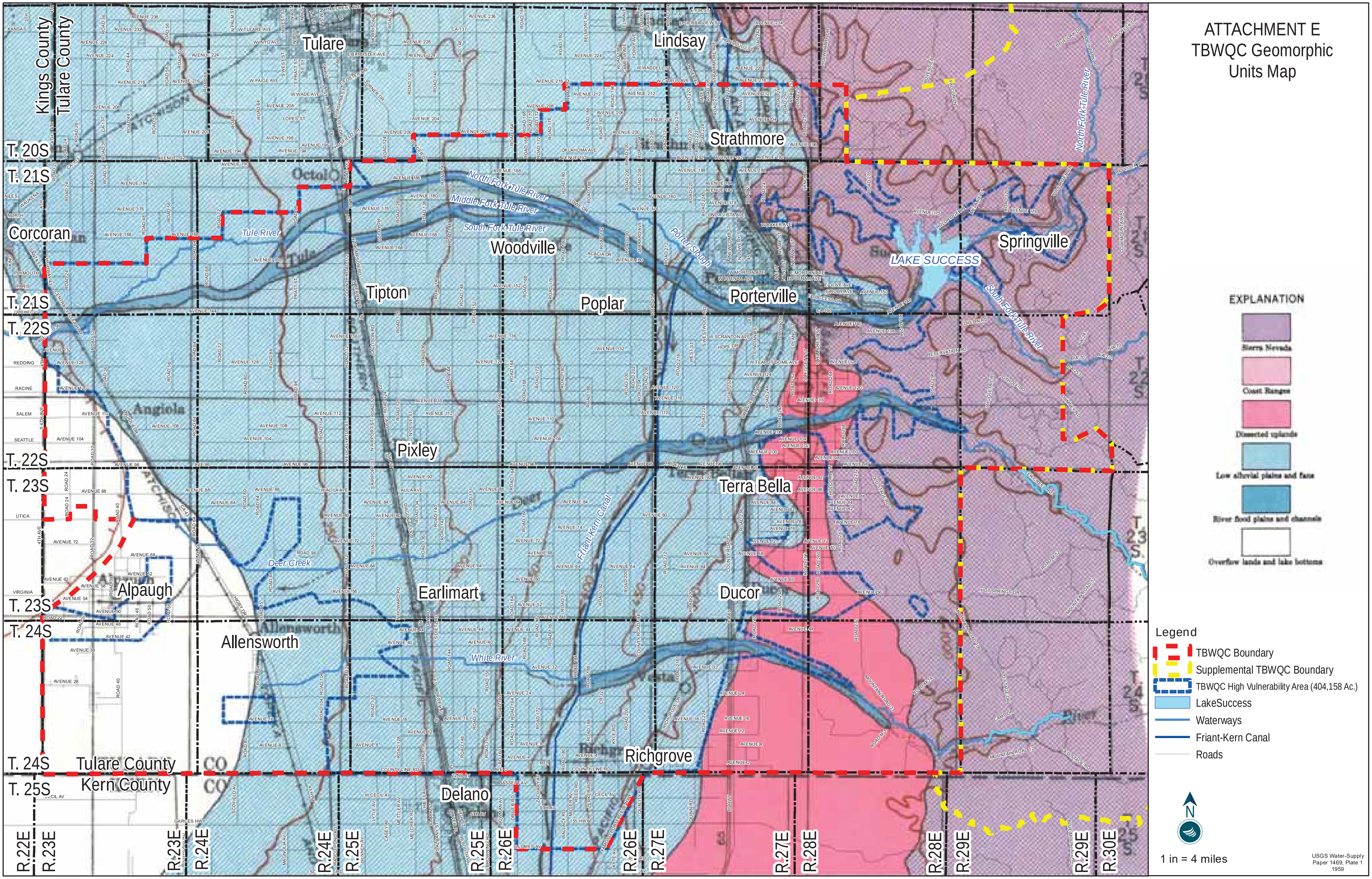
## Map Units-NW Kern County

- 103tw - Atesh-Jerryslu association, 0 to 2 percen*
- 111tw - Delvar clay loam, 2 to 9 percent slopes
- 114tw - Exeter loam, 0 to 2 percent slopes
- 119tw - Gareck-Garces association, 0 to 2 percent*
- 125 - Granoso loamy sand, 0 to 2 percent slopes
- 129tw - Nahrub silt loam, overwashed, 0 to 1 perc*
- 130tw - Nord fine sandy loam, 0 to 2 percent slop*
- 154 - Exeter sandy loam, 0 to 2 percent slopes
- 155 - Exeter sandy loam, 2 to 9 percent slopes
- 166ki - Twisselman silty clay, saline-alkali
- 174 - Kimberlina fine sandy loam, 0 to 2 percent *
- 183 - Lethent silt loam
- 192 - McFarland loam
- 243 - Wasco sandy loam
- 257 - Water

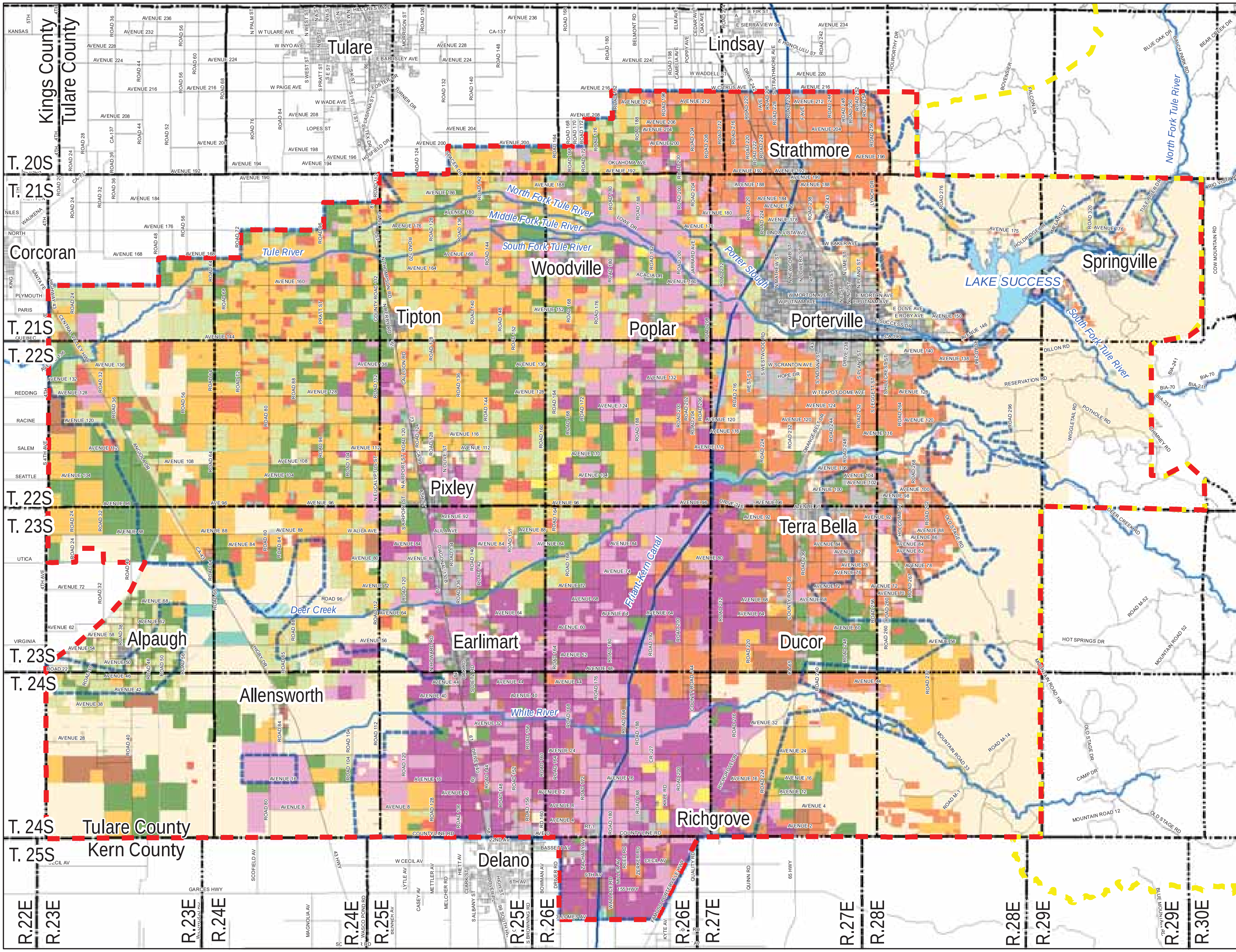
# ATTACHMENT D
# Geologic Map of the TBWQC Area



# ATTACHMENT E
# TBWQC Geomorphic Units Map



# ATTACHMENT F
# TBWQC DWR
# 2007 Land Use Map




Legend

- TBWQC Boundary
- Supplemental TBWQC Boundary
- TBWQC High Vulnerability Area (404,158 Acres)
- Townships
- LakeSuccess
- Waterways
- Friant-Kern Canal
- Roads

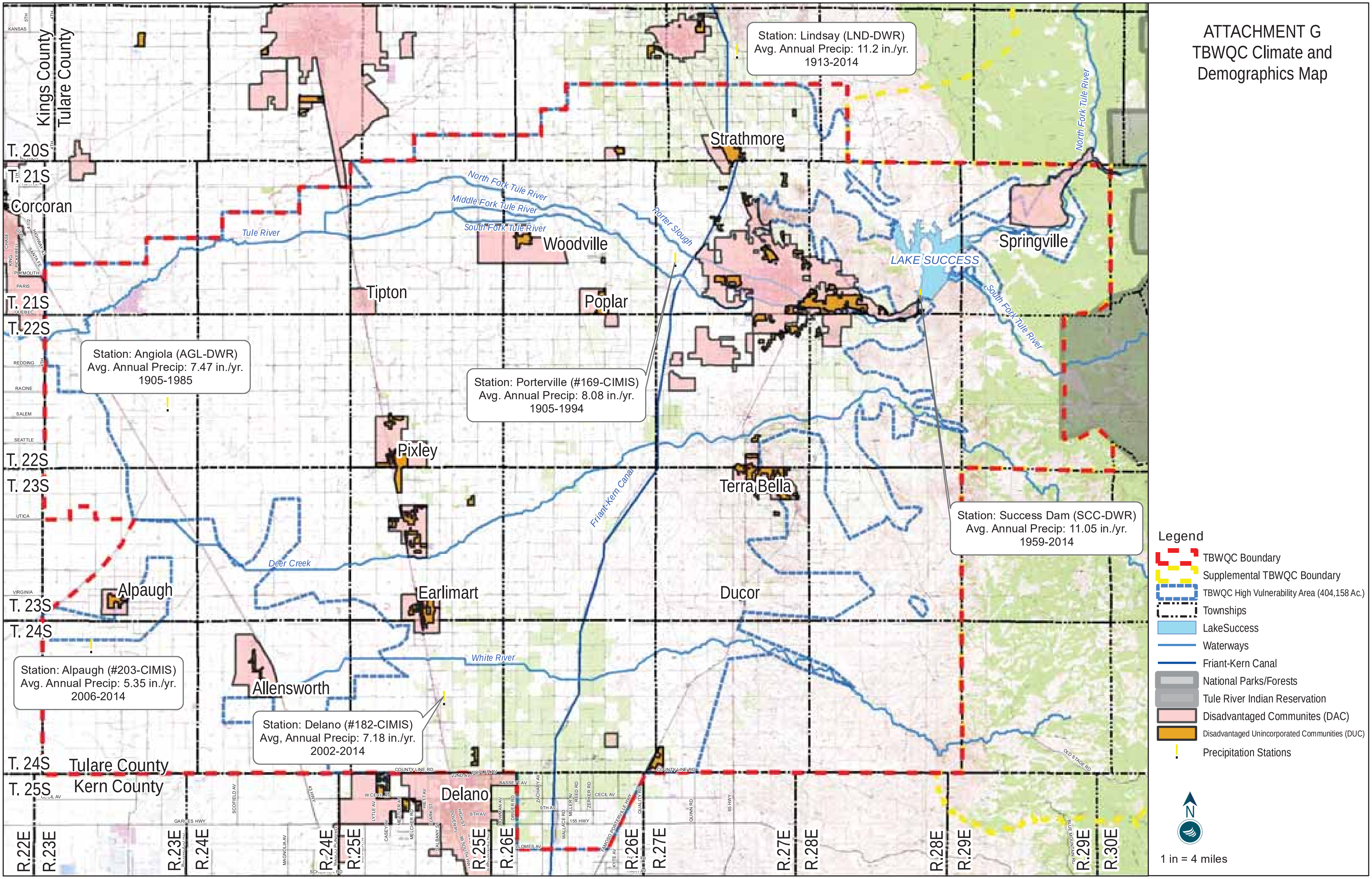
DWR 2007 Land Use

- Idle(11,578.5ac)
- Citrus And Subtropical(54,779.5ac)
- Deciduous Fruits And Nuts(59,647.0ac)
- Field Crops(53,215.8ac)
- Grain and Hay Crops(84,524.0ac)
- Pasture(49,176.3ac)
- Truck and Berry Crops(1,749.8ac)
- Barren(49.6ac)
- Riparian Vegetation(1,598.1ac)
- Incidental to Agriculture(15,350.2ac)
- Vineyard(35,892.5ac)
- Native Vegetation(165,776.9ac)
- Urban, Commercial, Industrial, Residential(35,892.5 ac.)
- Water Surface(9,747.5ac)

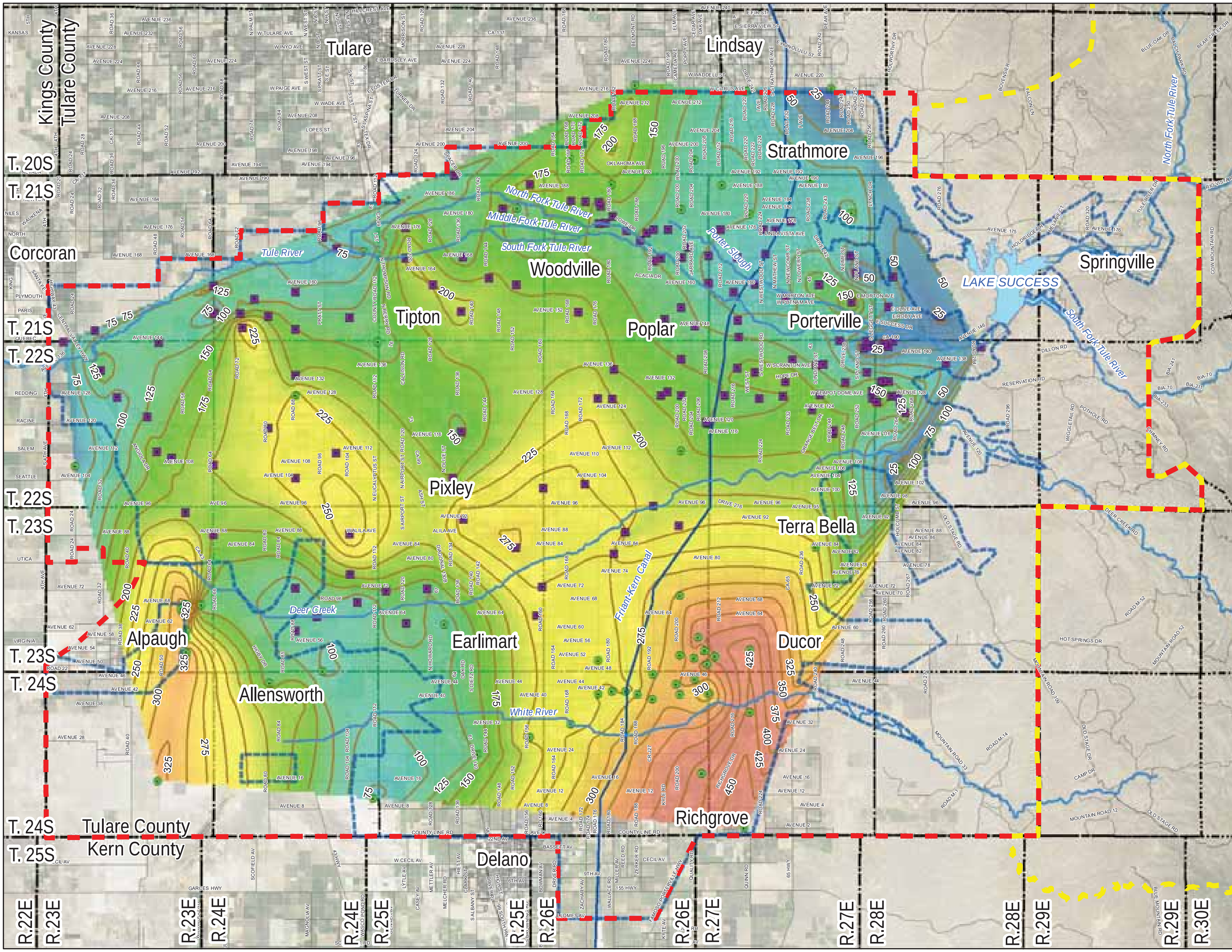
N

1 in = 4 miles

# ATTACHMENT G
# TBWQC Climate and Demographics Map



# ATTACHMENT H
# 2015 Spring
# Depth to Groundwater Map




Legend

- TBWQC Boundary
- Supplemental TBWQC Boundary
- TBWQC High Vulnerability Area (404,158 Ac)
- Townships
- LakeSuccess
- Friant-Kern Canal
- Waterways
- Roads
- 25' Contours

Value

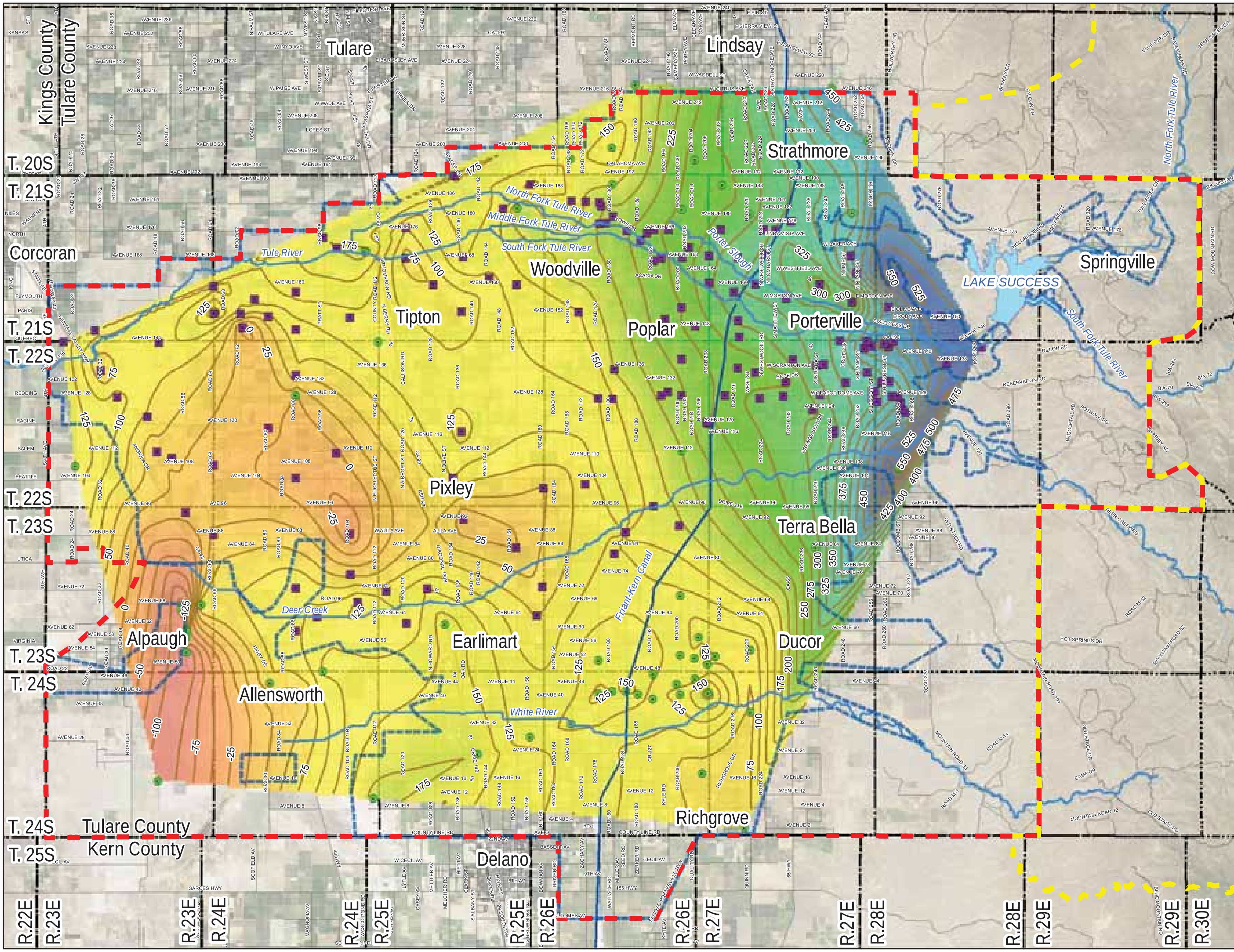
High : 480'

Low : 10'

Mean Depth to Groundwater: 180'

- CASGEM (74 Wells)
- DCTRA (153 Wells)

1 in = 4 miles




# ATTACHMENT I
## 2015 Spring
## Groundwater Elevation Map

**Legend**

- TBWQC Boundary
- Supplemental TBWQC Boundary
- TBWQC High Vulnerability Area (404,158 Ac)
- Townships
- LakeSuccess
- Friant-Kern Canal
- Waterways
- Roads
- 25' Contours

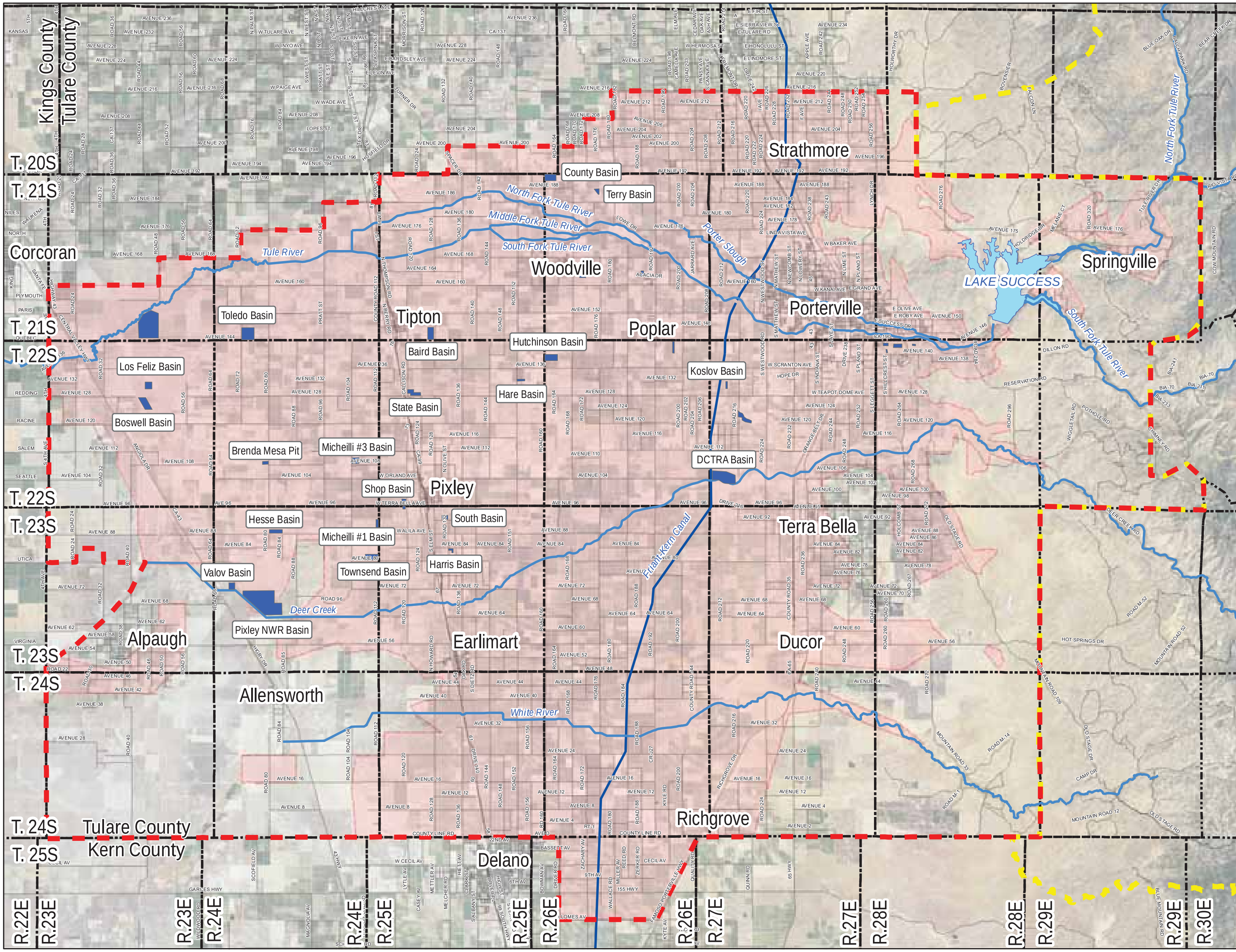
Spring 2015 Groundwater Elevation
High : 570'
Low : -140'
Mean Groundwater Elevation: 155'

- CASGEM (74 Wells)
- DCTRA (153 Wells)

N

1 in = 4 miles

# ATTACHMENT J
# Recharge Basins Map



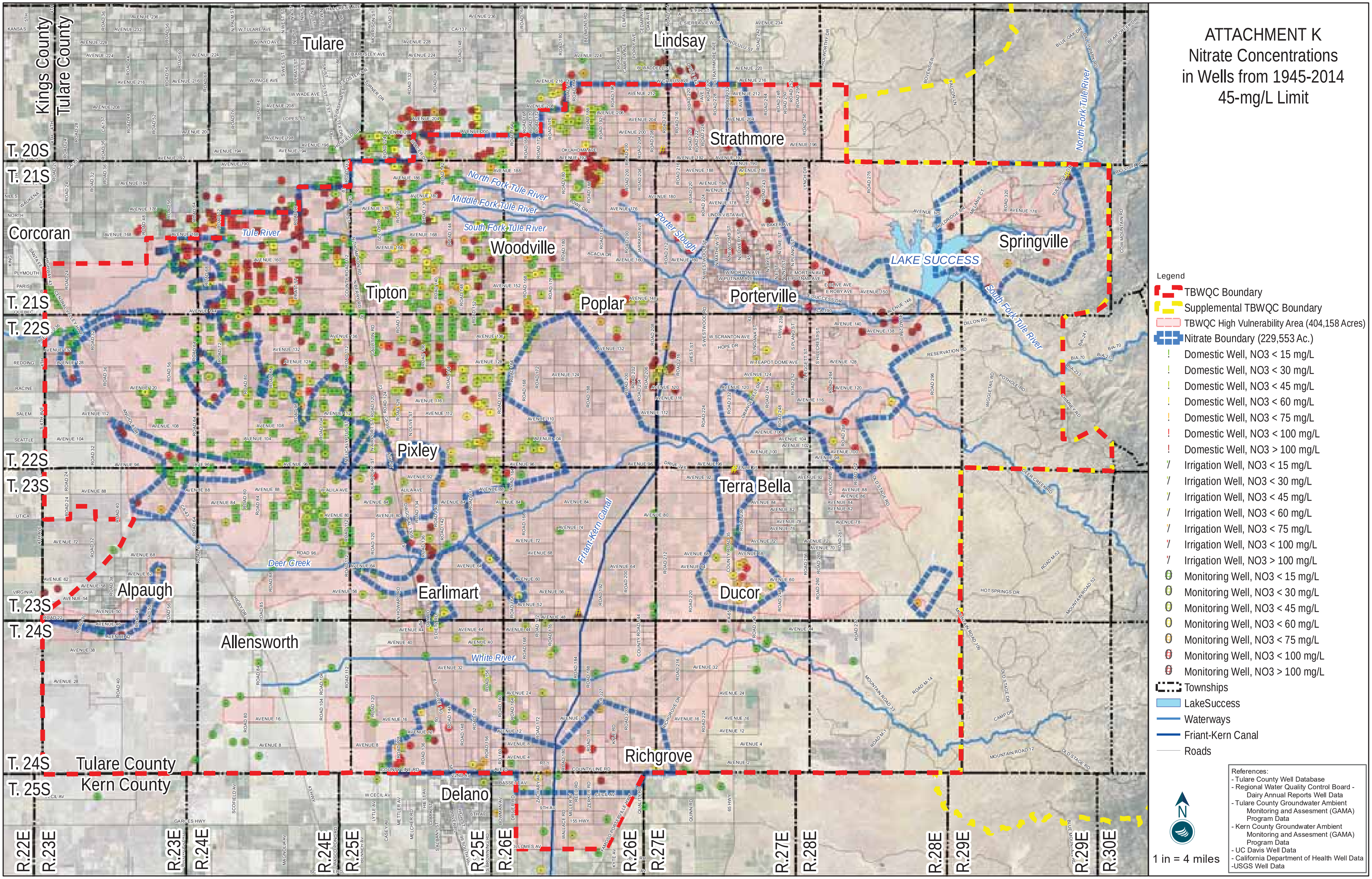

Legend

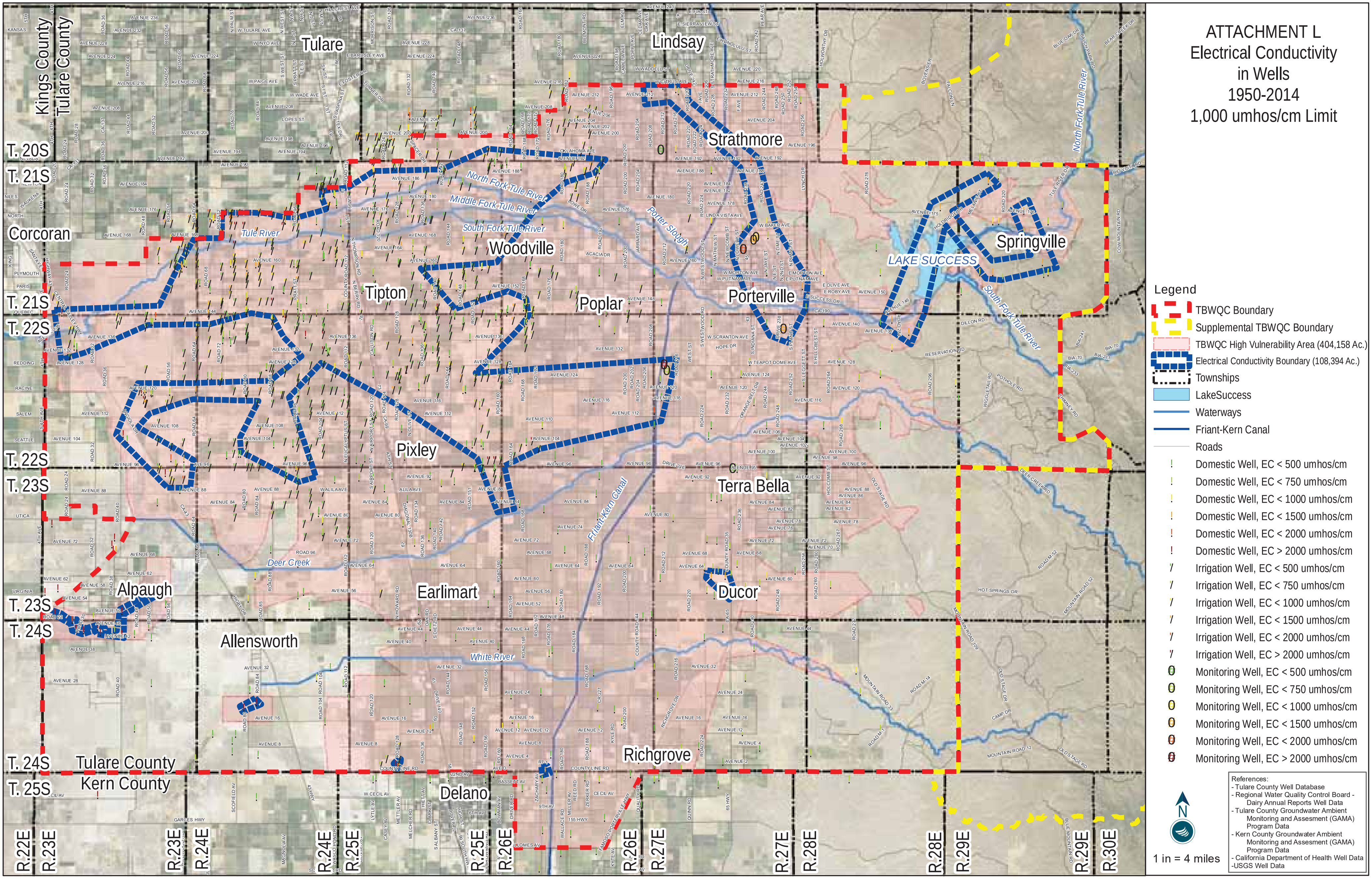
- Supplemental TBWQC Boundary
- TBWQC Boundary
- TBWQC High Vulnerability Area (404,158 Ac.)
- Townships
- LakeSuccess
- Waterways (166.6 Miles)
- Friant-Kern Canal
- Roads
- Recharge Basins (2,102.3 Ac.)

N

1 in = 4 miles

# ATTACHMENT K
## Nitrate Concentrations in Wells from 1945-2014 45-mg/L Limit




ATTACHMENT L
Electrical Conductivity
in Wells
1950-2014
1,000 umhos/cm Limit
Legend
TBWQC Boundary
Supplemental TBWQC Boundary
TBWQC High Vulnerability Area (404,158 Ac.)
Electrical Conductivity Boundary (108,394 Ac.)
Townships
LakeSuccess
Waterways
Friant-Kern Canal
Roads
Domestic Well, EC < 500 umhos/cm
Domestic Well, EC < 750 umhos/cm
Domestic Well, EC < 1000 umhos/cm
Domestic Well, EC < 1500 umhos/cm
Domestic Well, EC < 2000 umhos/cm
Domestic Well, EC > 2000 umhos/cm
Irrigation Well, EC < 500 umhos/cm
Irrigation Well, EC < 750 umhos/cm
Irrigation Well, EC < 1000 umhos/cm
Irrigation Well, EC < 1500 umhos/cm
Irrigation Well, EC < 2000 umhos/cm
Irrigation Well, EC > 2000 umhos/cm
Monitoring Well, EC < 500 umhos/cm
Monitoring Well, EC < 750 umhos/cm
Monitoring Well, EC < 1000 umhos/cm
Monitoring Well, EC < 1500 umhos/cm
Monitoring Well, EC < 2000 umhos/cm
Monitoring Well, EC > 2000 umhos/cm
N
1 in = 4 miles
References:
- Tulare County Well Database
- Regional Water Quality Control Board - Dairy Annual Reports Well Data
- Tulare County Groundwater Ambient Monitoring and Assesment (GAMA) Program Data
- Kern County Groundwater Ambient Monitoring and Assesment (GAMA) Program Data
- California Department of Health Well Data
-USGS Well Data
Kings County
Tulare County
Kern County
Tulare
Lindsay
Strathmore
Springville
Corcoran
Woodville
Tipton
Poplar
Porterville
Pixley
Terra Bella
Earlimart
Ducor
Alpaugh
Allensworth
Richgrove
Delano
LAKE SUCCESS
North Fork Tule River
Middle Fork Tule River
South Fork Tule River
Tule River
Porter Slough
Deer Creek
White River
Friant-Kern Canal
T. 20S
T. 21S
T. 22S
T. 23S
T. 24S
T. 25S
R.22E
R.23E
R.24E
R.25E
R.26E
R.27E
R.28E
R.29E
R.30E

# APPENDIX A

## TECHNICAL MEMORANDUM

# IDENTIFICATION, EXTENSION, AND IMPLEMENTATION OF MANAGEMENT PRACTICES TO MINIMIZE NITRATE LEACHING FROM CROP ROOT ZONES TO SATISFY GROUNDWATER QUALITY MANAGEMENT PLAN REQUIREMENTS

| | |
|---|---|
| PREPARED FOR: | South San Joaquin Valley Management Practices Evaluation Plan Committee |
| PREPARED BY: | MPEP Team |
| DATE: | August 25, 2016 |

It is anticipated that versions of this document, when appended to a GQMP deliverable by a South San Joaquin Valley (SSJV) Management Practices Evaluation Program (MPEP) member coalition, will serve to inform the Central Valley Regional Water Quality Control Board (Central Valley Water Board) about the management practices component of the coalition's GQMP.

## Table of Contents



## LIST OF ABBREVIATIONS

| | |
|---|---|
| CCA | Certified Crop Adviser |
| CDFA | California Department of Food and Agriculture |
| COC | constituent of concern |
| Committee | SSJV MPEP Committee |

| | |
|---|---|
| CSU | California State University |
| DWR | California Department of Water Resources |
| General Order | Waste Discharge Requirement General Order for the Growers within the Tulare Lake Basin Area that are members of a Third-Party Group, General Order No. R5-2013-0120, as modified by General Order No. R5-2013-0143. |
| GQMP | Groundwater Quality Management Plan |
| LTILRP | Long-term Irrigated Lands Regulatory Program |
| MPEP | Management Practices Evaluation Program |
| N | Nitrogen |
| $NH_4$ | Ammonium |
| NMP | Nitrogen Management Plan |
| $NO_3$ | Nitrate |
| NUE | nutrient use efficiency |
| SSJV | Southern San Joaquin Valley |
| SWAT | Soil and Water Assessment Tool |
| TDS | total dissolved solids |
| UCCE | University of California Cooperative Extension |
| USDA | United States Department of Agriculture |
| USDA-NRCS | United States Department of Agriculture Natural Resources Conservation Service |
| USGS | United States Geological Survey |
| Central Valley Water Board | Central Valley Regional Water Quality Control Board |
| WDR | Waste Discharge Requirement |
| Workplan | SSJV MPEP Workplan |

# 1 BACKGROUND AND PURPOSE

The Tule Basin Water Quality Coalition has joined with six others to form the SSJV MPEP Committee (Committee), and hired the MPEP Team to develop a workplan. This process and the Discussion Draft Workplan (2016; Workplan) advanced everyone's understanding of what the MPEP would entail, and when it would begin to produce results. Kaweah can now draw on this work to more clearly articulate how management practices will be identified, communicated to growers, implemented, and assessed, as requested in comments received from the Central Valley Water Board.

The Workplan deals explicitly with how that program will interface with individual coalitions, including their GQMPs. Section 2.1.3 (Exchanging Data with Coalitions and Informing Groundwater Quality Analyses) reads as follows:

*As mentioned previously, individual LTILRP coalitions are engaged in complementary activities that can inform the MPEP and allow for more rapid, effective work. Examples of data and work products from the coalitions that are potentially relevant to the MPEP include the following:*

- *Coalitions' data about the type and location of practices are fundamental to assessing the effects of irrigated agriculture on underlying groundwater. These data might arise from the following sources:*
    - *Farm Evaluations*
    - *Nitrogen Summary Reports*
    - *GARs*
    - *Trend Monitoring Reports*
- *Methodology and results (e.g., surface loading, loading to groundwater) from the MPEP can inform Groundwater Quality Management Plans (GQMPs) and other groundwater analyses undertaken by coalitions.*

Since the General Order provides for GQMPs to identify priority/urgent areas, and requires an MPEP to develop practices for such areas, it follows that the output of the MPEP should satisfy GQMP requirements related to management practices. The purpose of this memo is to fulfil this requirement for member coalition GQMPs related to nitrate.

The MPEP can satisfy management practice related requirements for any constituent of concern (COC), as evidenced by the following passage from Section 1 of the Workplan:

*The current General Orders focus on controlling nitrate ($NO_3$) contamination of groundwater by irrigated agriculture, but the overall program also pertains to other constituents that could be construed as pollutants (e.g., sediment in runoff, salts). Nitrate movement through irrigated lands is therefore the main focus of this Workplan. If at some point other constituents need to be addressed by growers, the MPEP would likely serve the same functions for those constituents. At that time, addenda to this Workplan might be required to supplement and update the general approach with specific considerations relative to those constituents. However, the general approach described here, if successful, would otherwise remain intact.*

Thus, for the Kaweah GQMP, where salinity and pesticides must be addressed, the MPEP will expand to incorporate practices that are protective relative to these COCs, in addition to practices deemed protective relative to nitrate.

The Workplan describes early outreach and assessment components:

- *…the initial inventory of management practices will result in a list of known, protective practices that will move immediately into this outreach process. It will be discussed with advisors and* *growers during 2016-17 meetings. Information on these practices will also be featured in an organized, accessible fashion on the Grower/Advisor Webpage, which water quality coalition membership will be encouraged to consult.* (p. 3-69)

- *…outreach products and activities will be documented and shared with the Central Valley Water Board in regular communications such as quarterly meetings and as part of required reporting.* (p. 3-69)
- …benchmarking the current degree of adoption of BMPs across the MPEP area. (p. 3-36)… Studies of management practice and production data from Farm Evaluations and Nitrogen Summary Reports, as supported and sanctioned by member coalitions, as well as similar data from packers who may gather such data from growers with whom they work. If these data are of sufficient quality, they could provide extremely powerful information about grower practices. (p. 3-38)
- *…a Grower/Advisor Webpage on its website, which includes an organized collection of many useful tools and references that already exist. This site will be updated as additional information becomes available from the Committee, member coalitions, partners (including the Central Valley Water Board), and other sources. This handy collection of resources for minimizing loss of applied nitrogen to groundwater will be available not only to member growers, but to growers and grower advisors anywhere. The Committee hopes that such a grower-oriented collection, focused on means to address this problem through sound management, will help growers actually apply these solutions in their practices on their fields, which must be done for actual benefits to be realized. Additional online tools, information, and applications will be developed to meet specific needs. For example:*
    - *Helpful information for growers and their advisors to efficiently derive maximum benefit from required Nitrogen Management Planning processes can be provided.*
    - *Tools to facilitate second-language growers to understand and comply with LTILRP requirements and derive maximum water quality and production advantages.*
    - *Query-able management practice databases to assist growers in evaluating the potential cost and benefits (production, water quality, labor) benefits of various suites of management practices, applied at their specific management block locations and planting dates. (p. 3-68)*

One purpose and feature of the SSJV MPEP is an efficient, collective effort to identify and increase implementation of protective practices, mainly by working with member coalitions to understand grower needs and to help them with resources to achieve this goal. As stated on page 2-6 of the Workplan:

- *Member coalitions are linked directly to the MPEP by their participation in the Committee. Growers are linked to the MPEP through their membership in their coalitions, meetings, communications, and data gathering. Growers will also participate in commodity, other winter, and special-purpose meetings where MPEP findings will be discussed during outreach sessions. Presenters primarily will be technical collaborators from public-sector research and extension, as well as private-sector production and grower experts.*

Therefore, it is natural and appropriate that when information and outreach to promote implementation of protective practices is identified as part of a Groundwater Quality Management Plan developed by one of the member coalitions, work of this sort being done as part of the MPEP should be incorporated. It is understood that GQMPs signify high priority areas where a prompt response is required of the coalitions. At this time, as evidenced in excerpts from the Workplan, the corresponding elements of the MPEP are scheduled for the coming months and therefore constitute a timely component of the GQMP. For example, the soonest that growers can be convened to discuss practices for the next (2017) season is fall 2016/winter 2017, the very period targeted in the MPEP for early outreach.

The purpose of this document is to summarize the following:

- Protective management practices identified to for application as part of GQMPs
- Use of outreach to expand implementation of protective practices, including assessment of barriers to adoption and grower response to outreach
- Assessment of barriers to adoption, the impact of outreach, and the extent of practice implementation

# 2 MANAGEMENT PRACTICE OVERVIEW FROM WORKPLAN AND EXPANDED MANAGEMENT PRACTICE INVENTORY

Table 3-3, beginning on page 3-28 of the workplan contains a summary of the range of protective management practice types. That table is reproduced here for convenient reference, and will be used to frame more specific and expanded descriptions of practices that will be shared with growers.

**TABLE 2-3. MANAGEMENT PRACTICES DOCUMENTED TO IMPROVE NITROGEN FERTILIZER EFFICIENCY AND BARRIERS TO THEIR ADOPTION AS MODIFIED FROM DZURELLA ET AL. (2012).** ***TABLE REPRODUCED FROM WORKPLAN.***

| | Management Practice | Barriers to Adoption |
|---|---|---|
| **Irrigation and Drainage Design and Operation** | | |
| Irrigation System Evaluation and Monitoring | | |
| 1 | Conduct irrigation system performance evaluation | Operational cost, land tenure, training |
| 2 | Install and use flow meters or other measuring devices to track water volume applied to each field at each irrigation | Capital cost, operational cost, training |
| 3 | Conduct pump performance tests | Operational cost, training |
| Irrigation Scheduling | | |
| 4 | Use weather-based irrigation scheduling | Operational cost, logistics, training, technology |
| 5 | Use plant-based irrigation scheduling | Operational cost, logistics, training |
| 6 | Use soil moisture content to guide irrigation timing and amount | Operational cost, logistics, training |
| 7 | Avoid heavy pre-plant or fallow irrigations for annual crops | Risk to yield or quality, logistics, training |

**TABLE 2-3. MANAGEMENT PRACTICES DOCUMENTED TO IMPROVE NITROGEN FERTILIZER EFFICIENCY AND BARRIERS TO THEIR ADOPTION AS MODIFIED FROM DZURELLA ET AL. (2012). *TABLE REPRODUCED FROM WORKPLAN.***

| Management Practice | | Barriers to Adoption |
|---|---|---|
| Surface Gravity System Design and Operation | | |
| 8 | Convert to surge irrigation | Capital cost, operational cost, logistics, training |
| 9 | Use high flow rates initially, then cut back to finish off the irrigation | Operational cost, logistics, training |
| 10 | Reduce irrigation run distances and decrease set times | Risk to yield or quality, capital cost, operational cost, land tenure, training |
| 11 | Increase flow uniformity among furrows (e.g. by compacting furrows) | Operational cost |
| 12 | Grade fields as uniformly as possible | Operational cost, training |
| 13 | Where high uniformity and efficiency are not possible, convert to drip, center pivot, or linear move systems | Capital cost, operational cost, land tenure, training |
| Sprinkler System Design and Operation | | |
| 14 | Monitor flow and pressure variation throughout the system | Operational cost |
| 15 | Repair leaks and malfunctioning sprinklers; follow manufacturer recommended replacement intervals | Capital cost, operational cost, training |
| 16 | Operate sprinklers during the least windy periods, when possible | Logistics |
| 17 | Use offset lateral moves | Operational cost, logistics, technology |
| 18 | Use flow-control nozzles when pressure variation is excessive | Capital cost, land tenure, training |
| Drip and Micro-sprinkler System Design and Operation | | |
| 19 | Use appropriate lateral hose lengths to improve uniformity | Training, capital cost |
| 20 | Check for clogging; prevent or correct clogging | Operational cost, capital cost, training |
| Other Irrigation Infrastructure Improvements | | |
| 21 | Installation of sub-surface drains in poorly drained soils[1] | Capital cost, technology |
| 22 | Backflow prevention | Capital cost, training |
| **Crop Management** | | |
| Change Crops to Use Those with Smaller N Requirements and Greater N Efficiency | | |

**TABLE 2-3. MANAGEMENT PRACTICES DOCUMENTED TO IMPROVE NITROGEN FERTILIZER EFFICIENCY AND BARRIERS TO THEIR ADOPTION AS MODIFIED FROM DZURELLA ET AL. (2012).** ***TABLE REPRODUCED FROM WORKPLAN.***

| | Management Practice | Barriers to Adoption |
|---|---|---|
| 23 | Cover crops to recover residual soil nitrate and immobilize it in soil organic matter | Risk to yield or quality of cash crop, capital cost, operational cost, logistics, training, technology, increased irrigation requirements for the cash crop |
| 24 | Include deep-rooted or N-scavenger crop species in annual crop rotations | Risk to yield or quality, capital cost, operational cost, logistics |
| 25 | Include perennial crop in rotation, e.g. alfalfa or perennial grasses | Capital cost, logistics, land tenure |
| **Nitrogen Fertilizer Management** | | |
| Improve Rate, Timing and Placement of N Fertilizers | | |
| 26 | Adjust N-fertilizer rates based on soil nitrate testing | Operational cost, training |
| 27 | Adjust timing of N fertilization based on plant tissue analysis | Risk to yield or quality, operational cost, training, lack of robust relationships between tissue test and amount of N fertilizer required |
| 28 | Apply N fertilizer in small multiple doses, rather than one or two large doses, to meet crop demand during the growing season without deficiency or excess | Operational cost, training |
| 29 | Know N content of irrigation water and adjust fertilizer rates accordingly | Operational costs, logistics, training |
| 30 | Reduce total N-fertilizer rates by replacing low-uptake-efficiency N-fertilizer applications to soil with high-uptake-efficiency foliar-N applications | Operational costs, training, technology |
| 31 | Vary N-application rates within large fields according to site-specific needs based on heterogeneity in soil N supply and/or crop growth | Operational costs, capital costs, training, technology |
| 32 | Use delayed injection procedure when fertigating in surface gravity systems | Operational costs, logistics, training |
| 34 | Develop an N budget that includes crop N harvest removal, supply of N from soil and other inputs to guide decisions on N-fertilizer rates and timing | Operational costs, training, technology |
| 35 | Use controlled release fertilizers, nitrification inhibitors, and urease inhibitors | Risk to yield quantity or quality, capital cost, training, technology, benefits depend on soil types and N-fertilizer management practices |

**TABLE 2-3. MANAGEMENT PRACTICES DOCUMENTED TO IMPROVE NITROGEN FERTILIZER EFFICIENCY AND BARRIERS TO THEIR ADOPTION AS MODIFIED FROM DZURELLA ET AL. (2012).** ***TABLE REPRODUCED FROM WORKPLAN.***

| | Management Practice | Barriers to Adoption |
|---|---|---|
| Improve Rate, Timing, and Placement of Animal Manure and Organic Amendment Applications | | |
| 36 | Apply appropriate rates of manure and compost, taking N mineralization characteristics of these organic N sources into account | Risk to yield quantity or quality, operational cost, logistics, training, technology |
| 37 | Incorporate solid manure immediately to decrease ammonia volatilization loss | Operational costs, training |
| 38 | Use delayed injection to improve application uniformity when applying liquid manure in surface-gravity irrigation systems | Operational cost, logistics, training, technology |
| 39 | Use quick-test methods to monitor dairy lagoon water N content immediately before and during application, and adjust application rate accordingly | Operational costs, training, technology |
| 40 | Calibrate solid manure and compost spreaders | Operational cost, logistics, training |

[1]Presumably beneficial to N management primarily by promoting more uniform crop growth and N uptake across the field.

This brief list of practices captures most of the categories of practices available to growers to retain mobile nutrients (like nitrogen) in their root zone so that the largest practicable proportion of it is used by the plant, and the least practicable amount percolates downward. Many practices are usable as they are stated (e.g., item 40, calibration of solid manure and compost spreaders could be implemented by any grower using these implements). Some require crop-specific information (e.g., item 27, adjusting timing of N fertilization based on plant tissue analysis requires that reference values for specific tissues be established, along with sampling and analysis protocols that produce consistent results). Not all practices apply to all crops. For example, tissue tests have not been found to be useful when assessing almond N status.

As part of early outreach, the SSJV MPEP is working with CDFA, UCCE, and other partners to inventory known protective management practices. This inventory is informed by the rather substantial knowledge base (literature, scientific and grower expertise) regarding practices that help growers to retain N for crop use and avoid excessive percolation losses. The inventory is being developed in database format so that it can be deployed in prioritizing and developing outreach curriculum, working with coalitions to assess implementation through Farm Evaluations, and to serve as an online resource to help growers explore and develop their management options. Practices tie into MPEP modeling/performance assessments too, since most can be quantitatively captured in model parameters and results. The inventory currently contains over 150 practices associated with various crops and crop classes, has identified 23 high-priority documents for review, posted 22 references in an online collection of grower resources (http://www.ssjwqc.org/_pdf/MPEP%20Tables.pdf), and identified another 29 to be posted. The inventory is being further augmented and will be posted during the coming months.

GQMP

# 3 METHODOLOGY

This section describes methods used for outreach, and for the assessment of how well outreach is working so that it can be improved.

## 3.1 OUTREACH

Coalitions and partners (UCCE, USDA/NRCS, CSU, CDFA, commodity groups) all have ongoing outreach programs that are partly or wholly devoted to sharing protective management practices with growers with the goal of broader implementation. The MPEP/GQMP outreach program aims to harness and supplement these programs to ensure that ILRP commitments are met, and to document these activities. To this end, MPEP/GQMP outreach will entail the following:

- A database of outreach and outreach-related activities and products, including dates, format (live presentation, video, online tools, or hardcopy literature [mailings, fliers]), practices covered, and number of grower/members participating. To the extent practicable, this will include events that occurred before the inception of the database. This database will periodically be shared with the Water Board so that staff can assess outreach.

- Curricula developed in the form of meeting materials (agendas and presentations), video, fliers, and online tools and informational resources.

- A network of cooperating partners, including other water quality coalitions, CDFA, UCCE, private-sector experts (e.g., CCAs), CSU, NRCS, and commodity groups will be tapped to assist with development and delivery of curricula. The video and online options will help to extend these scarce resources to meet what is a growing need. CDFA staff are currently working with the MPEP Team to expand the practices inventory. One or more protective practices workshops are planned with UCCE in the September/October timeframe, specifically to finalize curricula for the early-outreach period. All of these groups have been involved in developing the Workplan.

- Growers already attend many meetings where protective practices to achieve good environmental performance are discussed. The Workplan specifies that, to make the best use of grower's and partner's time, curricula will be delivered at these meetings whenever practicable. The MPEP Team is identifying candidate meetings and working with organizers to include on their agendas protective practice sessions where the curricula can be delivered to growers. Many of the partners listed previously are responsible for convening these meetings and are the focus of these contacts.

## 3.2 ASSESSMENT

While outreach is crucial for reaching growers, follow up and assessment are essential to understanding how effective outreach is. Assessment results will guide refinement of outreach so that it can become increasingly effective at informing and affecting grower behavior, and in expanding implementation of protective practices that are suitable to each crop, soil, climate, and hydrographic setting. Assessment methods are discussed in this section.

The means and methods for assessing outreach consist of the following:

- A database of outreach activities (including sponsor, subject matter, locale, number of participants, and curricula) has been developed to capture past, ongoing, and future activities. All relevant activities will be included, whether sponsored by water quality coalitions or not. This is appropriate since the MPEP strategy is to multiply effort through collaboration with a wide range of partners.
- Barriers to adoption will be investigated by discussing individual practices with key resource persons, including growers and those who work closely with them (CCAs, Farm Advisors, and NRCS staff). Once a barrier is identified, means will be sought to lower this barrier. Some examples of barriers and actions that may be taken to alleviate them include the following:
    - When growers or farmworkers lack information or training, this can be supplemented through outreach.
    - When practices are exceedingly complex, simplified versions, or tools that enable growers to cope with complexity, can be developed.
    - When material resources are lacking, funding and volume pricing can be sought to offset costs.
    - When practices are ill adapted to certain types of operations or soil/topographic/management settings, more workable alternatives will be sought, and the “recommendation domain” (the conditions under which the practice is applicable and necessary) will be adjusted. Ideally, each practice should be associated with a defined recommendation domain. In some cases, questions of applicability and alternative practices will need to be fed back into field research performed by MPEP research partners.
- Grower receptivity and comprehension to outreach topics will be assessed by discussing practices with groups of growers participating in outreach events. Results will be employed to adjust and/or supplement outreach curricula, and to follow up with participants, so that practices as communicated are acceptable and understood by participants.
- Management practice implementation will be tracked through Farm Evaluation data. As mentioned previously, certain practices are already included in Farm Evaluations. As other priority practices are identified, these will be added so that the extent and pace of implementation can be tracked. This information will also inform landscape-level modeling that demonstrates program performance. Many management parameters, when known, can be included among model management parameters, so that model output will reflect performance changes over time that result from management shifts.

# 4 SCHEDULE

[This section to be developed separately by each coalition, depending on their individual order, GQMP, and program.]

# 5 REFERENCES

MPEP Team for the SSJV MPEP Committee. May 2016. Discussion Draft Management Practices Evaluation Workplan, Southern San Joaquin Valley MPEP Committee.