North Kern W.S.D and Shafter-Wasco I.D Management Area Plan
Kern County, CA

Submitted to:
North Kern Water Storage District
33380 Cawelo Extended
Bakersfield, CA 93308

Submitted to:
Shafter-Wasco Irrigation District
16294 Central Valley Hwy
Wasco, CA 93280

Submitted by:
GEI Consultants, Inc.
5001 California Ave., Suite 120
Bakersfield, CA 93309
661.327.7601

August 2019

Public Draft
This Page Left Blank Intentionally
# Table of Contents

## Executive Summary

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 General Information</td>
<td>1</td>
</tr>
<tr>
<td>1.1.1 Purpose of Management Area Plan</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Agency Information</td>
<td>1</td>
</tr>
<tr>
<td>1.2.1 Legal Authority of Agencies</td>
<td>2</td>
</tr>
<tr>
<td>1.3 GSP Implementation Costs</td>
<td>3</td>
</tr>
<tr>
<td>1.3.1 Costs Generated by GSP Implementation</td>
<td>3</td>
</tr>
<tr>
<td>1.3.2 GSP Implementation Funding</td>
<td>5</td>
</tr>
<tr>
<td>1.4 Description of Plan Area</td>
<td>5</td>
</tr>
<tr>
<td>1.4.1 Geographic Areas Covered</td>
<td>6</td>
</tr>
<tr>
<td>1.4.2 Plan Area Setting</td>
<td>7</td>
</tr>
<tr>
<td>1.4.3 Existing Plans in Plan Area</td>
<td>8</td>
</tr>
<tr>
<td>1.4.4 Plan Elements from CWC Section 10727.4</td>
<td>12</td>
</tr>
<tr>
<td>1.5 Notice and Communication</td>
<td>14</td>
</tr>
<tr>
<td>1.5.1 Beneficial Uses and Users</td>
<td>15</td>
</tr>
<tr>
<td>1.5.2 Public Meetings</td>
<td>15</td>
</tr>
<tr>
<td>1.5.3 Comments Received</td>
<td>16</td>
</tr>
<tr>
<td>1.6 GSP Organization</td>
<td>17</td>
</tr>
</tbody>
</table>

## 2. Basin Setting

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Introduction</td>
<td>27</td>
</tr>
<tr>
<td>2.2 Hydrogeologic Conceptual Model</td>
<td>27</td>
</tr>
<tr>
<td>2.2.1 Subbasin Regional Setting</td>
<td>27</td>
</tr>
<tr>
<td>2.2.2 Groundwater Subbasin Lateral and Vertical Boundaries</td>
<td>29</td>
</tr>
<tr>
<td>2.2.3 Principal Aquifers and Aquitards</td>
<td>32</td>
</tr>
<tr>
<td>2.2.4 Data Gaps in the Hydrogeologic Conceptual Model</td>
<td>45</td>
</tr>
<tr>
<td>2.2.5 Mapped Physical Characteristics</td>
<td>45</td>
</tr>
<tr>
<td>2.3 Current and Historical Groundwater Conditions</td>
<td>51</td>
</tr>
<tr>
<td>2.3.1 Groundwater Trends</td>
<td>51</td>
</tr>
<tr>
<td>2.3.2 Hydrographs</td>
<td>53</td>
</tr>
<tr>
<td>2.3.3 Change in Groundwater Storage</td>
<td>56</td>
</tr>
<tr>
<td>2.3.4 Seawater Intrusion</td>
<td>56</td>
</tr>
<tr>
<td>2.3.5 Groundwater Quality</td>
<td>56</td>
</tr>
<tr>
<td>2.3.6 Land Subsidence</td>
<td>73</td>
</tr>
<tr>
<td>2.3.7 Interconnected Surface Water Systems</td>
<td>80</td>
</tr>
<tr>
<td>2.3.8 Potential Groundwater Dependent Ecosystems</td>
<td>80</td>
</tr>
<tr>
<td>2.4 Management Areas within NKWSD and SWID</td>
<td>83</td>
</tr>
<tr>
<td>2.4.1 NKWSD’s Management Areas</td>
<td>83</td>
</tr>
<tr>
<td>2.4.2 SWID’s Management Areas</td>
<td>84</td>
</tr>
<tr>
<td>2.5 District Water Budgets</td>
<td>84</td>
</tr>
</tbody>
</table>
3. **Sustainable Management Criteria**

3.1 Sustainability Goals 157

3.2 Undesirable Results 157

3.2.1 Undesirable Results for Chronic Lowering of Groundwater Levels 158

3.2.2 Undesirable Results for Reduction of Groundwater Storage 159

3.2.3 Undesirable Results for Degraded Water Quality 159

3.2.4 Undesirable Results for Land Subsidence 160

3.2.5 Undesirable Results for Seawater Intrusion 161

3.2.6 Undesirable Results for Interconnected Surface Water 161

3.3 Minimum Threshold 161

3.3.1 The Chronic Lowering of Groundwater Levels 163

3.3.2 Groundwater Storage 165

3.3.3 Degraded Water Quality 165

3.3.4 Subsidence 165

3.4 Measurable Objectives and Interim Milestones 166

3.4.1 The Chronic Lowering of Groundwater Levels 166

3.4.2 Groundwater Storage 168

3.4.3 Degraded Water Quality 168

3.4.4 Land Subsidence 168

3.5 Margin of Operational Flexibility 169

3.6 Potential Effects beyond Management Area 169

4. **Monitoring Networks**

4.1 Monitoring Network Objectives 183

4.1.1 Water Level Monitoring as a Key Sustainability Indicator 183

4.2 Monitoring Progress toward Measurable Objectives 184

4.2.1 Potential Impacts to Beneficial Uses and Users of Groundwater 184

4.2.2 Monitoring Network for Water Budget Components 186

4.2.3 Water Leaving the Subbasin 187

4.3 Monitoring Network Design 188

4.3.1 Monitoring Frequency Design 188

4.3.2 Spatial Density Design 188

4.3.3 Rationale for Design 189

4.4 Monitoring Network 189
4.4.1 Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage 189
4.4.2 Seawater Intrusion 194
4.4.3 Degraded Water Quality 194
4.4.4 Land Subsidence 194
4.4.5 Depletion of Interconnected Surface Water 195
4.5 Monitoring Protocols and Reporting Standards 196
4.6 Monitoring Network Improvement Plan 196
4.6.1 Assessment of Network Improvements 196

5. Projects, Management Actions, and Adaptive Management 201
5.1 Sustainability Goal 201
5.2 Projects and Management Actions Processes 201
5.2.1 Goals and Objectives 201
5.2.2 Circumstances for Implementation 201
5.2.3 Public Noticing 202
5.2.4 Permitting and Regulatory Process 202
5.2.5 Implementation and Timetable Status 203
5.2.6 Expected Benefits 203
5.2.7 Source and Reliability of Water Outside of NKWSD and SWID 203
5.2.8 Legal Authority Required 204
5.2.9 Estimated Costs and Funding 204
5.3 NKWSD Projects Planned as Part of GSP Implemented Regardless of Conditions 204
5.3.1 Calloway Canal and Water Delivery Improvements: Lining Snow Rd. to 7th Standard Rd. 204
5.3.2 Expanded Water Banking Program 205
5.3.3 Groundwater Banking Conveyance Improvements to NKWSD Recharge and Recovery 205
5.3.4 Beneficial Reuse of Oilfield Produced Water 206
5.3.5 SCADA Automation and Evapotranspiration Measurement Improvements 206
5.3.6 Poso Creek Weir 207
5.4 RRID Projects Planned as Part of GSP Implemented Regardless of Conditions 207
5.4.1 Expanded Recharge 207
5.4.2 Allocation of Available NKWSD Supplies 207
5.5 SWID Projects planned as part of GSP that will be implemented regardless of conditions 207
5.5.1 Diltz Intertie Lateral Piping and Water Management Improvements 208
5.5.2 Bell Recharge Project 208
5.5.3 Kimberlina Recharge Project 208
5.5.4 Leonard Avenue Conveyance Improvement Project 208
5.5.5 Improved Water Level Measurement of District Recharge Facility 208
5.6 NKWSD and SWID Management Actions planned as part of GSP 208
<table>
<thead>
<tr>
<th>Section</th>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6.1</td>
<td>Expansion of In-Lieu Recharge</td>
<td>209</td>
</tr>
<tr>
<td>5.6.2</td>
<td>On-Farm Efficiency/Deficit Irrigation Practices Incentive Program</td>
<td>210</td>
</tr>
<tr>
<td>5.6.3</td>
<td>On-Farm Recharge Incentive Program</td>
<td>210</td>
</tr>
<tr>
<td>5.6.4</td>
<td>Subsurface Recharge Feasibility Study</td>
<td>210</td>
</tr>
<tr>
<td>5.6.5</td>
<td>Conversion of Agricultural Land to Urban Use</td>
<td>211</td>
</tr>
<tr>
<td>5.6.6</td>
<td>Urban Water Conservation Program</td>
<td>211</td>
</tr>
<tr>
<td>5.6.7</td>
<td>In-District Allocation Structure</td>
<td>212</td>
</tr>
<tr>
<td>5.6.8</td>
<td>Voluntary Land Fallowing</td>
<td>213</td>
</tr>
<tr>
<td>5.6.9</td>
<td>Pumping Restrictions</td>
<td>213</td>
</tr>
<tr>
<td>5.7</td>
<td>Summary</td>
<td>213</td>
</tr>
</tbody>
</table>

6. References and Technical Studies                                             217

Appendix                                                                        223
List of Tables

Table 1-1. Kern Groundwater Authority Member Agencies
Table 2-1a. Local Aquifer Parameters
Table 2-1b. Local Aquifer Parameters
Table 2-2. Public Water Systems Within NKWSD
Table 2-3. Public Water Systems Within SWID
Table 2-4. List of Constituents and Standards
Table 2-5. Land Uses Within NKWSD and SWID
Table 2-6. Summary of TCP Prevalence Among Public Water Systems
Table 2-7. Summary of Nitrates Prevalence Within NKWSD
Table 2-8. Summary of Nitrates Prevalence Among Public Water System
Table 2-9. Summary of Sodium Prevalence Within NKWSD
Table 2-10. Summary of Sodium Prevalence Among Public Water Systems
Table 2-11. Contamination Sites Identified Within NKWSD and SWID
Table 2-12. Summary of Land Subsidence
Table 2-13. Evapotranspiration in NKWSD and RRID (1993-2015), in TAF
Table 2-14. Evapotranspiration within SWID (1993-2015), in TAF
Table 2-15. Summary of NKWSD and RRID Historical Surface Outflows (1993-2015), in TAF
Table 2-16. Summary of SWID Historical Surface Outflows (1993-2015), in TAF
Table 2-17. Summary of NKWSD and RRID Historical Surface Inflows (1993-2015), in TAF
Table 2-18. Summary of SWID Historical Surface Inflows (1993-2015), in TAF
Table 2-19. Urban Acreage for City of Shafter and City of Wasco within NKWSD and SWID
Table 2-20. City Pumpage Demand (from UWMPs) by Percent Area in District, in AF
Table 2-21. City of McFarland Recycled Water Volumes, in TAF
Table 2-22. City of Wasco Recycled Water Volumes, in TAF
Table 2-23. Historical Water Budget Summary for NKWSD and RRID (1993-2015), in AF
Table 2-24. Historical Water Budget Summary for SWID (1993-2015), in AF
Table 2-25. Current and Future Projected Water Budget Summary for NKWSD, in AF
Table 2-26. Current and Future Projected Water Budget Summary for RRID Management Area, in AF
Table 2-27. Current and Future Projected Water Budget Summary for SWID, in AF
Table 2-28. Projected City Groundwater Pumpage within Districts, in AF
Table 2-29. City Projected Recycled Water, in TAF
Table 2-30. Summary of Monitoring Committee
Table 2-31. Summary of Land Subsidence Monitoring in Study Area
Table 2-32. Types of Monitoring Programs Implemented within the District
Table 2-33. Pump-In Program Sampling Requirements
Table 2-34. PWS within the NKWSD and SWID Management Area
Table 3-1. Minimum Threshold for Chronic Lowering of Groundwater Levels in the NKWSD
Table 3-2. Minimum Threshold for Chronic Lowering of Groundwater Levels in the SWID
Table 3-3. Measurable Objective for NKWSD

GEI Consultants, Inc.
Table 3-4. SWID Measurable Objective for SWID
Table 3-5. Example District Operational Flexibility
Table 4-1. Potential Impacts of Overdraft with Corresponding Monitoring
Table 4-2. Weather Stations within the Vicinity
Table 4-3. NKWSD Water Level & Water Quality Monitoring Network
Table 4-4. SWID Water Level & Water Quality Monitoring Network
Table 4-5. Monitoring Network Well Density per Management Area (approximate)

List of Figures

Figure 1-1. NKWSD and SWID Jurisdictional Boundaries
Figure 1-2. NKWSD and SWID Management Areas
Figure 1-3. Land Use within NKWSD-SWID
Figure 1-4. Groundwater Dependent Communities
Figure 1-5. Well Density (Production)
Figure 1-6. Well Density (Domestic)
Figure 1-7. Well Density (Public)
Figure 2-1. NKWSD and SWID Administrative Area
Figure 2-2. Central Valley Hydrologic Regions – Tulare Lake Region
Figure 2-3. Conceptual Block Diagram Looking North from Kern River
Figure 2-4. Base of fresh water as reported by Page (1973)
Figure 2-5. Elevation Contours of 10,000 ppm TDS by Gillespie et. al. (2017) and Non-USDWs
Figure 2-6. Groundwater Subbasin Conceptual Profile
Figure 2-7. Corcoran Clay Layer Extent
Figure 2-8. Geologic Map (Bartow, 1991)
Figure 2-9. Cross Section A-A'
Figure 2-10. Cross Section B-B'
Figure 2-11. Geologic Index Map (CGS 2010a)
Figure 2-12. Topographic Map
Figure 2-13. NRCS Hydrologic Soil Groups
Figure 2-14. Taxonomic Soil Orders
Figure 2-15. Areas of Direct Recharge
Figure 2-16. Surface Water Features from National Hydrography Dataset
Figure 2-17. Source and Points of Delivery for Imported Surface Water
Figure 2-18. Generalized Groundwater Flow in Kern County Subbasin
Figure 2-19. NKWSD and SWID Spring 2015 Contours
Figure 2-20. NKWSD and SWID Fall 2015 Contours
Figure 2-21. Water Year Index (1995 to 2017)
Figure 2-22. General Hydrograph Trends by Year
Figure 2-23. Public Water Systems Identified within NKWSD and SWID
Figure 2-24. Land Use within NKWSD and SWID
Figure 2-25. Map of NKWSD Representative Wells for Water Quality Evaluation
Figure 2-26. Comparison of NKWSD Wells Nitrate Levels to Top Well Screen Perforation
Figure 2-27. Comparison of City of Shafter Wells Nitrate Levels to Depths of Annular Seal
Figure 2-28. Comparison of NKWSD Well Nitrate and Water Levels
Figure 2-29. Comparison of City of Shafter Wells Nitrate Levels in Respect to Location within Corcoran Clay
Figure 2-30. Max Sodium Concentrations within NKWSD
Figure 2-31. Rosedale Spreading Ground-Northeast Side Inverse Relationship of Sodium and Water Levels
Figure 2-32. Rosedale Spreading Ground-West Side Direct Relationship of Sodium and Water Levels
Figure 2-33. Central Spreading Ground-Southeast Side Inverse Relationship of Sodium and Water Levels
Figure 2-34. Central Spreading Ground-North Side Direct Relationship of Sodium and Water Levels
Figure 2-35. City of Shafter Wells within Corcoran Clay Direct Relationship between Arsenic and Water Levels
Figure 2-36. City of Shafter Wells Outside Corcoran Clay Inverse Relationship between Arsenic and Water Levels
Figure 2-37. City of Shafter Wells Outside Corcoran Clay vs. Well Depth
Figure 2-38. "Existing Data From Envirostor And Geotracker Databases"
Figure 2-39. NKWSD and SWID Historical Land Subsidence
Figure 2-40. NKWSD and SWID Land Subsidence (2007-2011)
Figure 2-41. NKWSD and SWID Land Subsidence Rate (2007-2011)
Figure 2-42. NKWSD and SWID Land Subsidence (2015-2017)
Figure 2-43. NKWSD and SWID Land Subsidence Rate (2015-2007)
Figure 2-44. Subsidence Monitoring Points and Results
Figure 2-45. NCCAG Vegetation
Figure 2-46. NCCAG Wetlands
Figure 2-47. NKWSD and SWID Management Area
Figure 2-48. Monument Survey by GPS Methods
Figure 4-1. North of the River Minimum Threshold Projected Contour Map (2040 Conditions)
Figure 4-2. 2040 Well Projection NKWSD
Figure 4-3. 2040 Well Projection SWID
Figure 4-4. Estimated Well Impact Analysis for NKWSD (Agricultural Wells)
Figure 4-5. Estimated Well Impact Analysis for SWID (Agricultural Wells)
Figure 4-6. Estimated Well Impact Analysis for NKWSD (Domestic Wells)
Figure 4-7. Estimated Well Impact Analysis for SWID (Domestic Wells)
Figure 4-8. Estimated Well Impact Analysis for SWID (Municipal Wells)
Figure 4-9. North of the River Measurable Objective Projected Contour Map (2030 Conditions)
Figure 4-10. Interim Milestones Groundwater Elevations NKWSD
Figure 4-11. Interim Milestones Groundwater Elevations SWID
Figure 5-1. Spatial Distribution of the Water Level Monitoring Sites
Figure 5-2. NKWSD Existing Land Surface Elevation Monitoring Points
Appendix

Appendix A  JPA Agreement
Appendix B  Relevant Sections of General Plans
Appendix C  Historical Changes in Groundwater Elevations
Appendix D  Groundwater Elevation Contour Maps
Appendix E  Hydrographs and Time Series Charts
Appendix E.1  Hydrographs with DMS data
Appendix E.2  Hydrographs of select representative wells and summary table of well data
Appendix F  Time Series Data and Subsidence Monitoring Points in NKWSD
Appendix H  Monitoring Network figure and table, list of wells from SWBMP
Appendix I  Communications & Engagement
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF</td>
<td>acre-feet</td>
</tr>
<tr>
<td>AFY</td>
<td>acre feet per year</td>
</tr>
<tr>
<td>AWMP</td>
<td>Agricultural Water Management Plan</td>
</tr>
<tr>
<td>BDCP</td>
<td>dibromochloropropane</td>
</tr>
<tr>
<td>CASGEM</td>
<td>California Statewide Groundwater Elevation Monitoring</td>
</tr>
<tr>
<td>CGPS</td>
<td>Continuous Global Positioning System</td>
</tr>
<tr>
<td>CUP</td>
<td>Conditional Use Permit</td>
</tr>
<tr>
<td>CV</td>
<td>Central Valley Project</td>
</tr>
<tr>
<td>CV-SALTS</td>
<td>Central Valley Salinity Alternatives for Long-Term Sustainability</td>
</tr>
<tr>
<td>CWD</td>
<td>Cawelo Water District</td>
</tr>
<tr>
<td>DLRP</td>
<td>Division of Land Resource Protection</td>
</tr>
<tr>
<td>DMS</td>
<td>Data Management System</td>
</tr>
<tr>
<td>DWR</td>
<td>California Department of Water Resources</td>
</tr>
<tr>
<td>EC</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>ET</td>
<td>EvapoTranspiration</td>
</tr>
<tr>
<td>EWMP</td>
<td>Efficient Water Management Practices</td>
</tr>
<tr>
<td>FKC</td>
<td>Friant-Kern Canal</td>
</tr>
<tr>
<td>GAMA</td>
<td>Groundwater Ambient Monitoring and Assessment Program</td>
</tr>
<tr>
<td>GDE</td>
<td>Groundwater Dependent Ecosystem</td>
</tr>
<tr>
<td>GEI</td>
<td>GEI Consultants</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>GMP</td>
<td>Groundwater Management Plan</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GSA</td>
<td>Groundwater Sustainability Agency</td>
</tr>
<tr>
<td>GSP</td>
<td>Groundwater Sustainability Plan</td>
</tr>
<tr>
<td>GWMP</td>
<td>Groundwater Management Plan</td>
</tr>
<tr>
<td>HCM</td>
<td>hydrogeologic conceptual model</td>
</tr>
<tr>
<td>HZ</td>
<td>Hydrogeologic zone</td>
</tr>
<tr>
<td>InSAR</td>
<td>Interferometric Synthetic Aperture Radar</td>
</tr>
<tr>
<td>IRWM</td>
<td>Integrated Regional Water Management</td>
</tr>
<tr>
<td>IRWMP</td>
<td>Poso Creek Integrated Water Management Plan</td>
</tr>
<tr>
<td>ITRC</td>
<td>Irrigation Training and Research Center</td>
</tr>
<tr>
<td>JPA</td>
<td>Joint Powers Authority</td>
</tr>
<tr>
<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
</tr>
<tr>
<td>KCS</td>
<td>Kern County Subbasin</td>
</tr>
<tr>
<td>KCWA</td>
<td>Kern County Water Agency</td>
</tr>
<tr>
<td>KFMc</td>
<td>Kern Fan Monitoring Committee</td>
</tr>
<tr>
<td>KGA</td>
<td>Kern Groundwater Authority</td>
</tr>
<tr>
<td>MA</td>
<td>Management Area</td>
</tr>
<tr>
<td>MCL</td>
<td>Maximum Contamination Level</td>
</tr>
<tr>
<td>MMU</td>
<td>Minimum Map Unit</td>
</tr>
<tr>
<td>NAD83</td>
<td>North American Datum of 1983</td>
</tr>
<tr>
<td>NAIP</td>
<td>National Agricultural Imagery Program</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NAVD88</td>
<td>North American Vertical Datum of 1988</td>
</tr>
</tbody>
</table>
NCCAG .................................Natural Communities Commonly Associated with Groundwater
NHD ..........................................................National Hydrography Dataset
NKWSD ..................................................North Kern Water Storage District
NORSD ..................................................North of the River Storage District
NTNC ..................................................Non-Transient Non-Community
NWI ..........................................................National Wetland Inventory
OMWC ..................................................Oildale Mutual Water Company
OMWC ..................................................Oildale Mutual Water Company
PWS ..........................................................Public Water System
QA/QC ..................................................Quality Assurance/Quality Control
RP ..........................................................Reference Point
RRBWSD .............................................Rosedale Rio Bravo Water Storage District
RRID ..................................................Rosedale Ranch Improvement District
SAGBI ..................................................Soil Agricultural Groundwater Banking Index
SCV ..........................................................Survey of California Vegetation
SDWIS ..................................................State Drinking Water Information System
SGMA ..................................................Sustainable Groundwater Management Act
SMC ..................................................Sustainable Management Criteria
SSJMUD ................................................Southern San Joaquin Municipal Utility District
Subbasin ..................................................Kern Subbasin
SWID ..................................................Shafter-Wasco Irrigation District
SWMP ..................................................Agricultural Water Management Plan
SWP ..........................................................State Water Project
SWSD ..................................................Semitropic Water Storage District
TAF ..........................................................thousand acre-feet
TCP .....................................................1,2,3-Trichloropropane
TDS ..........................................................Total Dissolved Solids
TNC ..................................................Transient Non-Community
UAVSAR .............................................Unmanned Aerial Vehicle Synthetic Aperture Radar
USBR ..................................................United States Bureau of Reclamation
USFWS ..................................................U.S. Fish and Wildlife Service
USGS ..................................................United States Geological Survey
UWMP ..................................................Urban Water Management Plans
VegCAMP .............................................Vegetation Classification and Mapping Program
WWTP ..................................................wastewater treatment plant
Executive Summary

This management area plan was written to represent the efforts of North Kern Water Storage District (NKWSD) and the Shafter-Wasco Irrigation District (SWID) (collectively known in this management area plan as “the Districts”) to comply with the California state regulated Sustainable Groundwater Management Act (SGMA) of 2014. According to SGMA, groundwater basins in California that have been classified as high or medium priority must correct current overdraft conditions in order to reset the balance of groundwater input/output as an effort to reach sustainability by the year 2040. This plan was written in conjunction with and in support of a basin-wide GSP drafted on behalf of the Kern Groundwater Authority (KGA). The KGA represents 15 member agencies within the boundary of the Kern County Subbasin (Subbasin) which are joined together by the adoption of a Joint Powers Agreement (JPA). While the Districts will be coordinating with the KGA to comply with SGMA, it will write their own management area plans. This management area plan follows the California Code of Regulations and discusses background information of the Districts and their corresponding management areas; current practices and existing plans; management structure and actions; and current groundwater conditions and future sustainability management practices required to comply with SGMA.

Both Districts are located within the Tulare Lake Region of the Central Valley. Beneficial users serviced within the District boundaries consist of agricultural; municipal and domestic; and industrial. Groundwater is used in this region to support agricultural production and industrial practices that support the economic viability of local communities. This management area plan includes a detailed overview of the Districts’ historical, current, and projected groundwater conditions, including groundwater storage, water quality, and land subsidence.

This plan provides the required elements of a GSP and identifies an initial path for sustainable management in the Districts’ portions of the Subbasin. As documented in this management area plan, the goal for the Districts are to balance the average inflow and outflows of water in the Districts so that a negative change in groundwater storage does not occur; thus, preventing the lowering of average groundwater levels beyond 2040 through the actions of the Districts. This goal is expected to maintain groundwater levels as well as prevent water quality degradation and land subsidence. To reach the sustainability goal by 2040, the Districts will implement projects and management actions over time by increasing supply or reducing demand. Once fully implemented, project and management actions are expected to reduce the groundwater pumping for the Districts to avoid undesirable results.
1. Introduction

1.1 General Information

1.1.1 Purpose of Management Area Plan

To comply with the requirements of the SGMA, NKWSD and SWID have contracted with GEI Consultants, Inc. (GEI) for the preparation of this management area plan for inclusion in the KGA GSP. This management area plan serves to do the following:

- Define and describe the geographic and geologic conditions of the NKWSD and SWID areas in the Subbasin
- Identify and describe the sustainability goal for the Subbasin and the NKWSD and SWID jurisdictional areas
- Identify and describe the six undesirable results set forth in SGMA as they pertain to the Subbasin and the NKWSD and SWID jurisdictional areas
- Identify and describe the specific minimum thresholds and measurable objectives required for NKWSD and SWID to achieve the sustainability goal of the Subbasin
- Define and identify projects and management actions proposed by NKWSD and SWID to achieve the sustainability goal

1.2 Agency Information

Agency’s Name: North Kern Water Storage District
Agency’s Address: P.O. Box 81435, Bakersfield CA 93380
Agency’s Phone Number: (661) 393-2696
Agency’s Fax Number: (661) 393-6884
Agency’s Website: http://www.northkernwsd.com/
Contact Person: Richard A. Diamond
Contact Person’s Title: General Manager, NKWSD

Agency’s Name: Shafter-Wasco Irrigation District
Agency’s Address: P.O. Box 1168, Wasco, CA 93280
Agency’s Phone Number: (661) 758-5153
Agency’s Fax Number: (661) 758-6167
Agency’s Website: http://www.swid.org/
Contact Person: Dana S. Munn
Contact Person’s Title: General Manager, SWID
NKWSD was formed in 1935, adopting its Project Report to convey Kern River water into the District for conjunctive use in 1950. This conjunctive use project was one of the first of such projects in California and was implemented to optimize the use of Kern River water supplies within NKWSD. NKWSD acquired the perpetual right to water accruing to various pre-1914 Kern River water rights. The District expanded its jurisdictional area with the addition of the Rosedale Ranch Improvement District (RRID) in 1966.

SWID was formed in 1937. The United States Bureau of Reclamation (USBR) provided a Factual Report for SWID in 1953, which identified groundwater supplies available to SWID and proposed surface water supplies to balance water demands within SWID. SWID adopted its Project with USBR in 1955 to receive water from the Central Valley Project’s Friant-Kern Canal (FKC) based on the 1953 Factual Report.

### 1.2.1 Legal Authority of Agencies

On May 27, 2014, agencies and districts listed in Table 1-1 below, and the County of Kern, entered into a Joint Powers Authority (JPA) agreement to form the KGA. To facilitate the implementation of the KGA GSP, the agency’s jurisdictional area is divided into management areas formed by the portion of the Subbasin that underlies the boundaries of each general member agency. Under this JPA agreement, the KGA was granted the authority to serve as the Groundwater Sustainability Agency (GSA) for all its member agencies. This JPA agreement was amended and restated on March 22, 2017. The amended and restated JPA agreement is included in Appendix A of the KGA GSP.

| Arvin Community Services District | Rosedale-Rio Bravo Water Storage District |
| Arvin-Edison Water Storage District | Semitropic Water Storage District |
| Cawelo Water District | Shafter-Wasco Irrigation District |
| City of Shafter | Southern San Joaquin Municipal Utility District |
| Kern County Water Agency – Pioneer Project | Tejon-Castaic Water District |
| Kern-Tulare Water District | West Kern Water District |
| Kern Water Bank Authority | Westside District Water Authority |
| North Kern Water Storage District | Wheeler Ridge-Maricopa Water Storage District |

NKWSD and SWID entered into a cooperative agreement with the City of Shafter and the City of Wasco for the purposes of coordinating SGMA compliance and the development and implementation of a management area plan under the KGA. Per the terms of the KGA’s JPA agreement, the Districts maintain authority over their own internal matters, including but not limited to their respective surface water supplies, their respective groundwater supplies, facilities, operations, water management, and water supply matters.
Nothing in this management area plan or in the related GSP determines or alters surface water rights or groundwater rights under common law, any provision of law that determines or grants surface water rights, or otherwise. (See, California Water Code section 10720.5(b)). This management area plan and the related GSP shall be construed consistent with Section 2 of Article X of the California Constitution and nothing provided in this management area plan modifies rights or priorities to use or store groundwater except as expressly stated in California Water Code section 10720.5(a). NKWSD and SWID each reserve and retain all rights to the use of water to the extent provided by law.

1.3 GSP Implementation Costs

On behalf of their customers and landowners, the Districts will incur costs to implement GSPs and maintain the plan via five-year updates, both on their own and as members of the KGA. These costs and sources of funding are described below.

1.3.1 Costs Generated by GSP Implementation

Table 1-2 and 1-3 present a description and an estimate of the costs associated with the implementation of the NKWSD/SWID management area plan and measures associated with SGMA compliance.

These costs are an estimate, based on known requirements for SGMA compliance and on projects that have been identified at this time. They are subject to change as SGMA is implemented both at the district-level and throughout the Subbasin.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Improvement of in-district monitoring network for SGMA compliance. Coordination of groundwater level, groundwater quality, and land subsidence monitoring activities for annual reporting and Five-Year Updates</td>
<td>$350,000 for the first 5 years</td>
</tr>
<tr>
<td>Projects</td>
<td>Implementation of projects that have already been developed.</td>
<td>$4,250,000</td>
</tr>
<tr>
<td>Management</td>
<td>Administration of management actions and SGMA implementation measures.</td>
<td>$65,000 per year</td>
</tr>
<tr>
<td>Annual Report</td>
<td>Reporting of data collected in-district for inclusion in the Subbasin’s Annual Report to DWR.</td>
<td>$25,000 per year</td>
</tr>
<tr>
<td>5-Year GSP Update and Report</td>
<td>Development of plan updates, based upon the ongoing evaluation of groundwater conditions, changes to monitoring network, and developments of new projects and management actions for SGMA implementation.</td>
<td>$500,000 every 5 years</td>
</tr>
</tbody>
</table>
Table 1-3: Estimated Costs for GSP Implementation in SWID

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Improvement of in-district monitoring network for SGMA compliance. Coordination of groundwater level, groundwater quality, and land subsidence monitoring activities for annual reporting and Five-Year Updates</td>
<td>$350,000 for the first 5 years</td>
</tr>
<tr>
<td>Projects</td>
<td>Implementation of projects that have already been developed.</td>
<td>$5,350,000</td>
</tr>
<tr>
<td>Management</td>
<td>Administration of management actions and SGMA implementation measures.</td>
<td>$65,000 per year</td>
</tr>
<tr>
<td>Annual Report</td>
<td>Reporting of data collected in-district for inclusion in the Subbasin's Annual Report to DWR.</td>
<td>$25,000 per year</td>
</tr>
<tr>
<td>5-Year GSP Update and Report</td>
<td>Development of plan updates, based upon the ongoing evaluation of groundwater conditions, changes to monitoring network, and developments of new projects and management actions for SGMA implementation.</td>
<td>$500,000 every 5 years</td>
</tr>
</tbody>
</table>

1.3.2 GSP Implementation Funding

Under the JPA agreement, the KGA may impose reasonable fees, charges, assessments, and other levies to implement its GSP. However, the KGA shall have no authority to impose any such fees, charges, assessments, or other levies on any of its members or within a management area without the express consent and approval of the affected members. Pursuant to the Water Code, NKWSD and SWID have their own authority within their own jurisdictions, to impose fees, charges, assessments, or other levies as defined in their respective Rules and Regulations.

1.4 Description of Plan Area

As defined in DWR Bulletin 118 KGA’s jurisdictional area is entirely within the Subbasin, south of the Tulare Lake hydrologic region of the San Joaquin Valley groundwater basin. The Subbasin is bounded by the Kern County – Tulare County line to the north, the Sierra Nevada mountains to the east, the Tehachapi mountains to the south, and the Temblor range to the west. The Kern River flows from the Sierra
Nevada mountains, to the southwest, thence north, to its terminus at the Tulare Lakebed.

NKWSD and SWID are bounded by the Southern San Joaquin Municipal Utility District (SSJMUD) and Semitropic Water Storage District (SWSD) to the north, SWSD to the west, Rosedale Rio Bravo Water Storage District (RRBWSD) to the south, and the Cawelo Water District (CWD) and SSJMUD to the east. California State Highway 99 approximates the eastern boundary of the areas covered by this management area plan. The FKC flows through NKWSD, from Millerton Dam on the San Joaquin River, running south and terminating at the Kern River. Poso Creek runs from the Greenhorn Mountains of the Sierra Nevada range through the northern portion of NKWSD towards the northwest.

1.4.1 Geographic Areas Covered

NKWSD and SWID’s SGMA jurisdictional areas are shown in Figure 1-1. This includes RRID annexed into NKWSD along with the undistricted lands located to the south of SWID and north of 7th Standard Road, known as the 7th Standard Annexation. Together, they represent 6.5% of the area within the Subbasin. Their boundaries are coincidental with the boundaries of SSJMUD, SWSD, RRBWSD, CWD, and undistricted lands in the unincorporated portion of Kern County. Both districts are located entirely within the Subbasin.

The southeastern portion of the incorporated City of Shafter (“new Shafter”) lies within NKWSD’s jurisdictional area, as well as land annexed into the City of McFarland for its wastewater treatment plant and the unincorporated community of Famoso. The portion of the City of Shafter that is located in NKWSD is serviced either by NKWSD or by Oildale Mutual Water Company (OMWC), depending on the land use. Within SWID, there are two incorporated cities. The majority of the City of Wasco is within the jurisdictional area of SWID, in addition to the western portion of the City of Shafter (“old Shafter”).

The portion of RRID that is covered by Kern River Groundwater Sustainability Agency (KRGSA) along with the 7th Standard Road annexation who are part of KGA but are developing their own management area plan are not included in this NKWSD-SWID management area plan. Additionally, there are two parcels owned by the City of Wasco, adjacent to SWID’s western border that are located outside of SWID. These parcels (totaling 45 acres) are also included in this management area plan, per the agreement between NKWSD and SWID and the cities of Shafter and Wasco. Figure 1-2 shows the areas covered by this management area plan.

There are no adjudicated areas within NKWSD or SWID. There are also a number of de minimis domestic water users and multi-parcel water systems located within the
NKWSD and SWID jurisdictional areas which will be covered by this management area plan.

1.4.2 Plan Area Setting

The total service area for NKWSD is approximately 60,000 acres, with an irrigated acreage of approximately 55,000 acres. The total service area for SWID is approximately 39,000 acres, with an irrigated acreage of approximately 30,000 acres. Land use within NKWSD and SWID consists mainly of deciduous fruits and nut crops, as shown in Figure 1-3. Additionally, field crops, pasture, and grain and hay crops are located throughout both Districts, but a large concentration of these crops can be found centered around the boundary between the two Districts, between the cities of Shafter and Wasco.

The irrigated acreage for NKWSD also includes those areas of RRID which are outside of the City of Bakersfield and outside of the Kern River GSA’s plan area. This area is serviced by NKWSD to supply surface water to lands under cultivation. NKWSD also services those portions of the City of Shafter that are still classified as agricultural. The land that has been converted to urban use is serviced by OMWC.

The majority of land within the limits of the City of Wasco is classified as urban, with some land as deciduous crops or idle. The western portion of the City of Shafter is in urban use, with deciduous crops, vineyards and pastures making up the rest of the land use within Shafter’s city limits. While the total irrigated acreage remains consistent, the actual parcels receiving surface water from each of the districts varies from year to year based on the availability of surface water and decisions made by landowners.

All communities in NKWSD and SWID SGMA jurisdictional areas are groundwater dependent. The cities of Shafter and Wasco, as well as the unincorporated community of Famoso, do not have a surface water supply and therefore are groundwater dependent. Figure 1-4 shows the areas for which surface water supplies are available and the communities which are groundwater dependent. This includes the two incorporated cities and the unincorporated communities. The de minimis domestic water users and multi-parcel water systems located within NKWSD and SWID jurisdictional areas are also groundwater dependent.

Based upon well completion reports available from the California Department of Water Resources (DWR), the jurisdictional areas of NKWSD and SWID have agricultural production well densities ranging from zero wells per sq. mi. to 11 wells per square mile (sq. mi.) (Figure 1-5). The jurisdictional areas of NKWSD and SWID have a density of domestic water supply wells that ranges from zero wells per sq. mi. to 8 wells per sq. mi. (Figure 1-6). The density of municipal supply wells in the jurisdictional areas of NKWSD and SWID ranges from zero wells per sq. mi. to
4wells per sq. mi. (Figure 1-7). The portions of RRID located in the Kern River GSA are further described in their plan.

### 1.4.3 Existing Plans in Plan Area

There are existing groundwater management plans within the management plan area, including: the 2007 Poso Creek Integrated Water Management Plan (IRWMP), the NKWSD 2015 Agricultural Water Management Plan (AWMP), the NKWSD 2012 Groundwater Management Plan (GMP), and the SWID 2015 GMP, and the SWID AWMP. The district level GMPs and AWMPs are further discussed in the Basin Setting section of this management area plan. A copy of the NKWSD AWMP, NKWSD GMP, SWID GMP, and NKWSD AWMP are included in Appendix B of this management area plan.

Originally adopted in July 2007 and subsequently updated in 2014, the Poso Creek IRWMP was created to address short and long-term water supply challenges on a regional scale. The IRWMP was developed by the Poso Creek Regional Management group comprised of seven agricultural districts, of which SWSD was the lead agency. Groundwater goals within the IRWMP included:

- Maintaining groundwater levels to support economically viable pumping lifts
- Protecting the quality of groundwater and enhancing it where practical
- Enhancing monitoring activities to meet groundwater levels and water quality goals

Facilitating effective groundwater management was of the highest priority to the IRWMP. In addition to the requirements of the Districts’ water management plans and the Poso Creek IRWMP, there are other federal, state, local, and regional programs that monitor groundwater levels, groundwater and surface water quality, surface water inflow, weather and precipitation, and land subsidence. Descriptions of these existing monitoring programs are provided in the Basin Setting and Monitoring Network sections of this management area plan.

In addition to these regional and district plans, each of the two incorporated cities in the NKWSD and SWID jurisdictional areas have adopted Urban Water Management Plans (UWMPs) and General Plans. OMWC, a portion of which is within NKWSD, also has a UWMP. For the areas not within the limits of the incorporated cities or in the service area for OMWC, the Kern County General Plan applies. The General Plans for the cities and the General Plan for the County each have land use elements which address water usage. These elements are to be considered in this management area plan. The relevant sections of these General Plans are included in Appendix B.
1.4.3.1 Oildale Mutual Water Company Urban Water Management Plan

Per the requirements of SB X7-7, OMWC adopted a UWMP in 1985. This plan was updated in 2015 and adopted in September 2016. As of 2015, OMWC serviced approximately 10,300 connections with approximately 7,900 acre-feet per year (AFY) of water sourced from OMWC’s surface supply or OMWC-owned wells. According to the UWMP, the 5-year groundwater usage baseline established from 2006 to 2010 is approximately 1,800 AFY for the entire service area.

The portion of OMWC’s service area located in NKWSD is also within the limits of the City of Shafter (in the area known as “Southeast Shafter” or “7th Standard Road”). The 7th Standard Road area of Shafter is covered by a specific plan, which is described in the City of Shafter’s General Plan, in terms of land use. However, for the purposes of groundwater management, this area falls under OMWC’s 2015 UWMP. According to the UWMP, the southeast Shafter service area within OMWC is completely serviced by groundwater. From 2011 to 2015, the average groundwater volume supplied to the Southeast Shafter service area was approximately 900 AFY.

The 2015 UWMP addresses SGMA in its Groundwater Management section by stating water conservation practices will include drought-resistant landscaping and the use of untreated groundwater produced from shallower zones for landscape irrigation. Indoor demands will be met with water that meets domestic water quality standards (i.e. produced from deeper aquifers and/or treated). While OMWC’s UWMP states that they will not have their own GMP, it acknowledges that NKWSD adopted its own SB X7-7 compliant plan for the area.

1.4.3.2 City of Shafter General Plan

The City of Shafter has included an Environmental Management Program in its General Plan (updated April 2005). This program includes a Water Resources Element, which states its objective is to “provide adequate water supplies to meet present and future needs for domestic consumption and emergencies, while obtaining maximum benefit from limited water resources.” Many of these policies pertain to conservation measures within the city, for existing and proposed development. However, there are some policies which address the use of groundwater directly. These policies listed in this element of the General Plan are:

**Policy #2**: To ensure that land use changes will not adversely affect the Groundwater basin, applicants for General Plan and zoning ordinance amendments shall provide a factual statement of the following:

- Current water demand: The amount of water necessary to support development under existing general plan and zoning designations
• Proposed water demand: The amount of water necessary to support development under the proposed General Plan and zoning designations

• Potential conservation: The amount of water that can be conserved by application of water conservation techniques in the proposed project

• Water from new sources: the amount of water necessary that can be specifically committed to this project

**Policy #7:** Secure supplemental water supplies as needed to avoid groundwater overdraft.

**Policy #9:** Protect the existing groundwater basin by promoting informational programs on ways to reduce water usage in homes and businesses.

### 1.4.3.3 City of Wasco General Plan

The City of Wasco’s General Plan (adopted in October 2002) includes a Conservation and Open Space Element, which contains objectives, policies, and standards specific to the protection of groundwater resources within the City of Wasco and its Planning Area. One of the objectives stated in the General Plan is to “protect natural resources including groundwater, soils, and air quality, to meet the needs of present and future generations.” The policies and standards that deal specifically with groundwater are as follows:

**Policy #1:** Protect areas of natural groundwater recharge from land uses and disposal method, which would degrade groundwater quality. Promote activities, which combine stormwater control, and water recharges

**Policy #2:** Expand programs that enhance groundwater recharge in order to maintain the groundwater supply, including the installation of detention ponds in new growth areas

**Policy #9:** To protect human health, the City groundwater resources will be monitored on a regular basis to test for bacteriological and toxic chemical components

### 1.4.3.4 Kern County General Plan

The Kern County General Plan contains provisions within the Land Use, Open Space and Conservation Element that relate specifically to groundwater resource management. These provisions, found in the Resource Policies of the Land Use, Open Space, and Conservation Element, are:

**Policy #10:** To encourage effective groundwater resource management for the long-term economic benefit of the County the following shall be considered:

a. Promote groundwater recharge activities in various zone districts
b. Support for the development of Urban Water Management Plans and promote Department of Water Resources grant funding for all water providers

c. Support the development of groundwater management plans

d. Support the development of future sources of additional surface water and groundwater, including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater and desalination

Under the General Provisions of the General Plan, there is a section which deals specifically with surface and groundwater. This section includes a policy statement which states that the County will “encourage the development of the County’s groundwater supply to sustain and ensure water quality and quantity for existing users, planned growth, and maintenance of the natural environment” and that “new high consumptive water uses, such as lakes and golf courses, should require evidence of additional verified sources of water other than local groundwater. Other sources may include recycled stormwater or wastewater.”

The implementation measures listed in the General Provisions which are directly related to groundwater are:

**Measure U:** The Kern County Environmental Health Services Department will develop guidelines for the protection of groundwater quality which will include comprehensive well construction standards and the promotion of groundwater protection for identified degraded watersheds.

**Measure X:** Encourage effective groundwater resource management for the long-term benefit of the County through the following:

i. Promote groundwater recharge activities in various zone districts

ii. Support for the development of Urban Water Management Plans and promote Department of Water Resources grant funding for all water providers

iii. Support the development of groundwater management plans

iv. Support the development of future sources of additional surface water and groundwater, including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater and desalination

**Measure Z:** General Plan Amendments subject to environmental review and not otherwise subject to California Water Code Section 10910 shall demonstrate through a water supply assessment that a long-term water supply for a 20-year timeframe is available. The water assessment shall include, but not limited to, the following:

i. Source and quantity of historical water use on the site

ii. Estimated water consumption of the proposed development
iii. Estimated storage, if any, in meeting the projected need

iv. Recommendations for additional sources of water to address demand shortage. Such measures may include, but not limited to, development of future sources of additional surface water and groundwater, including water transfers, conjunctive use, recycled water, conservation, and additional storage of surface water, groundwater, and desalination

Written acknowledgement that water will be provided by a community or public water system with an adopted Urban Water Management Plan shall constitute compliance with this requirement.

**1.4.4 Plan Elements from CWC Section 10727.4**

Per Section 354.8(g) of the GSP Emergency regulations, additional plan elements pertaining to Water Code Section 10727.4 shall be included in order to comply with SGMA. This section provides a general overview of plan elements with reference to sections included throughout this chapter for further details.

A. Control of Saline Water Intrusion

Seawater intrusion is not considered an issue in the Subbasin. The coastal range provides a barrier, preventing seawater from coming into contact with groundwater flow in the Subbasin.

B. Wellhead Protection Areas and Recharge Areas

Permits are issued by the Kern County Public Health Services Department (KCPHSD) Water Well Program to construct, reconstruct, and destroy water wells. The Districts assist their landowners through this process to comply with the wellhead protection area program. This program was implemented through the Safe Drinking Water Act and aims to prevent contamination in public water systems. The Districts also manage recharge areas throughout their jurisdictional boundaries and with adjacent water district recharge programs such as for the Kern Water Bank and Pioneer Project.

C. Migration of Contaminated Groundwater

There are two identified contamination plumes within NKWSD and SWID’s boundaries. Refer to Section 2.3.5 for further details.

D. Well Abandonment and Well Destruction Program

The KCPHSD issues permits to destroy water wells. The process consists of completing a water well permit through the county. All state and county regulations must be followed during the destruction process. According to the Kern County Ordinance Code 14.08, any
wells that are abandoned or wells with inadequate water supply must be destroyed. Furthermore, any abandoned wells on the site of an active new well construction permit must be destroyed prior to construction.

E. Replenishment of Groundwater Extractions

To manage the groundwater basin within its boundaries, the Districts actively participate in conjunctive use or underground storage programs (see Section 2.7.2). In addition to these efforts, the Districts will work to implement additional projects to bring more water into the basin to maintain sustainable groundwater conditions.

F. Conjunctive Use or Underground Storage

The Districts actively participate in conjunctive use and underground storage programs to manage the groundwater basin within its boundaries. These projects aim to reduce demand on local groundwater resources. Projects include land fallowing, expansion of recharge facilities, and water banking on behalf of the Districts (see Section 2.7.2).

G. Well Construction Policies

The KCPHSD, Environmental Health Division, issues permit to construct, deepen, or replace water wells. The permitting process consists of a county water well permit and the SGMA implemented Overdraft Supplemental Well Application accompanied by detailed site maps.

H. Groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects

Regarding groundwater contamination cleanup, there are two contamination plumes in Wasco: one active groundwater remediation site; and one open site for verification monitoring. Potential contaminants at both sites are pesticides, fumigants, and herbicides. Since there are no nearby municipal wells (within 1,500 feet of the sites), these sites are not impacting groundwater quality. NKWSD and/or SWID are not taking an active role in the remediation effort that is managed by the Department of Toxic Substance Control (DTSC).

Through its water management practices, the Districts are constantly pursuing water conservation. Efficient water management practices are described in each Districts’ GMP, which was updated in 2012. In addition to their conservation efforts, the Districts manage multiple groundwater recharge facilities and large conveyance systems that are used to deliver water for beneficial use in the district. For information regarding in-lieu use, water recycling, and extraction projects, see Section 2.7.2.

I. Efficient Water Management Practices
The existing groundwater management plans the Districts currently follow are their own GMP’s as well as the Poso Creek IRWMP. These plans were implemented to approach short and long-term water supply challenges throughout the region. These challenges were combatted with increased recharge capacities, improved conveyance, and coordinated operation of the water management programs.

J. Relationships with State and Federal Regulatory Agencies

SWID works closely with the Kern County Water Agency and the Central Valley Project for the coordination and delivery of their Federal water supply. NKWSD, while not a state or federal contractor, occasionally receives water from both the SWP and the CVP. The Districts also coordinate with other state and federal agencies as needed to manage its water supplies; construct and implement water management projects; monitor and report local water conditions; and coordinate and provide input to local, regional and state water policy matters.

K. Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.

Documents pertaining to land use plans and coordination between planning agencies are included in Section 1.4.3 of this management area plan. The Districts will continue to coordinate with the KGA and other GSAs in the Subbasin as the SGMA implementation process proceeds.

L. Impacts on Groundwater Dependent Ecosystems

The presence of GDE’s has not been identified. Section 2.3.8 of this management area plan provides an overview of the available information regarding GDEs in the Districts.

1.5 Notice and Communication

Per Section 354.10 of the GSP emergency regulations, the following sections discuss the notice and communication processes conducted by the Districts with other agencies and interested parties. A list public outreach meetings and workshops for the Districts’ beneficial users and other interested parties are provided along with a brief overview of their respective purpose. Participating Agencies

The following agencies were engaged in the public outreach activities related to the development of this management area plan:

- North Kern Water Storage District
- Shafter-Wasco Irrigation District
1.5.1 Beneficial Uses and Users

As required by Section 354.10(a) of the GSP emergency regulations, beneficial use and users in the Districts’ portions of the Subbasin have been identified. The beneficial uses of groundwater in the management area plan, consistent with the uses identified in DWR Bulletin 118, are:

- Agricultural;
- Municipal and Domestic;
- Industrial.

Users of groundwater have been identified as landowners, agricultural operations (including farms, dairies, and food processors), businesses, rural residents, and urban residents of incorporated communities and unincorporated communities. These beneficial users of groundwater have been identified as stakeholders for public outreach activities in the plan area.

1.5.2 Public Meetings

Throughout the development of this management area plan, NKWSD and SWID have conducted a series of public meetings to educate and engage the beneficial users within the Districts’ boundaries regarding the planning and implementation of SGMA. The Districts have also encouraged its beneficial users to participate in public meetings held by the KGA. A list of all meetings conducted by the Districts are provided in Table 1-4 below.

Following the enactment of SGMA in 2014, the Districts began conducting public outreach meetings and workshops to educate its beneficial users on SGMA implementation and to open the lines of communication for the development of this management area plan. Active participation was encouraged for all beneficial users in order to accurately reflect the diverse social, cultural, and economic elements of the beneficial users represented in this management area plan.

In addition to their respective, regularly scheduled board meetings, which are publicly noticed on District websites (see Section 1.2), NKWSD and SWID facilitated a publicly-noticed stakeholder outreach meeting on March 19, 2019 to discuss the Districts’ joint efforts to develop a management area plan under the KGA. This meeting was then followed-up with smaller, landowner-focused meetings on March 21, 2019. NKWSD also held monthly
meetings with a Landowner Advisory Group, as well as publicly-noticed quarterly landowner meetings.

The sign-in sheets, agendas, and minutes from these meetings are included in Appendix I. Feedback received was taken under consideration and used in the development of this management area plan. The Districts’ boards, along with the General Manager and Consultant, considered feedback to formulate a plan that accurately captures all beneficial use/users and their interests with a goal to achieve groundwater sustainability by 2040.

Table 1-4. NKWSD-SWID Public Meetings and Workshops

<table>
<thead>
<tr>
<th>Date</th>
<th>Meeting</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly</td>
<td>KGA Stakeholder Coordination Meetings</td>
<td>Review development of SGMA management area plan with KGA member agencies and coordinate on efforts for development.</td>
</tr>
<tr>
<td>Monthly</td>
<td>Board Meetings</td>
<td>Review development of SGMA management area plan.</td>
</tr>
<tr>
<td>October 17, 2018</td>
<td>Management Area Plan Development Meeting</td>
<td>Meeting with representatives from the cities of Shafter and Wasco and Oildale Mutual Water Co. to discuss plan progress and areas covered by the Districts’ development.</td>
</tr>
<tr>
<td>February 21, 2019</td>
<td>Management Area Plan Development Meeting</td>
<td>Overview of stakeholder workshop materials with the cities of Shafter and Wasco and the district managers.</td>
</tr>
<tr>
<td>March 19, 2019</td>
<td>Stakeholder Outreach Meeting</td>
<td>Review presentation of SGMA; participants; and overview of Plan development and sustainable management criteria. Meeting ended with a questions and answers session.</td>
</tr>
<tr>
<td>March 21, 2019</td>
<td>Stakeholder Outreach Meeting</td>
<td>Group meetings with landowners by hydrologic zones within NKWSD and SWID to discuss March 19 meeting materials.</td>
</tr>
<tr>
<td>March 21, 2019</td>
<td>Stakeholder Outreach Meeting</td>
<td>Group meetings with landowners by hydrologic zones within NKWSD and SWID to discuss March 19 meeting materials.</td>
</tr>
<tr>
<td>May 14, 2019</td>
<td>KGA Open House</td>
<td>Presentation of member agencies’ GSP/plan development with representatives from state agencies in attendance.</td>
</tr>
</tbody>
</table>

1.5.3 Comments Received

To be developed after the public comment period ends.
1.6 GSP Organization

This management area plan will address the following topics:

- Basin Setting elements, pertaining to the groundwater conditions and sustainability indicators of the portions of the Subbasin located within the jurisdictional areas of NKWSD and SWID (Section 2),

- The sustainability goal and undesirable results, adopted at the Subbasin, and applied to the management areas within NKWSD and SWID along with the sustainable management criteria for all sustainability indicators within NKWSD and SWID that have been identified as applicable to the Subbasin (Section 3),

- The identification of existing monitoring networks for the evaluation of sustainable management criteria and monitoring of sustainability indicators identified in the management area plan (Section 4), and

- The identification of projects and management actions proposed by the Districts to reach the sustainability goals identified in this management area plan (Section 5).
This Page Left Blank Intentionally
Llanas Camp Four
Water System
(CA1502164)

CWS - North Garden
Garden
(CA1510055)

Kimberlina
Housing Unit
(CA1503657)

The Garlic
Company
(CA1503290)

Rose Villa
Apartments
(CA1500426)

City of Wasco
(CA1510021)

Oildale MWC
(CA1510015)

Vaughn WC Inc
(CA1510029)

Treehouse
California Almonds
(CA1502133)

City of Shafter
(CA1510019)

Kern County, California

Groundwater Dependent Communities

North Kern Water Storage District
Shafter-Wasco Irrigation District

Management Area Plan

Kern County Subbasin Boundary
Waterway
Major Conveyance

SOURCE: CA DHS SDWIS (2019)
2. Basin Setting

The Basin Setting is made up of the hydrogeologic conceptual model (HCM), the current and historical groundwater conditions, the water budget components of the Subbasin, and the description of Subbasin management areas. This section provides the local and regional details as context for defining and assessing reasonable sustainable management criteria and projects and management actions for NKWSD and SWID.

2.1 Introduction

Regional details for the entire basin setting are included in the “umbrella” level section for the KGA GSP; whereas, the majority of the discussion provided in this section focuses on the extent of NKWSD and SWID boundaries and the immediate vicinity. Pertinent details related to the entire Subbasin that apply to NKWSD and SWID, such as the definition of the vertical and lateral extents of the groundwater Subbasin and the regional geology, regional structural setting, and aquifer hydrostratigraphy, are presented in this section.

The details of this study come from NKWSD’s 2012 Groundwater Management Plan (NKWSD, 2012), and SWID’s Groundwater Management Plan (SWID, 2007), which are referenced herein. Figure 2-1 presents the current extent of NKWSD and SWID’s jurisdictional area and its proximity to other agencies within the Subbasin.

2.2 Hydrogeologic Conceptual Model

The hydrogeologic conceptual model characterizes the physical components and interaction of the surface water and groundwater systems in the study area. A brief description of the regional geology and structural setting of the NKWSD and SWID, including the vertical and lateral extents of the groundwater Subbasin, groundwater flow, aquifer characteristics, and other physical characteristics are presented in this section.

2.2.1 Subbasin Regional Setting

As described in the KGA GSP Basin Setting, the Kern County Subbasin (5-22.14), is located in the southern San Joaquin Valley, known as the Tulare Lake Region of the Central Valley. The Tulare Lake Region encompasses the Central Valley subbasins from just north of Fresno to the Tehachapi Mountains and San Emigdio Mountains at the southern end of the valley; with the Sierra Nevada Mountains (Sierra Nevada) to the east, and the Coast Ranges to the west (Figure 2-2 below). NKWSD and SWID are situated in the northern central portion of the Subbasin.
For additional information on the regional geologic and structural setting for the entire Subbasin, please refer to Section 2 of the KGA GSP Basin Setting chapter (Chapter 2 of the KGA Plan).

![Central Valley Hydrologic Regions-Tulare Lake Region](image)

Figure 2-2. Central Valley Hydrologic Regions-Tulare Lake Region
2.2.1.1 Sediment Deposition

The southern San Joaquin Valley (and most of the Central Valley), was a large basin with marine deposition occurring from Late Jurassic and Cretaceous Periods into the Tertiary Period. Thereafter, continental deposition of alluvial, fluvial, and lacustrine sediments occurred along the margins and into the center of the valley. These younger sediments were derived from the surrounding mountain ranges (Planert and Williams, 1995). Sand, silt, and clay deposits were deposited in the study areas in a complex sequence by the Kern River and Poso Creek (Kern River Formation), flowing from the Sierra Nevada Mountains to the east, and to a lesser extent, by streams along the Coast Range to the west. The terminus for these flows in the geologic past was Tulare Lake (Tulare Formation) (NKWSD, 2012).

Figure 2-3 below is a conceptual block diagram provided as a general example of the sequence of deposition in the valley and shows the source of most fresh water into the basin originates from the Sierra Nevada mountains.

![Conceptual Block Diagram Looking North from Kern River](image)

Figure 2-3. Conceptual Block Diagram Looking North from Kern River

2.2.2 Groundwater Subbasin Lateral and Vertical Boundaries

Within NKWSD and SWID, jurisdictional boundaries limit the lateral extent of groundwater pumping, while natural boundaries delineate the vertical extent or bottom of groundwater with beneficial use.
The KGA GSP provides context for the discussion of lateral and vertical extents of groundwater in the Subbasin. By applying California Water Code §10723.2, the bottom of the groundwater Subbasin includes groundwater that can be applied to beneficial use. The KGA GSP basin setting references criteria from the state and federal code for defining the extent of groundwater with beneficial use in the Subbasin. For details on these criteria, refer to the KGA GSP. In general, the groundwater Subbasin extent, where no exemptions or commercially producible hydrocarbons or minerals exist, likely ranges between 3,000 mg/L and 10,000 mg/L TDS depending on the feasibility of treatment and recovery of the groundwater for beneficial use.

2.2.2.1 Datasets with Lateral and Vertical Distribution of Groundwater in the Subbasin

As described above, the KGA GSP basin setting discusses criteria for defining the bottom of the groundwater Subbasin. This section and subsections present datasets with general vertical distribution of groundwater ranging from 2,000 to 10,000 mg/L TDS.

Page’s 1973 depth to fresh groundwater with a TDS of 2,000 mg/L is presented on Figure 2-4. There are other definitions for fresh groundwater (Heath, 1983), but for this discussion, Page’s dataset is used because it is a commonly known and is a published dataset in the Central Valley. Page’s (1973) base of fresh water is not however, the defined bottom of the groundwater Subbasin.

The depth to groundwater with a TDS of 10,000 mg/L (one of the criteria for the USDW), is presented on Figure 2-5. This dataset was recently developed by research in the Subbasin based on geochemical analysis of water samples and geophysical log analysis (Gillespie et al., 2017; and Kong, 2016), and provides further insight of the distribution of groundwater that may be within the range for potential beneficial use.

Both the lateral and bottom boundaries of the groundwater in the Subbasin are constrained by the primacy productive limits with depths to hydrocarbons, and aquifer exemptions with corresponding depths. However, within NKWSD, north of 7th Standard Road and SWID, there are no aquifer exemptions, and the oil field depths to hydrocarbons are below the base of 10,000 mg/L TDS. South of 7th Standard Road, the Rosedale Ranch Oil Field underlies agricultural lands that may have groundwater production. The base of 10,000 mg/L TDS may underlie the depth to hydrocarbons of the oil field; where applicable, the shallowest of the two is considered the bottom of the Subbasin.

2.2.2.2 Conceptual profile of the Groundwater Basin underlying NKWSD and SWID

As depicted Figure 2-6 below, in a conceptual profile of the groundwater basin in NKWSD and SWID, the groundwater basin is laterally continuous until reaching the jurisdictional boundaries of the districts. The vertical extents are defined by the base of USDW. Both the base of fresh water and the base of USDW dip to the east. At about the middle of NKWSD
the base of freshwater levels out and decreases in depth toward CWD and SSJMUD. Although the conceptual profile does not illustrate the oil fields, as stated above, there are no primacy limits or aquifer exemptions within the vertical groundwater Subbasin boundaries of SWID and NKWSD.

![Groundwater Subbasin Conceptual Profile](image)

**Groundwater Subbasin Conceptual Profile**

*Note: Oil and Gas details are not depicted in this conceptual diagram. Modified from: Todd, 2017; SWSD, 2012; LADWP, 1974*

**2.2.2.3 NKWSD Lateral Boundaries**

The lateral boundaries of NKWSD groundwater are jurisdictional and do not represent physical boundaries of the Subbasin. NKWSD is located in Kern County, west of U.S. Highway 99, southwest of the City of McFarland, northwest of the City of Bakersfield, and east of SWID and most of the City of Wasco. The district in its entirety represents approximately 60,000 acres of land, with approximately 51,000 acres of irrigated land. While most of NKWSD lies north of 7th Standard Road, the area to the south is referred to as Rosedale Ranch Improvement District (RRID), represents about 10,000 acres of NKWSD’s total area. RRID was annexed into NKWSD in 1966. It later became part of the NKWSD service area with the expansion of surface water distribution in 1980 (NKWSD, 2012).
2.2.2.4 SWID Lateral Boundaries

The lateral boundaries of SWID groundwater are jurisdictional and do not represent physical boundaries of the Subbasin. SWID covers approximately 39,000 acres with approximately 30,000 acres being irrigated. SWID is bounded to the east by NKWSD, to the west and north by SWSD, to the south by the undistricted land and further south is Rosedale-Rio Bravo WSD. California State Route 43 runs North-South through the middle of SWID, intersecting State Route 46 at the City of Wasco in the Northeast part of the District.

2.2.2.5 NKWSD Subbasin Vertical Boundaries

From Page’s data (Figure 2-4), the base of 2,000 mg/L TDS “fresh water” ranges from approximately -2,550 ft msl (~3000 feet below ground surface) in the central portion of NKWSD near 27S25E25, and -2,450 ft msl (~2,800 feet bgs) near 28S26E34, to -1,500 ft msl (~1,780 ft bgs) in the northwest near 26S24E10.

Based on Gillespie et. al. (2017) (Figure 2-5), the base of 10,000 mg/L TDS ranges from approximately -4,000 ft msl (~-4,400 ft bgs) southeast in 28S27E31 to -1,900 ft msl (~-2,100 ft bgs) in the northwest in 26S24E10.

2.2.2.6 SWID Subbasin Vertical Boundaries

From Page’s data (Figure 2-4), the base of 2,000 mg/L TDS “fresh water” ranges in SWID from approximately -2,450 ft msl (~2,800 feet bgs) in the southeast near 28S25E25, to -675 ft msl (~975 ft bgs) in the southwest near 28S24E10, -1,900 ft msl (2,250 ft bgs) near Shafter, and approximately -1,600 ft msl (~-1,900 ft bgs) near Wasco.

Based on Gillespie et. al. (2017) (Figure 2-5), the base of 10,000 mg/L TDS ranges from approximately -2,650 ft msl (~-3,000 ft bgs) in the southeast near 28S26E30, to approximately -1,900 ft msl (~-2,200 ft bgs) in the southwest near 28S24E10, to -2,400 ft msl (~-2,700 ft bgs) near Shafter and -2,100 ft msl (~-2,400 ft bgs) near Wasco.

2.2.2.7 General Observations of Base of Fresh Water

Underlying NKWSD and SWID, the base of fresh groundwater forms a northwest-trending trough of fresh groundwater between Bakersfield and Wasco. This trough of fresh groundwater lies between the concealed Poso Creek fault to the northeast and the concealed, pre-Quaternary Greeley fault system on the southwest. Historical displacement on the Greeley Fault and historical and recent displacement on the Pond Fault may have led to this depression of Quaternary sediments that accommodate this trough of fresh groundwater.

2.2.3 Principal Aquifers and Aquitards

As described above, NKWSD and SWID are underlain by 1,000 to 3,000 feet of fresh water in an aquifer system made up of lenticular deposits of alluvial, fluvial, and lacustrine origin.
The study area is located just east of the axis of the main valley depositional trough where the Tulare Formation and Kern River formation interfinger. The bottoms of these formations effectively define the lower extent of the aquifer system; however, the lower portions contain brackish water, which is not considered suitable for beneficial use. According to Croft (1972), NKWSD and SWID are underlain mostly by alluvium derived from the Sierra Nevada and below the alluvium is the Kern River Formation (LADWP, 1974). Some clays of the Tulare Formation appear to interfinger with alluvium and the Kern River Formation underlying the study area (Croft, 1972). These clays thin eastward from the Tulare Lake depocenter toward the study area (Croft, 1972).

The area underlying NKWSD and SWID represents, for the most part, a single aquifer zone. The upper zone from SWSD above the Corcoran Clay likely extends northwest NKWSD and east into northwest SWID, where it merges with the lower zone into a single aquifer zone at the eastern limit of the Corcoran E-Clay or equivalent. The E-Clay extends eastward to T27S R25E and potentially into T26S R25E as documented by Croft, (1972); LADWP, (1974); PGA, (1991); DWR, (2018); and USGS, (2018); however, it becomes shallow and thin to the east until it is no longer an effective confining unit.

### 2.2.3.1 Aquifer System within NKWSD

Within NKWSD, a heterogeneous aquifer system contains water under unconfined conditions in the upper few hundred feet, that grades into confined conditions with depth. Confinement is dependent on the extent of the clay layers. The Corcoran Clay or E-Clay has been identified to both the west and north of the district. To the north, in Township 25 South, Range 25 East, it pinches out and is not considered to be an effective hydrologic barrier further to the south (NKWSD, 2012). Some upper zone unconfined groundwater contour maps from Schmidt and Associates present water level data in NKWSD near T25S R25E (Historical contour maps from Semitropic Water Storage District Monitoring Committee).

The 2012 GMP describes an upper zone of clay lenses as the “300-foot clay”, a middle zone of clay lenses as the “700-foot clay”, a lower zone of clay lenses at the “900-foot clay”, and a contact between oxidized and reduced sediments below the clays. The “300-foot clay”, a set of discontinuous clay lenses, may have been contemporaneously deposited during the same general geologic time as the E-Clay. The “300-foot clay” is discontinuous, allowing for downward groundwater movement, and it appears to produce mildly semi-confined conditions rather than confined conditions in the underlying aquifer (NKWSD, 2012). Most supply wells are screened below the “300-foot clay”.

### 2.2.3.2 Aquifer System within SWID

SWID overlies areas of both unconfined and confined aquifers. There are limited areas of perched water and shallow groundwater tables (SWID, 2007). Most of the groundwater is pumped from the confined zone of the regional aquifer system.
Confinement and the presence of both the upper and lower zones of the aquifer system as identified in SWSD is dependent on the extent of the clay layers in SWID. The Corcoran E-Clay or equivalent has been identified throughout SWID based on various studies and datasets (Croft, 1972; LADWP, 1974; PGA, 1991; DWR, 2018; USGS, 2018; and Schmidt and Associates, 2019). Although there isn’t routine historical data available for upper zone water levels, some unconfined groundwater contour maps from Schmidt and Associates present water level data northwest of SWID near T26S R24E and T27S R24E (Historical contour maps from Semitropic Water Storage District Monitoring Committee).

As described by the USBR (1953), the sediments of the Kern River formation and alluvium make up the main aquifer underlying the district. The aquifer has varying permeabilities that “allow virtually unrestricted migration from one bed to another, but at varying rates” (USBR, 1953). Below the Kern River Series is the San Joaquin formation which is mostly made up of clay and has poor water quality. The San Joaquin formation is below the base of fresh water and the base of USDW.

### 2.2.3.3 Formation Names and Descriptions within Aquifers.

As described above, the aquifers underlying the study area are made up of alluvium, the Tulare Formation, and the Kern River formation. The Tulare formation (Plio-Pleistocene), in conjunction with the Kern River formation (Mio-Pliocene to early Pleistocene), represent west-east facies change across the Subbasin. The contacts are not easily mappable and may be gradational. The Tulare and Kern River formations are moderately to highly permeable and are major freshwater sources within the Subbasin (Page, 1986; SWSD, 2012).

Alluvium includes younger and older alluvium, which are often indistinguishable from each other. The Holocene-age younger alluvium and flood basin deposits vary in character and thickness in the study area. These deposits consist of up to approximately 150 feet of interstratified and discontinuous beds of clay, silt, sand, and gravel. The sand and gravel sized alluvium were primarily deposited from into the Poso Creek Fan and the Kern River Fan as coalescing alluvial fans with periodic flooding and subsequent flood-basin deposits (Page, 1986; Logan, 1992).

Croft (1972), documented differences in sources of alluvium from west-east in the Subbasin, and in depositional conditions and exposure. Alluvium in the central portion of the Subbasin (study area) and East are dominated by Sierra Nevada sediment derived from granitic sources. West of the study area and the historical Kern River Channel, alluvium is derived from the Coast Range and is typically finer grained and derived from sedimentary formations. Oxidized alluvium, derived from the Sierra Nevada, has been delineated in shallow and eastern alluvium as described by Croft (1972). In general, oxidized alluvium was deposited in shallower, higher energy environments associated with the Kern River, Poso Creek, and Sierra Nevada drainage. Further west from the distal edges of the Kern River and
Poso Creek Fans, are fine grained deposits that accumulated in the depocenter of the valley, typically under reduced conditions. During periods when lacustrine advances dominated the valley fine grained lenses of clay interfinger with alluvium (A, C, and E-Clays interfinger with alluvium). Many of these sediments were deposited in reduced environments and have been characterized in historical cross sections as reduced alluvial deposits (Croft, 1972).

Older alluvium and terrace deposits overly the Tulare and Kern River formations. Depositional processes are very similar to the younger alluvium. The older alluvium also makes up a portion of the regional aquifer system. These deposits are composed of up to 250 feet or more of Pleistocene-age lenticular deposits of clay, silt, sand, and gravel that are loosely consolidated to cemented (Croft, 1972). They are moderately to highly permeable and yield sufficient water to wells. They are often indistinguishable from the underlying Tulare and Kern River formations (DWR, 2006).

The Tulare formation (western Subbasin) contains up to 2,200 feet of interbedded, oxidized to reduced sands, gypsiferous clays, and gravels derived primarily from Coast Range sources. The permeable deposits of the Tulare Formation are divided into upper and lower units, separated by the Corcoran Clay member of the formation. Groundwater beneath the Corcoran Clay is typically confined to semiconfined (Page, 1986; SWSD, 2012). In addition to its confining properties, laboratory tests indicate that the clay is highly susceptible to compaction (Faunt, et al., 2009).

The Corcoran Clay occurs laterally to the north and southwest of NKWSD and SWID (~34 miles wide in extent) from Delano to Lost Hills (Figure 2-7), and narrows to the south just to the west of the Kern River banking facilities to about 3.5 miles wide; just west of the study area, between the Kern River and Highway 46, the depth to the Corcoran Clay varies from 300 to 450 feet. Further north to the county line, the depth varies from 200 to 750 feet. The Corcoran Clay, most notably the modified E-clay (Page, 1986) is generally very fine grained; however, isolated, coarser zones are possible, particularly where the clay is less than 20 feet thick. The clay might be as thick as 60 to 80 feet in isolated areas, but the thickness typically varies between 10 and 30 feet. The Corcoran Clay does not exist under the Kern Alluvial Fan (Kern Fan) to the southwest of the study area. The shallow unconfined layers are separated from deeper layers by an intermediate zone of interbedded sands and silts which retard vertical groundwater flow and create an increase in semi-confinement with depth. The Corcoran Clay is not present eastward from the cities of McFarland and Bakersfield (Faunt et al., 2009).

The Kern River formation includes from 500 to 2,000 feet of poorly sorted, lenticular deposits of clay, silt, sand, and gravel derived from the Sierra Nevada. The Kern River formation crops out east of NKWSD and SWID in the foothills of the Sierra Nevada and reaches its maximum thickness of 2,600 feet in the subsurface southwest of Cawelo (Bartow
and Pittman, 1983). The formation consists mostly of poorly sorted fluvial sandstone and conglomerate with interbeds of siltstone or mudstone that becomes finer grained northward and westward. Some of the thicker siltstone or mudstone interbeds may represent deposits of small ephemeral lakes or ponds (Bartow, 1983). The Kern River formation is coarsest in its easternmost exposures, generally the area south of the Kern River, where the composition includes a cobble conglomerate with boulders near the base and pebbly sandstone. (Bartow and Pittman, 1983). Two oil-producing zones occur in the lower part of the formation where it is believed to have migrated to the Kern River formation from older marine sediments (Bartow and Pittman, 1983).

Discussion of older geologic units underlying the Tulare formation and Kern River formation are detailed in the KGA GSP basin setting. These formations are effectively below the base of fresh water and the base of USDW in NKWSD and SWID. The umbrella basin setting includes a hydro stratigraphic column of geologic units.

2.2.3.4 Physical Properties of Each Aquifer and Aquitard

Aquifer parameters within the study area are available from both well pumping tests and calibrated groundwater models. Data are summarized in Table 2-1a and 2-1b. Aquifer properties reported herein include hydraulic conductivity which is a function of an aquifer’s ability to move or transmit water (transmissivity) through an aquifer of a given saturated thickness, and the specific yield (unconfined systems) and storage coefficient (semiconfined to confined systems), which are functions of an aquifer’s ability to store and release water from storage (storativity).

Aquifer data derived from pumping tests were taken from three sources: 1) relatively short (1.5- to 5-hour) pumping tests by the USGS at irrigation wells during the late 1950s and 1960 (McClelland, 1962), 2) from constant rate pumping tests from engineering consultants in the 2000’s (Todd, 2018), and 3) from groundwater model calibrated parameters. The depth of test wells varied from 590 to 830 ft bgs, and pumping rates varied from 1,600 to 2,100 gpm. The analysis included the use of water level recovery data from pumping wells and water levels from observation wells. From these tests, the hydraulic conductivity was estimated and ranges from 35 to 215 feet per day (ft/d), which is consistent with published ranges for clean, medium- to coarse-grained sand (Heath, 1983), or for a fine sand to coarse gravel (Schwartz & Zhang, 2003). These values also fall within the range of the groundwater models that were partially calibrated with these data (C2VSim; CVHM; Todd, 2018; Todd, 2017), and are presented in the KGA GSP Basin Setting of this GSP.

The Corcoran Clay of the Tulare formation is most commonly known for its fine-grained beds; however, lithology does vary from fine (clay and silt) to coarse (sand) texture (Page, 1986; Faunt et al., 2009). Data are available for the Corcoran Clay from the USGS regional model. In the absence of local data, the regional modeling data results are presented herein.
Faunt et al., (2009) compiled and estimated horizontal hydraulic conductivities within the range of 0.0024 to 33 ft/d, which is within the range of silt to fine/medium sand (Heath, 1983). A range of vertical hydraulic conductivity was estimated from permeameters and field tests between $6.6 \times 10^{-6}$ ft/d to $1.5 \times 10^{-3}$ ft/d (Faunt et al., 2009), representing a potential vertical anisotropy range of $3.6 \times 10^{2}$ to $2.2 \times 10^{4}$. As noted by Faunt et al., (2009) laboratory permeameter tests may have underestimated the hydraulic conductivity while field testing may have overestimated hydraulic conductivity due to potential for intra-borehole flow across the clay. Additionally, recent inelastic compaction of the Corcoran Clay in areas of subsidence may have further reduced vertical hydraulic conductivity (Faunt et al., 2009).
Table 2-1a. Local Aquifer Parameters

<table>
<thead>
<tr>
<th>Well</th>
<th>Estimated Specific Capacity (gpd/ft)</th>
<th>Estimated Transmissivity (gpd/ft)</th>
<th>Estimated Horizontal Hydraulic Conductivity (gpd/ft²)</th>
<th>Estimated Horizontal Hydraulic Conductivity (ft./day)</th>
<th>Coefficient of Storage</th>
<th>Discharge Rate (gpm)</th>
<th>Drawdown (feet)</th>
<th>Sum of Perforated Intervals (feet)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>27S/24E-35K1</td>
<td>190</td>
<td>230,000 to 460,000</td>
<td>800 to 1600</td>
<td>100 to 215</td>
<td>0.001</td>
<td>1,900</td>
<td>10</td>
<td>288</td>
<td>McCelland, 1962</td>
</tr>
<tr>
<td>27S/25E-3J2</td>
<td>83.5</td>
<td>150,000 to 250,000</td>
<td>270 to 450</td>
<td>35 to 60</td>
<td>0.001</td>
<td>2,100</td>
<td>25</td>
<td>556</td>
<td>McCelland, 1962</td>
</tr>
<tr>
<td>27S/26E-30F1</td>
<td>100</td>
<td>250,000 to 470,000</td>
<td>600 to 1,150</td>
<td>80 to 150</td>
<td>0.001</td>
<td>1,900</td>
<td>19</td>
<td>408</td>
<td>McCelland, 1962</td>
</tr>
<tr>
<td>27S/26E-32G1</td>
<td>--</td>
<td>260,000 to 450,000</td>
<td>500 to 800</td>
<td>60 to 110</td>
<td>0.001</td>
<td>1,600</td>
<td>--</td>
<td>545</td>
<td>McCelland, 1962</td>
</tr>
<tr>
<td>28S/25E-16F</td>
<td>48,000</td>
<td>258,000</td>
<td>860</td>
<td>115</td>
<td>--</td>
<td>2,010</td>
<td>60</td>
<td>300</td>
<td>Todd, 2012</td>
</tr>
</tbody>
</table>
Table 2-1b. Local Aquifer Parameters

<table>
<thead>
<tr>
<th>Well</th>
<th>Estimated Specific Capacity (gpd/ft)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>T26S-R24E</td>
<td>84,000</td>
<td>Davis et. al. 1964</td>
</tr>
<tr>
<td>T26S-R25E</td>
<td>85,000</td>
<td>Davis et. al. 1965</td>
</tr>
<tr>
<td>T27S-R22E</td>
<td>88,000</td>
<td>Davis et. al. 1964</td>
</tr>
<tr>
<td>T27S-R24E</td>
<td>94,000</td>
<td>Davis et. al. 1964</td>
</tr>
<tr>
<td>T27S-R25E</td>
<td>147,000</td>
<td>Davis et. al. 1965</td>
</tr>
<tr>
<td>T27S-R26E</td>
<td>81,000</td>
<td>Davis et. al. 1966</td>
</tr>
<tr>
<td>T28S-R24E</td>
<td>132,000</td>
<td>Davis et. al. 1964</td>
</tr>
<tr>
<td>T28S-R25E</td>
<td>112,000</td>
<td>Davis et. al. 1965</td>
</tr>
<tr>
<td>T28S-R26E</td>
<td>117,000</td>
<td>Davis et. al. 1966</td>
</tr>
<tr>
<td>T28S-R27E</td>
<td>89,000</td>
<td>Davis et. al. 1964</td>
</tr>
</tbody>
</table>

Specific Yield and Storage

Storage of an aquifer is primarily described and quantified by the storativity or the volume of water released from storage per unit surface area of the aquifer per unit decline in hydraulic head. It is important to note that while storativity applies to both confined and unconfined systems, it can be further simplified for these two systems. Storativity accounts for aquifer compression and water expansion (specific storage components), which are the primary factors for estimating storage in confined systems; thus, for confined systems, the specific storage or storage coefficient is most often reported. In contrast, for unconfined systems, the specific yield or effective porosity (gravity-driven dewatering of an aquifer) better represents storativity because aquifer compressibility and water expansion are somewhat negligible in unconfined systems. For unconfined systems, specific yield is most often reported, and is a function of porosity and specific retention.

For confined systems, the aquifer compressibility of the storage coefficient can be further defined as elastic and inelastic skeletal specific storage, where inelastic storage will be lost once compression and dewatering occur. It is estimated that in the Central Valley, the inelastic specific storage typically is 30 to several hundred times larger than the elastic skeletal specific storage (Faunt et al., 2009; Ireland et al., 1984). Where fine-grained deposits with inelastic storage are thick in the aquifer system, water released could be a major source of water, but could also result in a permanent loss in storage capacity of fine-grained sediments.

Specific yield of unconfined zones and the storage coefficient of confined zones within the Subbasin have been estimated by laboratory testing of sample cores, calculation based on lithology type, and groundwater model calibration (Dale, 1966; Davis et al., 1959; Davis et al., 1964; Faunt et al., 2009; DWR, 2013; Todd, 2017 and 2018). Based on the McClelland pumping tests, storage is estimated at 0.001, which is within the range of values published for semiconfined to confined aquifers (Todd, 1980).
2.2.3.5 Geologic Features that Significantly Affect Groundwater Flow

Folds

Numerous geologic structures are present in the Subbasin, some of which, including faults and folds, may affect groundwater flow. These features are shown for the study area in Figure 2-8 (Bartow, 1991). A basin-scale version of this map with descriptions of geologic formations is included in the umbrella section of the GSP.

According to Bartow (1991), NKWSD and SWID are in the southwestern corner of the southern Sierran block, which is bounded by the westside structural zone to the west and the Bakersfield Arch to the south. The southern Sierran block is the stable, little-deformed east limb of the valley syncline (Bartow, 1991); however, some minor folding occurs within SWID (southwest of the Greeley Fault, and south of Shafter), and is the eastern expression of the boundary of the westside structural zone. Although Page (1986) and DWR (2006) identified some anticlinal folds of the westside as restrictions to groundwater flow, it is unknown if the folds underlying SWID affect flow.

Underlying the southern half of the study area, is the northern flank of the Bakersfield Arch (Figure 2-8) which separated deposition and sedimentation in the valley, from the middle to late Miocene time to Pleistocene. To the south of the Kern River was the Tejon depocenter and to the north was the Buttonwillow depocenter (Vasconcellos, 2016). The arch is not a barrier to flow but does represent one part of the upgradient topographic high that allows water to flow from the river, northward into the study area.

Faults

Regarding faulting in the study area, Faunt et al., (2009) included four northwest-trending “potential horizontal flow barriers” in the groundwater Central Valley Hydrologic Model (CVHM) near Semitropic Ridge and Buttonwillow Ridge and east toward Pond-Poso Fault. Based on Bartow (1991), Lamar et. al. (1983), and CGS (2018), there are four major faults, from southwest to northeast, that are likely the Semitropic anticline fault system (two faults at Buttonwillow and Semitropic ridges), the Greeley fault system, and the Pond Fault (a part of the Pond-Poso Fault System), respectively. Although these faults are reported in regional datasets, LADWP (1974), indicates that Semitropic anticline fault system and Greeley fault system do not show displacement in sediments shallower than 10,000 feet (well below the base of USDW), and, are therefore, not directly impactful to groundwater flow in the Subbasin.

On the other hand, the Pond-Poso Fault System reportedly affects groundwater flow. The Pond-Poso Fault system is a zone of four subparallel breaks/faults 2/3 mile in width, which extends from just east of Trico anticline (T25S-R24E) southeasterly approximately 48 miles through the Poso Creek oil field to the base of the Sierra Nevada (LADWP, 1974). Based on seismic reflection lines and vibratory seismic profile lines, the Pond-Poso Fault dips southwesterly at 50 to 70 degrees. LADWP (1974) and Holzer (1980) documented approximately 30 to 65 feet of difference in water levels across the fault zone, respectively from 1974 and 1978 studies. Holzer (1980) observed that fault offset of groundwater levels
was greater during dry years when the lowest seasonal water level low occurred. The Pond-Poso Fault System is also documented to offset sediment in the subsurface. This vertical offset of sediment ranges from approximately 20 to 80 feet in the upper 1,000 feet of the subsurface (LADWP, 1974 and PGA, 1991), and the displacement decreases northwesterly along the fault system (LADWP, 1974). Exploratory trenches documented offset of 9 inches at 10 feet depth, and slickensides in the trenches show near vertical, oblique slip movement (LADWP, 1974). Coincidentally, Holzer (1980) concluded that 9 inches of offset had occurred along the Pond-Poso Fault System since the 1950’s. Holzer (1980) observed fault movement from February 1977 to March 1979 during seasons of water level decline.

**Cross Sections with Structures that Affect Groundwater Flow in NKWSD/SWID**

The purpose of developing cross sections for this management area plan was to identify prevailing conditions that affect groundwater flow and groundwater quality in the study area, and not to focus on correlating detailed stratigraphy. Furthermore, sediments underlying the study area are highly lenticular and, although some locally continuous clays are present, the eastern extent of the E-clay or other equivalent confining beds is debatable (Logan, 1992); thereby making accurate correlations difficult.
However, to provide context for groundwater flow within the study area, a brief discussion of correlated stratigraphy in the literature is provided below, with the understanding that developed cross sections for this management area plan do not fully attempt to correlate stratigraphy across the study area.

**Historical Cross Sections**

Selected historical cross sections (NKWSD, 2012) provide some detail on the lenticular nature of sediments underlying the study area. Broad clay layers (300-foot clay and 700-foot clay) in A-A’ and C-C’ (NKWSD, 2012) may act as semiconfining beds in some portions of SWID and NKWSD (Logan, 1992), but they are not laterally continuous and do not significantly divide the aquifers as does the Corcoran Clay westward in SWSD. As reported by many USGS investigators as well as Logan (1992), the alluvium on the eastern half of the basin is made up of coalescing deposits of ancient Kern Fan and Poso Creek Fan deposits, as well as alluvial fan deposits from other drainages along the eastern margins. Northward from the study area, the Corcoran Clay has been correlated by USGS (Croft, 1972) and others (Lofgren and Klausing, 1969). A generalized cross section West to East was included in SWID’s groundwater management plan (SWID, 20017), and it shows the Corcoran Clay is more prominent just north of the study area, as well as the Santa Margarita Sand and Olecese Sands that are aquifers further east from the study area.

Cross sections developed by Croft (1972) delineate oxidized and reduced alluvium underlying the study area. Alluvium may range up to 700 feet in depth in the study area (D-D’) and 550 feet in depth in H-H’. Oxidized deposits near the Pond Fault may be as deep as 1150 feet in H-H’; these oxidized sediments make up the deposits associated with alluvium of the Poso Creek Fan. The reduced sediments are associated with finer grained deposits of lacustrine and flood over bank deposits, while oxidized alluvium is more common in areas of deposition that were higher energy and more exposed to oxidative atmosphere. Below the alluvium are continental deposits of either Tulare Formation or Kern River Formation (Section D-D’; Croft, 1972). Croft’s section shows very little correlation of the E-Clay eastward into SWID; however, Page (1986) correlates the modified E-Clay to just east of Wasco and just west of Shafter. In addition, PGA’s (1991) C-C’ cross section also suggests the Corcoran Clay may be further east than documented by Page; however, PGA’s Corcoran correlations have been controversial with previous investigators due to the lack of lithologic well log data tie-ins and the general interpretation that often disagrees with Page’s (1986) conclusions.

PGA’s (1991) C-C’ reports displacement across the Pond-Poso fault zone near the northeast part of NKWSD. This displacement was reported based on examination of seismic data during development of basin-wide correlations (PGA, 1991). PGA’s magnitude of displacement across the fault is consistent with LADWP (1974) (20 to 80 of displacement), except that LADWP reported the fault zone dipping to the southwest.

**Current Cross Sections**
Cross sections for NKWSD and SWID are provided as Figures 2-9 and 2-10 of this management area plan. A geologic index map displays the locations of these cross sections with mapped geologic features (Figure 2-11). Cross section A-A’ is northeast trending to be perpendicular to faults, folds, and the axis of the valley. Cross section B-B’ are northwest trending to be parallel to the folds and axis of the valley. The cross sections include surficial geology along with folds and faults by the California Geological Survey (CGS, 2010a, b), the base of fresh groundwater (Page, 1973), the E-Clay confining layer (DWR, 2018), groundwater elevations for the upper and lower aquifer zones, and general interpretations of faults and folds underlying SWSD. The E-Clay data on the cross sections represent the C2VSim Corcoran model layer. The C2VSim Corcoran model layer was compared with the CVHM model layer (USGS, 2018) and mapped Page (1986) modified “E” clay extent and was found to be in general agreement. The C2VSim Corcoran layer was chosen because C2VSim fine-grid model is the basis for the Kern County Subbasin groundwater model. The cross sections also include a representation of general well construction across the study area. Seismic form lines by data correlations from PGA (1991), are included to depict the general bedding and dips of sediment in the subsurface. These seismic forms also agree with general cross sections from B-E (1968) for nearby SWSD.

Discussion

The following are observations, when comparing both historical and current cross sections underlying NKWSD and SWID:

1. Eastward, from SWSD, it appears the E-Clay shallows, thins and becomes an ineffective confining bed. In general, the major aquifer is considered one zone that becomes semiconfined with depth due to various discontinuous clay layers. Lenses of semi-continuous fine-grained beds such as the modified E-Clay of Page (1986) in SWID, or the “300-foot clay” or “700-foot clay” in SWID and NKWSD (NKWSD, 2012), provide some confinement of underlying aquifers.

2. The base of freshwater (Page, 1973), deepens eastward from SWID into NKWSD, where a deep north-northwestward trending “trough” of freshwater is observed in the central portion of NKWSD.

3. In the northeast area of NKWSD, the Pond-Poso Fault system displaces beds approximately 20 to 80 feet on the southwest side of this normal fault system (LADWP, 1974 and PGA, 1991). The Pond-Poso fault has been reported to alter horizontal flow of groundwater (Holzer, 1980); however, data reported on cross sections were insufficient to show this level of detail.

2.2.3.6 General Water Quality of Principal Aquifers

A general summary of water quality variation both laterally (from west to east across the Subbasin) and vertically (shallow–deep within the Subbasin) is provided in the water quality section of this report. In general, water quality is poor in the shallow water above the Corcoran Clay or equivalent “300-foot clay” and is fresher below the clay and eastward into the main trough of freshwater underlying NKWSD. Below is a summary:

- Elevated nitrate levels are typically due to surface contamination and have been more prevalent in shallower wells or in areas where a confined aquifer is not present.
- TCP contamination is widespread throughout the Subbasin, but there appears to be less occurrence in the Study Area where the Corcoran Clay or “300-foot clay” is present.
- Salinity tends to decrease near spreading grounds where freshwater is introduced to the aquifer system.
- A salinity plume on the southeast of NKWSD is underlain by fresher water so it is assumed that the salinity is due to unknown anthropogenic factors.
- Arsenic decreases as depth below confining clays increase. Arsenic increases in unconfined shallow wells as water levels drop and becomes closer to confining clays.

2.2.3.7 Primary Use of Each Principal Aquifer

The unconfined zone to the east of the Corcoran Clay and the production zone beneath and outside the extent of the Corcoran Clay are the key zones within the study area that provide the bulk of water production for beneficial use. The primary uses of the Subbasin aquifer system include agricultural, municipal, domestic, and storage for the banking of surface water.

2.2.3.8 Summary of Beneficial Uses and Users of Groundwater

Land use in the Subbasin includes agriculture, urban/industrial/residential, and open space use. According to the 2014 SGMA legislation, beneficial users of groundwater and property interests potentially affected by using groundwater include:

- Agricultural Users
- Domestic Users
- Municipal Well Operators
- Public Water Systems
- Local Land Use Planning Agencies, and
- Environmental Users
According to DWR well completion reporting and the CASGEM program, groundwater wells are constructed for a variety of uses including:

- Domestic / Residential
- Irrigation
- Stock
- Municipal / Public
- Monitoring / Observation
- Industrial, and
- Other / Unknown

### 2.2.4 Data Gaps in the Hydrogeologic Conceptual Model

The primary data gaps in the hydrogeologic conceptual model include:

- Groundwater Upper and Lower Zone characterization in the northwestern portions of NKWSD and SWID where the Corcoran Clay may be present and mapped Upper and Lower zones are reported in neighboring SWSD.
- Aquifer properties including hydraulic conductivity and storage properties of any upper unconfined zones as well as the main production zone of NKWSD and SWID.
- Physical properties of any confining clay layer within NKWSD and SWID.
- Groundwater quality of the primary aquifer zones and confined zones on the eastern and western flanks of the Subbasin, from wells screened solely in a single aquifer zone.

### 2.2.5 Mapped Physical Characteristics

#### 2.2.5.1 Topographic Information

Figure 2-12 presents a topographic map of NKWSD and SWID’s administrative area and the adjacent areas within the Subbasin.

NKWSD is located just east of Shafter and Wasco, west of Famoso, and south of McFarland. NKWSD is about 20 miles in length (North to South) by 7 miles wide (West to East). The general ground surface slopes to the northwest with an elevation ranging from approximately 425 feet above sea level to 275 feet above sea level. The Friant Kern Canal (FKC) flows southward through the district, while the Calloway and Lerdo canals provide water northward into the district. Spreading basins along Calloway Canal, Lerdo Canal, and Poso Creek provide recharge to the underlying aquifer.

SWID is located about 20 to 25 miles northwest of Bakersfield. SWID is about 8 miles wide (east to west) by 11 miles long (North to South). Highway 43 runs through SWID from south to north through the towns of Shafter and Wasco. The general ground surface slope of the district is west at the rate of
about 10 to 15 feet per mile (USBR, 1953). The elevation ranges from 350 feet above sea level to 275 feet above sea level (USBR, 1953).

### 2.2.5.2 Surficial Geology

As described in the umbrella setting, the surficial geology of the Subbasin has been documented in a variety of previous investigations by Bartow (1991), Page (1986), and CGS (2010a). According to the CGS (2010a) (Figure 2-11), the district is underlain by Pleistocene to Recent unconsolidated and semi-consolidated alluvial (Q), lake, playa, and terrace deposits. Bartow (1991) provides a similar map (Figure 2-8) as the CGS map but refers to Quaternary alluvial and lacustrine sediments (Qs). As discussed further below, Bartow showed the location of the Bakersfield Arch as well as three structural regions within the Subbasin.

Page (1986) provides a somewhat different interpretation of the surficial geology, as discussed in the KGA GSP Basin Setting. The study area is underlain by Miocene to Recent continental deposits (QTc) – a heterogenous mixture of gravel, sand, silt, and clay with some layers of conglomerate, sandstone, siltstone, and claystone. Near the Kern River, recent river deposits (Qr) are shown as a long, narrow strip from the mouth of the Kern Canyon, and are comprised of gravel, sand, silt, and minor amounts of clay. The center of the valley floor is underlain by recent flood basin (Qb) – clay, silt, and some sand; and by Pliocene to Recent lacustrine and marsh deposits (QTl) – clay, silt, and some sand with extensive subsurface clay layers (A-, C-, E- Clays). The former unit is associated with the original Kern River drainage and flood basin while the latter unit is associated with the historical Kern Lake Bed, Buena Vista Lake Bed, Goose Lake Beds, and the southern edge of the Tulare Lake Bed. Like the other maps, remnants of older continental deposits are shown along the rim of the Subbasin, primarily the southeastern side, including Oligocene to Miocene deposits (Tcmo) of gravel, conglomerate, sand, and clay; and Eocene to Miocene deposits (Tcme) of conglomerate, sandstone, fanglomerate, claystone, and breccia plus limited occurrences of undifferentiated marine deposits (Tm) of sand, clay, silt, sandstone, shale, mudstone, and siltstone of Eocene to Pliocene ages.

### 2.2.5.3 Soil

Soils within the study area can be categorized into three types according to texture, a measure which is indicative of other characteristics such as electroconductivity (EC) and acidity (pH). Fine to coarse sand and gravel throughout the Poso Creek Fan underlying much of SWID and NKWSD. Fine-textured soils are present in the southeast corner of NKWSD in between the Poso Creek Fan and Kern River Fan. The majority of the area includes medium- to coarse-textured soils which are relatively low in salinity and within the optimal pH range for crop production, except in the areas where finer grained soil is present.

Soils in the valley floor have two general origins. The eastern alluvial fans were deposited primarily by runoff from the Sierra Nevada, Tehachapi, and Transverse mountain ranges. These soils originate from mixed igneous and metamorphic material and are typically well drained, and very low in salinity. The western alluvial fans originated from Coastal Range sedimentary marine rocks. This region tends to have more areas with fine-textured, poorly drained soils of relatively marginal quality. Detailed soil
survey data for the entire study area can be found in two USDA reports: *Soil Survey of Kern County, California* (USDA, 1988 and 2007), including recent online updates.

**Hydrologic Soils Groups**

For the purposes of SGMA, a useful index of a soil’s capacity to infiltrate precipitation and applied irrigation water is the NRCS Hydrologic Soils Group classification. Hydrologic Soils Groups typical of the Study area are defined below and are displayed on Figure 2-13 – Hydrologic Soils Groups - which was developed using data from the NRCS’ Soil Survey Geographic Database (SSURGO).

- Hydrologic Group A – “Soils in this group have low runoff potential when thoroughly wet. Water transmitted freely” (NRCS, 2012). Group A soils have a high infiltration rate due to well drained sands or gravelly sands giving the group the highest potential for contributing to groundwater recharge.

- Hydrologic Group B – “Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission is unimpeded” (NRCS, 2012). Group B soils are moderately well drained due to moderately fine to coarse textures and have the second highest potential permeability and potential for contributing to groundwater recharge. These soils are present on the east, west, and south sides of the valley floor.

- Hydrologic Group C – “Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission is somewhat restricted” (NRCS, 2012). This group has limited potential to contribute to groundwater recharge. Group C soils have a low infiltration rate due to their fine texture or because of a layer that impedes downward movement of water. These soils are present along the valley floor, along the eastern highlands, and at various locations along the northwestern side of the Study area.

- Hydrologic Group D – “Soils in this group have high runoff potential when thoroughly wet. Water transmission is very restricted” (NRCS 2012). This group has a very limited capacity to contribute to groundwater recharge. These soils have a very slow infiltration rate due to the presence of clay and are located primarily along the northern boundary of the Study area.

**Taxonomic Soil Orders**

Figure 2-14 displays taxonomic soil orders for the study area north of the Kern River, as defined by the Soil Survey Geographic Database (SSURGO) mapping obtained from the DWR SGMA Data Viewer website (2018). This figure shows six soil orders with the most prominent being Aridisols and Entisols and Inceptisols along the eastern highland mixed with Alfisols, Mollisols, and Vertisols. Based on the NRCS publication *Keys to Soil Taxonomy* (NRCS, 12th edition, 2014), the following characteristics are associated with each of these soil types:
• Ardisols are dry soils characterized by a low humus, light colored surface horizon with a subsurface accumulation of soluble salts, silicate clays, and possibly a cemented layer of calcium carbonate, calcium sulfate (gypsum) or silica.
• Entisols are characterized by the absence of soil horizons due to recent deposition or active erosion under extreme wet or dry conditions.
• Inceptisols exhibit a weak appearance of soil horizons overlying a weathering-resistant parent material.
• Alfisols are characterized by well-developed soil horizons enriched with aluminum- and iron-bearing (Al/Fe) minerals but depleted of calcium carbonate. Translocated clays typically form a layer with relatively high amounts of mineral nutrients (calcium, magnesium, sodium, and potassium).
• Mollisols are characterized by a thick, dark surface horizon of humus, which typically originates from native grass vegetation with mineral nutrients present in most horizons.
• Vertisols are clay-rich soils (>30%) with significant cracking during the dry season due to the shrink-swell response of the clay minerals during the dry and wet seasons. The shrink-swell action produces significant vertical mixing of the soil.

2.2.5.4 Natural Recharge, Direct Recharge Areas, and Potential Recharge Areas

In the Subbasin, there are multiple sources of groundwater recharge. This section differentiates between natural recharge, direct recharge, and in-lieu recharge. It also discusses the identification of potential recharge areas.

• Natural recharge occurs by groundwater underflow from adjacent sources, precipitation exceeding evapotranspiration to allow deep percolation in a Subbasin, or from deep percolation of natural surface waters flowing into the Subbasin.
• Direct recharge is either planned or unplanned deep percolation of surface water from unlined conveyance, field application, managed recharge, and spreading operations.

In-lieu recharge refers to instances where surface water is applied to lands that otherwise would have been irrigated using groundwater. Imported surface water for in-lieu recharge to the study area is conveyed through the same pipelines and canals as contracted imported water. These conveyances are described in the surface water bodies section of this management area plan. In-lieu recharge will be further discussed in the water budget section of this management area plan because it is an accounting aspect of water input to the basin. It represents the application of surface water for use to meet water demands and does not represent direct recharge to the subsurface for the purposes of replenishing aquifers, although it benefits the aquifer system by alleviating groundwater pumping demand. Natural Recharge

As discussed in the KGA GSP Basin Setting, natural recharge to the Subbasin occurs mainly by underflow or surface recharge from the eastern and southern highlands (Sierra Nevada and Tehachapi
Mountains). The surface water bodies as a source of recharge are shown in Figure 2-15 discussed in the next section.

Fresh water primarily recharges the aquifer underlying the districts, from the south and east where the E-Clay or other equivalent beds “300-foot clay” are either not present or are not effective confining units. These areas of recharge extend from the Kern River and Poso Creek through the fans of alluvium spreading out from these tributaries.

In general, natural recharge by precipitation is minimal in the study area, and may only occur in extreme wet years, because typically evapotranspiration exceeds the amount of natural precipitation to the Subbasin (Provost and Pritchard et. al., 2015).

**Direct Recharge**

In NKWSD, direct recharge to groundwater occurs from infiltration through unlined canals, applying water to over 1,500 acres of district spreading grounds, and application of irrigation water in excess of the combined evaporation and crop transpiration of irrigated land which migrates below the root zone. Figure 2-15 presents the major unlined canals (Calloway and Lerdo) that may contribute to recharge, as well as the spreading basins along Poso Creek (Poso 27, Switch Field, and Minter Field), Lerdo Canal (Wright Field), and Calloway Canal (Rosedale Spreading Grounds).

Direct recharge to groundwater occurs in SWID from infiltration by applied water to the district’s recharge basin off the Calloway Canal between Shafter and Wasco, and by application of irrigation water more than the total ET of farmland that migrates below the root zone. Figure 2-15 presents the location of Kimberlina Spreading Grounds in SWID, near the boundary between SWID and NKWSD.

Direct recharge also occurs as managed and unmanaged recharge through natural waterways such as the dry channel of Poso Creek, percolation of applied surface water that descends below crop root zones, and other minor unlined canals (Figure 2-15).

**Potential Recharge Areas**

As described in the KGA GSP Basin Setting, the Soil Agricultural Groundwater Banking Index (SAGBI), may further estimate groundwater recharge suitability; however, the dataset may be limited to the shallow subsurface at or just below the root zone (O’Geen et al, 2015). The California Soil Resource Lab at University of California Davis has developed an online application ([https://casoilresource.lawr.ucdavis.edu/sagbi/](https://casoilresource.lawr.ucdavis.edu/sagbi/)) to present the SAGBI, which estimates groundwater recharge suitability based on five major factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

The UC Davis mapping coverage of the SAGBI indicates a moderately good to excellent rating for the Poso Creek alluvial fan underlying SWID and NKWSD and the Kern River alluvial fan to the south of the districts. SAGBI ratings are moderately poor to very poor along the eastern and central western margins of the basin.
2.2.5.5 Surface Water Bodies and Supplies

Figure 2-16 presents the location of surface water bodies in NKWSD and SWID according to the National Hydrography Dataset (NHD). Surface water bodies in or bordering the districts include the FKC, Lerdo Canal, Calloway Canal and Poso Creek. Although the Kern River doesn’t flow through either district, it is the most important local source of surface water to Kern County and to NKWSD. The Kern River has been regulated by the Isabella Dam and Reservoir since 1954. The dam and reservoir are operated by the U.S. Army Corps of Engineers and the distribution of water is administered by the Kern River Water Master.

Poso Creek and the Kern River provide local surface water during the wet season and during above normal and wet water years. Irregularly occurring flows are captured, to the degree possible, by spreading grounds and recharge facilities as described above in each district (Figure 2-15).

The Calloway, Friant-Kern, and Lerdo canals run north-south through NKWSD; Poso Creek runs northwest through the north part of NKWSD; and the Kern River is south of the District, all as shown on Figure 2-15 and 2-16.

2.2.5.6 Source and Point of Delivery for Surface Water Supplies

SWID and NKWSD use both groundwater and surface water, from local and imported sources. Poso Creek and other minor streams contribute occasionally, and water produced from the operation of the Kern Front State-Designated Oilfield is an additional source of imported supply for NKWSD. Figure 2-17 displays the location of the points of delivery (turnouts) for surface water supplies for each respective district.

The principal surface water supply for NKWSD is the Kern River, which is diverted and delivered northward into the District through a largely open canal, gravity system, which consists mainly of Beardsley/Lerdo Canal and Calloway Canal. NKWSD holds contracts for both Class 1 and Class 2 water and takes advantage of additional supplies from the State Water Project (SWP) and the Central Valley Project (CVP), either directly or through exchanges with other agencies. Poso Creek, although relatively small and infrequent amounts, is also a source of local surface water to NKWSD.

Imported water is supplied to SWID by the CVP from the Friant Division. The FKC is a feature of the CVP. The canal diverts water from Millerton Reservoir, created by Friant Dam on the San Joaquin River, and extends southward a distance of 152 miles through Fresno, Tulare, and Kern counties to its terminus at the Kern River near Bakersfield. Water districts along the east side of the San Joaquin Valley entered into long-term water supply contracts with the Bureau of Reclamation, which provide for the delivery of three types of water; Class 1, Class 2, and Section 215. SWID holds a contract for Friant Division for both Class 1 and Class 2 water. Figure 2-17 shows the FKC and indicates where water from this canal is delivered to SWID.

NKWSD is not a long-term CVP contractor; therefore, it does not receive CVP water unless purchases are made for Section 215 water. This does occur from time to time; the circumstances in which this may
occur are described in the section below. NKWSD, through its banking exchange program, also receives other CVP water from districts which have agreements with NKWSD. In addition to occasional Section 215 water purchases, NKWSD imports oilfield produced water.

**Section 215 Water**

Section 215 water is available in exceptionally large water supply years and in infrequent and otherwise unmanaged flood flows of short duration. This category of water is not storable for project purposes (i.e., for meeting contract obligations for Class 1 and Class 2 water). Section 215 water can be made available under temporary contracts to districts who are not long-term Friant contractors, a mechanism NKWSD, who is not a long term CVP contractor, has exercised. The historical allocation priorities for section 215 water are as follows:

1. Long-term contractors;
2. Cross Valley contractors;
3. Other parties within the Friant Division service area with direct delivery capabilities;
4. CVP contractors outside of the Friant Division service area; and
5. Other parties.

NKWSD has purchased CVP water that has been available from time to time, typically during the peak runoff period of wet years. Since exchanges occur, it should be noted that NKWSD has constructed two turnouts from the FKC to facilitate these purchases. These turnouts are also to facilitate banking and exchange arrangements with neighboring districts. Figure 2-17 shows the FKC and indicates where water from this canal is delivered to NKWSD.

### 2.3 Current and Historical Groundwater Conditions

#### 2.3.1 Groundwater Trends

Annual groundwater elevation contour maps covering much of NKWSD and SWID have been prepared by Schmidt and Associates since the 1990s, on behalf of the Semitropic Monitoring Committee, and KCWA in water supply reports since before the 1990s. These maps are included in Appendix D. They illustrate seasonal high groundwater level conditions from winter and spring water level data, prior to most active groundwater pumping and growing season.

Below is a generalized diagram of groundwater flow in the Subbasin (Figure 2-18). In the absence of pumping or significant barriers, groundwater naturally flows from high elevation points of recharge to lower elevation points with less recharge. Based on a review of the 1995 to 2017 Schmidt and Associates maps and historical groundwater data from USGS and KCWA (Page, 1986; and KCWA, 2018), groundwater generally flows westward from the Sierra Nevada and Kern River. Groundwater flows from natural and managed recharge points along the Kern River, which is situated on the Bakersfield Arch and has a broad topographical rise that gradually dips to the north and south of the river; thus, the rough alignment of the river effectively splits the Subbasin into Northern and Southern
groundwater areas. To the north of the river, groundwater flows from the uplands along the east margins of the Subbasin toward the west and northwest until it leaves the Subbasin as subsurface underflow or is captured by pumping wells for irrigation or potable consumption. Figure 2-18 below presents the approximate location of the San Joaquin Valley (Buttonwillow) Syncline. The syncline likely negates the potential flow of saline connate water of the westside from significantly impacting groundwater in the main production zone of the Subbasin.

As observed in cross sections, the seismic form correlations confirm the general flow direction of groundwater and the general topographic high of the Bakersfield Arch with bedding gradually dipping northerly on the northside of the Arch, and southerly on the south side of the Arch. Cross sections also depict some of the highs of the anticlines and the low of the Buttonwillow Syncline. In general, groundwater elevations near the river tend to respond to flow in the river channel and the management of groundwater banking projects located near the river, whereas, groundwater elevations further away from the river show more pronounced seasonal responses from pumping and recharge.

Figure 2-18 Generalized Groundwater Flow in Kern County Subbasin

The following sections include the discussion of groundwater elevation contours, hydrographs, and other details to present the historical and current groundwater conditions within NKWSD and SWID.
2.3.1.1 Groundwater Elevation and Flow Directions (Groundwater Contour Map)

Groundwater elevation contour maps were prepared for Spring 2015 (seasonal high) (Figure 2-19) as well as Fall 2015 (seasonal low) (Figure 2-20). In general, flows were consistent with historical trends. For more details on regional groundwater flow, refer to the umbrella basin discussion. Below is a description of groundwater trends for NKWSD and SWID.

2.3.1.2 Groundwater Trends in NKWSD

In general, the prevailing groundwater gradient is west to northwest toward the trough of the valley. Figure 2-19 shows groundwater elevation contours in the district and surrounding areas for spring 2015. Groundwater flow direction is west to northwest indicating subsurface underflow/outflow through the district. This generalized pattern of groundwater underflow has persisted for many years and is consistent with historical water supply reports from KCWA and Schmidt and Associates (NKWSD, 2012).

Elevations ranged from 140 feet mean sea level in the southeast to less than -50 feet msl northwest along Sherwood Avenue in 2015. The horizontal gradient to the west and northwest was approximately 0.002 ft/ft.

Figure 2-20 shows groundwater elevation contours in the district and surrounding areas for fall 2015. Groundwater flow direction is northwest indicating subsurface underflow/outflow through the district. Elevations ranged from less than 120 feet mean sea level in the southeast to less than -10 feet msl northwest. The horizontal gradient to the northwest was approximately 0.002 ft/ft.

2.3.1.3 Groundwater Trends in SWID

In general, the prevailing groundwater gradient is west to northwest toward the trough of the valley. Figure 2-19 shows groundwater elevation contours in the district and surrounding areas for spring 2015. Groundwater flow direction is from southeast to northwest indicating subsurface underflow/outflow through the district.

Groundwater elevations ranged from 60 feet mean sea level in the southeast to less than -60 feet msl northwest of Wasco. The horizontal gradient to the west and northwest was approximately 0.0017 ft/ft.

Figure 2-20 shows groundwater elevation contours in the district and surrounding areas for fall 2015. Groundwater flow direction is northwest indicating subsurface underflow/outflow through the district. Elevations ranged from less than 60 feet mean sea level in the southeast to less than -110 feet msl in the northwest. The horizontal gradient to the northwest was approximately 0.002 ft/ft.

2.3.2 Hydrographs

Hydrographs provided in Appendix E present groundwater elevations versus time with corresponding water years. In general, groundwater levels decline during dry years and increase during wet years based on the availability of imported surface water supplies. As a reference for recent surface supply water
years, the Figure 2-21 below presents the water year indexes from 1995 to 2017 for both the Sacramento Valley Index (typically representative of the State Water Project allocations), and the San Joaquin Valley Index (typically representative of the FKC allocations). The 23-year period (1995-2017) started with six years of wet to above-normal years followed by 12 of the final 17 years as below normal to critically dry years. The implementation of SGMA (2015) began with critically-dry and dry years midway through a historic 5-year drought period.

<table>
<thead>
<tr>
<th>Water Year</th>
<th>Sacramento Valley</th>
<th>San Joaquin Valley</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Wet</td>
<td>Wet</td>
</tr>
<tr>
<td>1996</td>
<td>Wet</td>
<td>Wet</td>
</tr>
<tr>
<td>1997</td>
<td>Wet</td>
<td>Wet</td>
</tr>
<tr>
<td>1998</td>
<td>Wet</td>
<td>Wet</td>
</tr>
<tr>
<td>1999</td>
<td>Wet</td>
<td>Above Normal</td>
</tr>
<tr>
<td>2000</td>
<td>Above Normal</td>
<td>Above Normal</td>
</tr>
<tr>
<td>2001</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>2002</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>2003</td>
<td>Above Normal</td>
<td>Below Normal</td>
</tr>
<tr>
<td>2004</td>
<td>Below Normal</td>
<td>Dry</td>
</tr>
<tr>
<td>2005</td>
<td>Above Normal</td>
<td>Wet</td>
</tr>
<tr>
<td>2006</td>
<td>Wet</td>
<td>Wet</td>
</tr>
<tr>
<td>2007</td>
<td>Dry</td>
<td>Critical</td>
</tr>
<tr>
<td>2008</td>
<td>Critical</td>
<td>Critical</td>
</tr>
<tr>
<td>2009</td>
<td>Dry</td>
<td>Below Normal</td>
</tr>
<tr>
<td>2010</td>
<td>Below Normal</td>
<td>Above Normal</td>
</tr>
<tr>
<td>2011</td>
<td>Wet</td>
<td>Wet</td>
</tr>
<tr>
<td>2012</td>
<td>Below Normal</td>
<td>Dry</td>
</tr>
<tr>
<td>2013</td>
<td>Dry</td>
<td>Critical</td>
</tr>
<tr>
<td>2014</td>
<td>Critical</td>
<td>Critical</td>
</tr>
<tr>
<td>2015</td>
<td>Critical</td>
<td>Critical</td>
</tr>
<tr>
<td>2016</td>
<td>Below Normal</td>
<td>Dry</td>
</tr>
<tr>
<td>2017</td>
<td>Wet</td>
<td>Wet</td>
</tr>
</tbody>
</table>

Source: http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

**Figure 2-21. Water Year Index (1995 to 2017)**

Figure 2-22 below is an example hydrograph from the study area showing that groundwater elevations decline during dry years when surface water supplies are generally less available, and groundwater elevations recover or increase during wet years when more surface water supplies are available.
Figure 2-22. General Hydrograph Trends by Year

2.3.2.1 NKWSD Hydrographs

A complete set of hydrographs for data in the DMS is contained in Appendix E.1. A select group of representative hydrographs with a summary table of well data are included in the Appendix E.2 and are discussed below. These representative hydrographs were selected from a group of district-owned supply wells that are routinely monitored and included in historical hydrographs.

T26S-R25E. Hydrographs represent wells in the northern portion of the study area. The magnitude in seasonal drawdown and rise and fall of water levels between wet and dry years may indicate extensive pumping and confining conditions.

T27S-R25E. Hydrographs represent wells in central NKWSD south of Poso Creek. The magnitude in seasonal drawdown and rise and fall of water levels is not as large as northern portion of the district, but data may indicate extensive pumping and confining conditions.

T28S-R25E. Southeast of Shafter in western NKWSD shows less seasonal drawdown in some wells and a smaller response in water level change between dry years and wet years. These trends may indicate more semiconfined to unconfined conditions with a few wells perforated in more confined intervals.

T28S-R26E. Southern NKWSD, north of 7th Standard road shows less seasonal drawdown a smaller response in water level change between dry years and wet years. These trends may indicate semiconfined to unconfined conditions.

Overall, for all areas of NKWSD, water levels are declining in dry years, and stabilizing or increasing in wet years.
2.3.2.2 SWID Hydrographs

A complete set of hydrographs for data in the DMS is contained in Appendix E.1. A select group of representative hydrographs with a summary table of well data are included in the Appendix E.2 and are discussed below. These representative hydrographs were selected from wells with more data reported from 1995-2015 than most wells, and in general are well data that are available through CASGEM.

Group 1. West of Wasco. Sections 3 to 10 of T27S-R24E. The magnitude in seasonal drawdown and rise and fall of water levels between wet and dry years may indicate extensive pumping and confining conditions.

Group 2. South of Shafter. Sections 22 to 28 of T28S-R25E. These hydrographs show less seasonal drawdown in some wells and a smaller response in water level change between dry years and wet years. These trends may indicate semiconfined to unconfined conditions.

Group 3. Central-Western SWID. Sections 1 and 2 of T28S-R24E and Sections 34 and 35 of T27S-R25E. These hydrographs show more seasonal drawdown than Group 2. These trends may indicate extensive pumping and semiconfined to confined conditions.

Overall, water levels in SWID are declining in dry years and stabilizing or increasing in wet years.

2.3.3 Change in Groundwater Storage

Change in groundwater storage is estimated at the umbrella level of the GSP. Included with the description are graphs of the change in groundwater storage over the study time period of 1995 through 2015.

Historical changes in groundwater elevation maps for NKWSD and SWID are documented in Appendix C. As observed with the change in elevation maps and hydrographs, groundwater storage is reduced during “dry” water years when imported surface water deliveries are limited, resulting in greater reliance on pumping groundwater to meet water demands.

2.3.4 Seawater Intrusion

Seawater intrusion is not applicable to Kern County Subbasin. The Coast Ranges are a barrier to groundwater flow that separates seawater from the Subbasin.

2.3.5 Groundwater Quality

The purpose of this groundwater quality section is to discuss groundwater quality issues that may affect the supply and beneficial uses of groundwater as stated under CCR §354.16. This section includes a discussion of water quality standards used and information relevant to capturing the groundwater quality in NKWSD and SWID boundaries.
Public Water Systems

While land use within NKWSD and SWID is predominately agricultural, there are 14 public water systems that are located within the District’s service area identified through GAMA. Six of these water systems are classified as community water systems, meaning that there are at least 15 service connections, or 25 year-round residents are served. The remaining public water systems are either Non-Transient Non-Community (NTNC) or Transient Non-Community water systems (TNC). This classification is generally designated for businesses who supply water to their employees, or a transient (pass through) population. Tables 2-2 and 2-3 list the public water systems with a brief description, classification, and estimated population served. Figure 2-23 shows where they are located within the District boundaries. City of Shafter is in both Districts, with their wells primarily located in SWID service area.

Water quality data from regulated drinking water systems is available through the State Drinking Water Information System (SDWIS). Community NTNC water systems are required to test for most regulated constituents at least once every 3 years. TNC have less stringent monitoring requirements and typically only test for nitrate and bacteria on a regular basis.
Table 2-2. Public Water Systems Within NKWSD

<table>
<thead>
<tr>
<th>Water System #</th>
<th>Water System Name</th>
<th>Type</th>
<th>Population Served</th>
<th>Service Area</th>
<th>Number of Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>1502826</td>
<td>B&amp;J Land Company</td>
<td>TNC</td>
<td>NT=5; T=225</td>
<td>Other Transient</td>
<td>1</td>
</tr>
<tr>
<td>1510019</td>
<td>City of Shafter</td>
<td>C</td>
<td>19,100</td>
<td>Residential</td>
<td>6</td>
</tr>
<tr>
<td>1502033</td>
<td>Golden State Vintners – Franzia McFarland</td>
<td>TNC</td>
<td>NT=20; T=13</td>
<td>Industrial/Agricultural</td>
<td>1</td>
</tr>
<tr>
<td>1503657</td>
<td>Kimberlina Housing Unit</td>
<td>TNC</td>
<td>26</td>
<td>Residential</td>
<td>1</td>
</tr>
<tr>
<td>1503384</td>
<td>South Valley Farms – Beech Huller</td>
<td>NTNC</td>
<td>75</td>
<td>Industrial/Agricultural</td>
<td>1</td>
</tr>
<tr>
<td>1503290</td>
<td>The Garlic Company</td>
<td>NTNC</td>
<td>120</td>
<td>Industrial/Agricultural</td>
<td>2</td>
</tr>
<tr>
<td>1503642</td>
<td>Weeks Roses Water System</td>
<td>NTNC</td>
<td>25</td>
<td>Industrial/Agricultural</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2-3. Public Water Systems Within SWID

<table>
<thead>
<tr>
<th>Water System #</th>
<th>Water System Name</th>
<th>Type</th>
<th>Population Served</th>
<th>Service Area</th>
<th>Number of Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>1510019</td>
<td>City of Shafter</td>
<td>C</td>
<td>19,100</td>
<td>Residential</td>
<td>6</td>
</tr>
<tr>
<td>1510021</td>
<td>City of Wasco</td>
<td>C</td>
<td>22,690</td>
<td>Residential</td>
<td>5</td>
</tr>
<tr>
<td>1502164</td>
<td>Llanas Camp Four Water System</td>
<td>C</td>
<td>NT=3; R=31; T=20</td>
<td>Residential</td>
<td>1</td>
</tr>
<tr>
<td>1500426</td>
<td>Rose Villa Apartments</td>
<td>C</td>
<td>65</td>
<td>Residential</td>
<td>1</td>
</tr>
<tr>
<td>1502133</td>
<td>Treehouse California Almonds</td>
<td>NTNC</td>
<td>35</td>
<td>Industrial/Agricultural</td>
<td>1</td>
</tr>
<tr>
<td>1510801</td>
<td>Wasco St. Prison Reception Center</td>
<td>C</td>
<td>4,857</td>
<td>Institution</td>
<td>2</td>
</tr>
<tr>
<td>1504001</td>
<td>Wonderful Nurseries</td>
<td>NTNC</td>
<td>250</td>
<td>Other Transient</td>
<td>1</td>
</tr>
</tbody>
</table>

C = Community water system
NTNC = Nontransient non-community water system
TNC = Transient non-community water system
NT = Nontransient
T = Transient
R = Residential

Existing Water Quality Monitoring Programs

These wells are sampled on a rotational schedule: on average, 80 to 90 wells are sampled annually depending on the type of hydrological year. During wet water years, most wells are not in operation because surface water is available; therefore, offline wells are not sampled. During dry water years, almost all wells are operational and will be sampled. Water quality data collected by NKWSD, between 2009 and 2018, was used for this groundwater characterization. NKWSD currently owns approximately 100 supply wells.

SWID does not own any wells or directly monitor groundwater quality within its service area. Groundwater quality in this region was based on data available from public water systems located within
the District’s boundaries. 17 municipal wells water quality data were evaluated from 2008 to 2018. When water quality data was not available for a municipal well during the ten-year timeframe, then the most current data was used.

**Domestic Wells**

Domestic wells are used exclusively to supply general household needs of the property owner and are typically constructed to a shallower depth than municipal or agricultural wells. Therefore, domestic wells are more commonly impacted by surface contaminants leaching into the groundwater.

Currently, information about domestic wells is limited. There is an effort being led by the SWRCB, as well as multiple other agencies, to explore the best sources of information and conduct a Needs Assessment of domestic wells in contaminated groundwater basins. An effort that is specific to NKWSD and SWID is being conducted by the Tulare Kern Funding Area Disadvantaged Community Involvement Program that anticipates its study will be completed by the end of 2019. This study is seeking to quantify the number of domestic wells in the funding area. These studies will also gather information on the disadvantaged communities and domestic well owners and explore potential remedies for contaminated wells.

**Water Quality Standards**

Federal and State Drinking Water Standards are predominantly referenced when discussing water quality standards. However, the predominant land use in NKWSD and SWID is for agricultural purposes. For this reason, the agricultural *Water Quality Goals* (Ag goals) will also be referenced for evaluation of groundwater quality in this area. The most applicable standard, Drinking Water Standard or Ag goals will be used as a reference point when discussing each constituent.

Water quality constituents that have the potential to impact the groundwater quality of NKWSD and SWID are: arsenic, hexavalent chromium, nitrate, chloride, sodium, boron, 1,2,3-Trichloropropane (TCP) and dibromochloropropane (DBCP). The list of these constituents along with their corresponding standards are listed in Table 2-4. In the Subbasin, arsenic, hexavalent chromium, and boron are predominately naturally occurring. Constituents related to salinity - chloride and sodium - also naturally occurring but concentrated by surface activities. Nitrate is predominately anthropogenic. DBCP and TCP are manmade chemicals and are completely anthropogenic.
Table 2-4. List of Constituents and Standards

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Units</th>
<th>Drinking Water Standard</th>
<th>Agricultural Water Quality Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>ppb</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Boron</td>
<td>ppb</td>
<td>1,000</td>
<td>700</td>
</tr>
<tr>
<td>Chloride</td>
<td>ppm</td>
<td>250</td>
<td>106</td>
</tr>
<tr>
<td>Dibromochloropropane (DBCP)</td>
<td>ppt</td>
<td>2</td>
<td>n/a</td>
</tr>
<tr>
<td>Hexavalent Chromium</td>
<td>ppb</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Nitrate</td>
<td>ppm</td>
<td>10</td>
<td>n/a</td>
</tr>
<tr>
<td>Sodium</td>
<td>ppm</td>
<td>n/a</td>
<td>69</td>
</tr>
<tr>
<td>1,2,3-Trichloropropane (TCP)</td>
<td>ppt</td>
<td>5</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*ppt = parts per trillion
ppb = parts per billion
ppm = parts per million

Land Use

Multiple sources were used to determine the land and crop land uses within NKWSD and SWID. Ideally one single source would be used, however none of the single sources cover the entire extent of Kern County. Using the combination of sources, land use for the entire county is accounted for. The sources that were used in priority order are: 2014 data from Land IQ, 2016 Kern County Data from Department of Agriculture and Measurement Standards, and 2006 data from Department of Water Resources (DWR).

Land IQ was contracted by DWR to assist in obtaining land use data. In addition, Land IQ works in partnership with many other water districts within Kern County and uses satellite data to obtain the land and crop records. Given that water districts have worked closely with Land IQ to develop the data, this dataset was given the highest priority of the three sources to develop the land and crop land uses within NKWSD and SWID.

Data from Land IQ also covers much of the crop land in the county and it was determined that crop patterns have been consistent within the last ten years. 2016 Kern County data was then used to fill in any spatial gaps of missing data from Land IQ. The last source, 2006 DWR data, was used to fill in any missing gaps from the two other sources. Despite DWR data being older than Land IQ and Kern County data, much of the missing land data filled by DWR are generally riparian and native vegetation land.

 Geographic Information System software (GIS) was used to merge shapefiles from all three data sources together.

When evaluating water quality, it is important to know what the land uses are in the area. Often, the land use activities may impact the groundwater quality. NKWSD and SWID has a combined land acreage of 111,987.61. Of the total land within NKWSD and SWID, about 89 percent is dedicated to agricultural land. From the agricultural land data, about 91 percent of it was determined from the use of Land IQ data, 4 percent from Kern County data, and 5 percent from DWR data. The next largest percentage of
land use within both districts is urban at about 5 percent. Urban land use is predominately located in the western and southern portions of the Districts. Table 2-5 provides a breakdown of these land uses. Figure 2-24 shows the land use within NKWSD and SWID.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acres</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>99,568.44</td>
<td>88.91</td>
</tr>
<tr>
<td>Industrial</td>
<td>1,007.07</td>
<td>0.90</td>
</tr>
<tr>
<td>Commercial</td>
<td>104.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Riparian</td>
<td>715.69</td>
<td>0.64</td>
</tr>
<tr>
<td>Native Vegetation</td>
<td>2,032.49</td>
<td>1.81</td>
</tr>
<tr>
<td>Urban</td>
<td>5,559.24</td>
<td>4.96</td>
</tr>
<tr>
<td>Urban Landscape</td>
<td>55.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Residential</td>
<td>333.73</td>
<td>0.30</td>
</tr>
<tr>
<td>Vacant</td>
<td>1,328.05</td>
<td>1.19</td>
</tr>
<tr>
<td>Surface Water</td>
<td>1,263.77</td>
<td>1.15</td>
</tr>
<tr>
<td>Total</td>
<td>111,987.61</td>
<td>100</td>
</tr>
</tbody>
</table>

Data Used

NKWSD Wells

District wells include both production and monitoring wells. Production wells are used exclusively for agricultural purposes and are routinely sampled. Data used to conduct this evaluation were obtained from NKWSD’s existing monitoring network and the municipal wells that submit water quality test results to SDWIS. Data was not available from SWID since the District does not own any wells.

Due to the large quantity of wells within NKWSD’s monitoring network, the following method was used to select the representative wells to characterize the groundwater. NKWSD was divided into Township-Range, then representative wells were selected based on their well construction, specifically the depth of the top perforation of the well. The wells were then selected based on geographic locations to represent the Township-Range. Consideration was given to select wells located near or within spreading grounds and away from spreading grounds to determine if there are differences in water quality. Finally wells with similar water quality were grouped together to narrow down the list of representative wells.

Through this effort, GEI identified 26 representative wells to characterize the groundwater basin that underlies the District. These representative wells provide geographic and vertical representation of the groundwater. Figure 2-25 shows the distribution of wells that were used for this evaluation. The District’s wells are predominately located in the eastern portion of the District outside of the Corcoran Clay.
Public Water System Wells

Public water systems were identified through GAMA and water quality data was extracted from SDWIS. Since most of the water systems identified are businesses, monitoring requirements are sometimes less extensive than municipalities serving residential communities. Consequently, there are some water systems with no data or only one result available for the identified constituents of concern in this region. Since SWID does not own any groundwater wells and water quality data was not available, municipal well data was used for representation. Of the 13 public water systems identified, 24 wells were evaluated, and water quality data was trended from 2008 to current.

Well construction details were not available for municipal wells, which was challenging in determining where wells are perforated within the aquifer. This information is helpful for understanding what the water quality trends mean in relation to the aquifer. Water level data is also of value to determine if water quality trends are related to fluctuation in wet and dry water years. When examining the data, depths where constituents are more prevalent in the aquifer should be considered. Knowing this can help determine if water levels and well construction have an impact on water quality conditions.

Water Quality Evaluation

Groundwater conditions in NKWSD was conducted using a combination of 26 representative wells and public water system data. All available water quality data was evaluated to identify constituents of concern. Not all constituents that are commonly found in the Subbasin, as identified in Table 2-6, are found at concerning concentrations in NKWSD. Therefore, only TCP, nitrate, chloride, and sodium are addressed as constituents of concern.

TCP

TCP is a newly regulated synthetic organic chemical. The State Water Board reports that contamination in the Central Valley is predominately from legacy pesticide applications of certain soil fumigants. The drinking water MCL is 5 ppt; there is no Ag goal.

While TCP contamination is widespread throughout Subbasin, there appears to be less occurrence where the Corcoran Clay is present. Detections in SWID are relatively intermittent and appear to only occur above the 5 ppt detection limit when wells are perforated in the upper aquifer, or when a nearby well is serving as a conduit between the upper and lower aquifers.

Of the public supply wells tested, 92 percent have detections above the MCL of 5 ppt. Table 2-6 shows the water systems and the number of wells that are impacted by TCP. This shows that for all water systems with data, all but one is out of compliance. According to SDWIS, the city of Shafter has TCP treatment installed for three of their five wells. The table confirms that TCP is a contaminant of concern for NKWSD and SWID given that 92 percent of the wells in the region exceeded the MCL.
Table 2-6. Summary of TCP Prevalence Among Public Water Systems

<table>
<thead>
<tr>
<th>Water System</th>
<th>TCP Concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-Detect</td>
</tr>
<tr>
<td>B&amp;J Land Company</td>
<td></td>
</tr>
<tr>
<td>City of Shafter</td>
<td></td>
</tr>
<tr>
<td>City of Wasco</td>
<td></td>
</tr>
<tr>
<td>Golden State Vintners – Franzia McFarland</td>
<td></td>
</tr>
<tr>
<td>Kimberlina Housing Unit</td>
<td></td>
</tr>
<tr>
<td>Llanas Camp Four Water System</td>
<td></td>
</tr>
<tr>
<td>Rose Villa Apartments</td>
<td></td>
</tr>
<tr>
<td>South Valley Farms – Beech Huller</td>
<td></td>
</tr>
<tr>
<td>The Garlic Company</td>
<td></td>
</tr>
<tr>
<td>Treehouse California Almonds</td>
<td></td>
</tr>
<tr>
<td>Wasco St. Prison Reception Center</td>
<td></td>
</tr>
<tr>
<td>Weeks Roses Water System</td>
<td></td>
</tr>
<tr>
<td>Wonderful Nurseries</td>
<td></td>
</tr>
<tr>
<td>Total Wells</td>
<td>1</td>
</tr>
</tbody>
</table>

Nitrate

Nitrate contamination is a significant concern in rural communities, particularly where agriculture is the predominant land use. However, a significant source of nitrate also comes from septic systems that are used in these rural communities. Since municipal services (drinking water or wastewater collection systems) are not available in the majority of NKWSD and SWID, all domestic and public wastewater disposal is through onsite septic systems.

Nitrate can be naturally present at low concentrations in groundwater, typically less than 2 ppm. Moderate and high concentrations generally occur because of human activities. Septic systems typically contribute moderate concentrations between 5 and 15 ppm of nitrate as nitrogen. Typically, higher concentrations (greater than 20 ppm) are associated with applying fertilizers to crops. Nitrate contamination is a significant public health concern because it has acute health effects. High concentrations of nitrate are typically found in shallow groundwater, such as those in the unconfined aquifer. About 35 percent of NKWSD’s representative wells are over the drinking water MCL for nitrate, while 8 percent of the public water system wells are exceeding the MCL. Table 2-7 shows the number of wells at different concentration levels for Nitrate in NKWSD. Table 2-8 shows the summary of number of wells of nitrate prevalence in public water systems.

Table 2-7. Summary of Nitrate Prevalence Within NKWSD

<table>
<thead>
<tr>
<th>Nitrate Concentrations (ppm)</th>
<th>0-5</th>
<th>6-10</th>
<th>&gt;11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Water System</td>
<td>0-5 ppm</td>
<td>6-10 ppm</td>
<td>&gt;11 ppm</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>---------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>B&amp;J Land Company</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Shafter</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>City of Wasco</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Golden State Vintners – Franzia McFarland</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Kimberlina Housing Unit</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Llanas Camp Four Water System</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Rose Villa Apartments</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Valley Farms – Beech Huller</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>The Garlic Company</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treehouse California Almonds</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Wasco St. Prison Reception Center</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Weeks Roses Water System</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wonderful Nurseries</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Wells</td>
<td>7</td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>

Since the District wells did not have annular seal information, the top screen perforations were used to evaluate how deep in the aquifer elevated nitrate levels are detected. Of the wells that exceed the MCL, 70 percent have top screen perforations between 300 and 400 feet. When examining available annular seal depths for the cities of Shafter and Wasco, the same correlation for wells with shallower annular seals with elevated nitrate levels compared to the wells with annular seals deeper than 450 feet can be seen. Figures 2-26 and 2-27 show two wells in NKWSD and the City of Shafter where Well A has a shallower top well screen or depth of annular seal compared to Well B. In both cases, Well A has elevated nitrate levels compared to Well B. This comparison shows how nitrate levels are elevated in wells with shallower top well screens and annular seals.
When looking at Figure 2-26, it is observed that Well B, which has a lower screen perforation, had stable nitrate levels until 2015. In 2015, water levels were historically very low due to drought. Figure 2-27 shows water levels beginning to drop in 2012 when the drought started. In 2015, water levels further drop, which causes nitrate levels to significantly increase close to the MCL. When water levels begin to slowly recover, nitrate levels decrease. Figure 2-29 demonstrates that nitrate levels for this NKWSD well is impacted by water level. The increase in nitrate levels when water levels are low indicate there is less dilution in the aquifer causing constituent levels to increase.
The location of these elevated nitrate concentrations tends to be in rural areas where municipal services are not available. Despite most of the land use being agricultural, there are rural communities as well. As previously mentioned, since there are no municipal services, these communities rely on septic systems to manage their wastewater. Septic tanks are known to have failures such as leakage and are not as well maintained as municipal sewer systems. Failing septic tanks leak contaminants, such as nitrate, which eventually enters the groundwater. This is especially concerning if there is a groundwater well downgradient of a septic tank. Elevated nitrate levels in a groundwater well are typically due to surface contamination and have been more prevalent in shallower wells or in areas where there is no confined aquifer. Figure 2-29 shows how Well A, which is located within the Corcoran Clay, has lower nitrate levels compared to Well B, which is located outside the Corcoran Clay. Well A is considered to be in a confined aquifer since Corcoran Clay is present. Figure 2-29 shows that even though Well A has a shallower annular seal, at 200 feet, compared to Well B with an annular seal at 480 feet, the nitrate levels are higher in Well B since there is no confining clay layer. Since nitrate is a surface contaminant, wells with shallow screened intervals or annular seals and in unconfined aquifers typically show the highest levels of contamination. Deeper wells typically have more dilution in the aquifer and will tend to show lower nitrate concentrations.

![Figure 2-29. Comparison of City of Shafter Wells Nitrate Levels in Respect to Location Within Corcoran Clay](image)

**Sodium and Chloride**

Since land uses within NKWSD and SWID are predominately agricultural, the State Water Board’s Ag goals are referenced as the appropriate value rather than drinking water standards. Sodium and chloride have an agricultural goal of 69 and 106 ppm, respectively. Drinking water does not apply a limit for sodium. The recommended limit for chloride is 250 ppm and the upper limit is 500 ppm.
Ag goals were published by the Food and Agriculture Organization of the United Nations in 1985. The criteria are protective of various agricultural uses of water, including irrigation of various types of crops and stock watering. At or below the thresholds presented in the Water Quality Goals database, agricultural uses of water should not be limited.

Both sodium and chloride show similar trends in the wells evaluated; therefore, for this discussion, they will be collectively referred to as salinity levels. Since sodium concentrations is an important measurement to crop yield, the focus of salinity level discussion will be on sodium. Tables 2-9 and 2-10 summarize sodium concentrations and their relationship to well perforations.

<table>
<thead>
<tr>
<th>Sodium Concentrations (ppm)</th>
<th>0-34</th>
<th>35-69</th>
<th>&gt;70</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2-10. Summary of Sodium Prevalence Among Public Water Systems

<table>
<thead>
<tr>
<th>Water System</th>
<th>0-34 ppm</th>
<th>35-69 ppm</th>
<th>&gt;70 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>B&amp;J Land Company</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Shafter</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>City of Wasco</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golden State Vintners – Franzia McFarland</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kimberlina Housing Unit</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Llanas Camp Four Water System</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rose Villa Apartments</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Valley Farms – Beech Huller</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Garlic Company</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treehouse California Almonds</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasco St. Prison Reception Center</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weeks Roses Water System</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wonderful Nurseries</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Wells</td>
<td>3</td>
<td>14</td>
<td>7</td>
</tr>
</tbody>
</table>

When compared against Ag goals, data indicates there are elevated sodium levels in NKWSD. Figure 2-30 shows well locations within the District and their maximum sodium concentrations, which were plotted instead of the average since it showed a more representative picture of the general increasing trend seen in most of the wells, especially along the eastern portion of the District.

When comparing the trends along the eastern and southern portions of the District to the western portion, concentrations are noticeably lower in the western portion. The general groundwater gradient in this region flows westerly and northwesterly. Sodium concentrations follow this groundwater flow, especially near the spreading grounds of NKWSD. When comparing the sodium levels of wells between
the eastern and western sides of each spreading grounds, it is evident that these spreading grounds are contributing to the dilution of sodium. Figure 2-31 shows the inverse relationship between the sodium and water levels in a well located northeast of the Rosedale Spreading Ground, which is the furthest southern spreading ground in the District. As the water level drops, sodium levels increase. On the other hand, Figure 2-32 shows a direct relationship between sodium and water levels in a well located on the west side of the spreading ground. This well shows an opposite sodium trend compared to the well located east of the spreading ground. As the water level drops, the sodium levels also drop due to dilution from the spreading ground.

![Figure 2-31. Rosedale Spreading Ground – Northeast Side Inverse Relationship of Sodium and Water Levels](image1)

![Figure 2-32. Rosedale Spreading Ground – West Side Direct Relationship of Sodium and Water Levels](image2)
Like the trends observed in the Rosedale spreading ground, this was also noted in the central spreading ground located directly northwest. Figure 2-33 shows a well located to the southeast side of the central spreading ground with elevated sodium levels and an increasing trend. The sodium level has been increasing as the water levels have been dropping. Figure 2-34 shows a direct relationship between the sodium and water levels of a well located in the north end of the central spreading ground. The sodium levels here are below the Ag limit and shows a decreasing trend.

![Central Pond - Southeast Side](image1)

**Figure 2-33. Central Spreading Ground – Southeast Side Inverse Relationship of Sodium and Water Levels**

![Central Pond - North Side](image2)

**Figure 2-34. Central Spreading Ground – North Side Direct Relationship of Sodium and Water Levels**
In general, it is observed that the sodium levels located along the eastern portion of the District are elevated based on Ag goals and have increasing trends. Wells located downstream of the spreading grounds or even within the spreading grounds show sodium levels and decreasing trends. The spreading grounds appear to dilute the sodium levels coming from the east. The groundwater gradient flowing westerly and northwesterly indicates that wells downgradient of spreading grounds have lower sodium levels due to dilution. Since managing sodium concentrations to meet Ag goals is important to the land uses within NKWSD, management actions that will slow or reverse the increasing sodium trends considered. Studies conducted through CV-SALTS, and the projects that are planned, will aid in salinity management.

**Arsenic**

Even though arsenic is not a concern in terms of elevated concentrations within the Districts, there was a noticeable trend observed. There is a primary drinking water standard of 10 ppb for arsenic. The Ag goal is 100 ppb. All water quality data is NKWSD and SWID indicates that arsenic is below the Ag goal.

The most common source of arsenic is from natural geochemical processes that leach metals from the sediments, particularly in the lakebed areas and where dark clay deposits occur. Studies conducted by USGS found that arsenic is in an easily exchangeable state where oxidizing geochemical conditions, caused by groundwater containing higher oxygen content, dissolve the pyrite (a mineral which can contain arsenic) and release arsenic into the groundwater. Smith et. al. (2018) found that over-pumping in the San Joaquin Valley has led to land subsidence due to compaction of the lakebed deposits (clay layers) that then releases the high arsenic pore water from the clay layers into the groundwater. In NKWSD, the Corcoran Clay is in the northwest portion of the District. However, the Corcoran Clay is present in a majority of SWID, especially in the north and west portion of the District. The City of Shafter public water system located in south SWID has two of their six wells located within the Corcoran Clay.

There was an observed difference in arsenic trends when looking at a well’s location in relation to the Corcoran Clay. For wells within the clay, there is a direct relationship between arsenic and water levels. Figure 2-35 shows as the water level drops, so do arsenic levels. Wells A and B are deep wells with total depths of 800 and 860 feet, respectively, which indicates that the water being pumped is not in contact with clay layers that contain arsenic. For wells outside the clay, there is an inverse relationship between the water and arsenic levels. Figure 2-36 shows that as water level drops, arsenic levels are increasing. Well B is a deeper well compared to Well A and when looking at the screened intervals between the two, Well B’s perforations are also deeper. This indicates that the higher levels of arsenic from Well B is due to pumping from the deeper part of the aquifer where there is less dilution.
It was also observed in Shafter that a well greater than 1,000 feet, located outside of the Corcoran Clay, has higher arsenic concentrations compared to shallower wells. Figure 2-37 shows that Well C, with a
total well depth of 1,055 feet has the highest arsenic level compared to the other two wells. Both Wells A and B have a total well depth of 800 feet with levels around half the MCL. Since Well C only has two data points, there is not enough data to make a conclusion on the increased concentration.

![City of Shafter - Arsenic vs. Well Depth](image)

**Figure 2-37. City of Shafter Wells Outside Corcoran Clay Arsenic vs. Well Depth**

**Contamination Plumes**

A search of contamination plumes within NKWSD and SWID was conducted using both GeoTracker and EnviroStor databases. The criteria outlined in the KGA GSP basin setting was applied during this review. Based on the criteria, two facilities in Wasco were identified and cleanup efforts are being overseen by the Regional Board as shown in Figure 2-38. Both sites are located near the boundary between NKWSD and SWID. No nearby impacted wells or municipal wells within 1,500 feet of each site were identified. Table 2-11 identifies the facilities and the potential contaminants of concern. Since there are no nearby affected wells and remediation efforts have begun, these sites are not impacting the groundwater quality.

<table>
<thead>
<tr>
<th>Global ID#</th>
<th>Potential Contaminants of Concern</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLT5FS184436</td>
<td>Insecticides, pesticides, fumigants, herbicides</td>
<td>Open – Remediation as of 8/15/16</td>
</tr>
<tr>
<td>SLT5FQ444336</td>
<td>DDD, DDE, DDT, insecticides, pesticides, fumigants, herbicides</td>
<td>Open – Verification monitoring as of 4/20/10</td>
</tr>
</tbody>
</table>
**Groundwater Quality Findings**

Based on data evaluated in this groundwater quality characterization; TCP, nitrate, and salinity are the primary constituents of concern for NKWSD’s and SWID’s service areas. SWID did not have any water quality data at the time of evaluation.

Following TCP, nitrate and salinity are of concern. Nitrate is a primary drinking water standard with acute health effects. About 35 percent of NKWSD’s representative wells are over the drinking water MCL for nitrate, while 8 percent of the public water system wells are exceeding the MCL. Since nitrate is a surface contaminant, wells with shallow screened intervals or annular seals typically show the highest levels of contamination. It was also observed in a District well that nitrate may also be impacted by water levels. Lowering water levels increases the nitrate concentration by lessening the dilution factor in the aquifer. To comply with the Human Right to Water, nitrate levels will need to be closely monitored and management actions will need to be in place to comply with the nitrate drinking water standard.

Salinity levels were observed to be highest along the eastern and southern portion of the NKWSD. When following the flow of the groundwater gradient, which is westerly and northwesterly, an evident trend was observed. By evaluating sodium levels following the groundwater gradient across these spreading grounds, it was evident that the spreading grounds are providing dilution to the elevated sodium levels in wells located upstream. Wells within the spreading ground or downstream of the spreading grounds had lower sodium levels.

While other groundwater contaminants commonly found throughout Subbasin were evaluated, there was limited presence of most constituents in NKWSD and SWID. Water quality data used was collected between 2010 and 2018. Overall, there is high-quality water in this portion of the aquifer.

**2.3.6 Land Subsidence**

As described in the KGA GSP basin setting, inelastic (irrecoverable) land subsidence (subsidence) is a potential concern in areas of active groundwater extraction with underlying fine-grained sediment, such as in the study area. Increased potential for undesirable results may occur due to land subsidence. Undesirable results of land subsidence may include, but are not limited to, flood risk in low lying areas; well casing damage or collapse, canal and infrastructure damage or collapse; and reduced groundwater storage (LSCE, 2014).

According to DWR (2014), the Kern County Subbasin was rated at a high potential for future subsidence, due to 1) most of the wells monitored with water levels at or below historical lows; 2) documented historical subsidence; and 3) documented current subsidence. Moreover, greater amounts of subsidence are occurring to the north of Kern County boundaries in the Tulare Lake Subbasin. The amount of future subsidence will depend on whether future water levels decline below previous low levels and remain low for a considerable amount of time. Maintaining water levels above the previous low water levels may limit the risk of future subsidence.
Several processes contribute to land subsidence in the Subbasin and include, in order of decreasing magnitude: aquifer compaction by overdraft, hydro compaction (shallow or near-surface subsidence) of moisture deficient deposits above the water table that are wetted for the first time since deposition, petroleum reservoir compaction due to oil and gas withdrawal, and subsidence caused by tectonic forces (Ireland et al., 1984).

Inelastic compaction (subsidence) typically occurs in the fine-grained beds of aquifers and in the aquitards. The fine-grained beds contain water in the pore spaces between the clay particles at the time of deposition and this water supports the clay particles which contributes to the thickness of the fine-grained bed. During dry conditions when surface water supplies are diminished, over-pumping of groundwater may cause a one-time release of water from the clay (dewatering). This one-time release is also referred to as the inelastic skeletal specific storage of clay. Once the clays dewater, the volume released from inelastic storage results in permanent realignment of the clay particles and the collapse of the clay layer structure, or permanent land subsidence. Although space within the overall aquifer is reduced by an amount equivalent to subsidence of the land surface (due to reduced thickness of the clay layers), this storage reduction does not substantially decrease usable storage for groundwater in the aquifer because the clay layers do not typically store significant amounts of recoverable, usable groundwater (LSCE, 2014). However, Ojha et. al. (2019), references recent studies suggesting that subsidence between 2007-2015 in the Central Valley (primarily San Joaquin Valley) resulted in losses of 0.4% to 5.25% storage capacity in the aquifer system. Although much this capacity mostly represents fine grained layers, this loss may impact the overall aquifer system by increasing the replenishment time of the aquifer which could pose further challenges to water management (Ojha et. al., 2019).

The one-time release of water of compaction has been substantial in some areas of the Central Valley; and it is estimated that by the mid-1970s, about one-third of the volume of water pumped from storage in areas such as Los Banos-Kettleman City, came from compaction of fine-grained beds (Poland et al, 1975; Faunt et al, 2009); therefore, water budget projections may need to consider the one-time release of water from compaction as an irrecoverable water source for future projections. Although the largest body of fine-grained beds is the Corcoran Clay, a relatively insignificant volume of water has been released from storage in the Corcoran Clay (Faunt et al, 2009). However, aquifer water quality could be impacted by poor quality water released from the dewatering of clays, as postulated for an increase in arsenic (Smith et. al, 2018). The surface displacement of subsidence represents the reduced thickness of the impacted clay layers and this vertical displacement, if significant enough, may cause damage to wells and structures.

Groundwater overdraft is considered to be the primary driver of historical land subsidence in the Central Valley (Faunt et. al., 2009). USGS estimates that about 75 percent of the subsidence occurred in the 1950s and 1960s, corresponding to extensive groundwater development (Galloway, et al., 1999), prior to implementation of the SWP, CVP, and other development of surface water resources.
2.3.6.1 Subsidence Results and Methodology in the Study Area.

Results of subsidence estimates are summarized in the Table 2-12 below and on Figures 2-39 to 43. In addition, time-series charts of subsidence are provided in Appendix F. Results were compiled from historical leveling surveys, recent GPS data, extensometer data, and satellite- and aircraft-based remote sensing.

Table 2-12. Summary of Land Subsidence

<table>
<thead>
<tr>
<th>District Area</th>
<th>Date Range</th>
<th>Approximate Cumulative Subsidence (inches)</th>
<th>Approximate Annual Rate of Subsidence (inches/year)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of SWID and NKWSD boundary (Historical)</td>
<td>1926 to 1970</td>
<td>0 to 150</td>
<td>0 to 3.4</td>
<td>Ireland, 1984. Topographic Maps and Leveling Data</td>
</tr>
<tr>
<td>West of and East of SWID and NKWSD boundary (Historical)</td>
<td>1926 to 1970</td>
<td>0 to 12</td>
<td>0 to 0.3</td>
<td>Ireland, 1984. Topographic Maps and Leveling Data</td>
</tr>
<tr>
<td>South half of NKWSD and SWID</td>
<td>1926 to 1970</td>
<td>12 to 24</td>
<td>0.3 to 0.5</td>
<td>Ireland, 1984.</td>
</tr>
<tr>
<td>North half of NKWSD and SWID</td>
<td>1926 to 1970</td>
<td>24 to 48</td>
<td>0.5 to 1.1</td>
<td>Ireland, 1984.</td>
</tr>
<tr>
<td>I-5 southwest within SWSD</td>
<td>Oct-06 to Oct-09</td>
<td>0.8</td>
<td>0.3</td>
<td>CGPS PBO (P545).</td>
</tr>
<tr>
<td></td>
<td>Jan-07 to Mar-11</td>
<td>1.4</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct-11 to Oct-16</td>
<td>1.9</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May-15 to Sep-16</td>
<td>0.60</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dec-13 to Oct-16</td>
<td>1.4</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>I-5 south within SWSD</td>
<td>Oct-06 to Oct-09</td>
<td>1.1</td>
<td>0.4</td>
<td>CGPS PBO (P563).</td>
</tr>
<tr>
<td></td>
<td>Jan-07 to Mar-11</td>
<td>1.4</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct-11 to Oct-16</td>
<td>1.5</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May-15 to Sep-16</td>
<td>0.3</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dec-13 to Oct-16</td>
<td>1.2</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Wasco Proximity</td>
<td>Oct-06 to Oct-09</td>
<td>5.5</td>
<td>1.8</td>
<td>CGPS PBO (P564).</td>
</tr>
<tr>
<td></td>
<td>Jan-07 to Mar-11</td>
<td>4.3</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct-11 to Oct-16</td>
<td>10.3</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring-12 to Jul-17</td>
<td>10.7</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May-15 to Sep-16</td>
<td>3.0</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dec-13 to Oct-16</td>
<td>6.8</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>SWID and NKWSD extent</td>
<td>Jan. 2007 to Mar. 2011</td>
<td>0 to 3</td>
<td>0 to 0.7</td>
<td>LSCE, 2014. Compiled from InSAR.</td>
</tr>
<tr>
<td>SWID and NKWSD extent</td>
<td>May 2015 to Sept. 2016</td>
<td>1.5 to 6</td>
<td>1.2 to 4.6</td>
<td>InSAR ESA Sentinel-1A (Farr et al., 2016)</td>
</tr>
<tr>
<td>NKWSD Benchmark Monitoring Network</td>
<td>2012 to 2017</td>
<td>-1.6 to 8.3</td>
<td>-0.3 to 1.7</td>
<td>NKWSD monitoring results of Subsidence Monitoring Network.</td>
</tr>
</tbody>
</table>
Historical Results

Within the study area, historical subsidence has been documented from leveling surveys by the National Geodetic Survey at up to 6.5 feet from 1926 to 1970 (Ireland et al., 1984). Compaction data by the extensometers were plotted against the DWR water year indices. Greater rates of compaction generally correlated with low water year indices (critical, dry, or below normal) while compaction rates were lower during high water year indices (wet, and above normal).

In general, Figure 2-39 shows that centers of historical subsidence occurred northeast of the NKWSD-SWID plan area and propagated outward to the south into the NKWSD-SWID plan area.

CGPS

Recent subsidence studies of the Central Valley, and the Subbasin have utilized continuous GPS (CGPS) station data. The following CGPS stations are located in or near the study area: P544 (Twisselman Road), P545 (Lerdo Highway), P563 (Buttonwillow Rest Area), P564 (Wasco), and P565 (Delano), respectively located west of SWSD along I-5 and Twisselman Road, southwest of SWSD (along I-5 just north of Lerdo Highway), south of SWSD along I-5 at the Buttonwillow Rest Area, within SWID at Wasco Airport, and to the north of NKWSD at Delano Municipal Airport. These CGPS stations are monitored as a part of UNAVCO’s Plate Boundary Observation (PBO). Day-to-day CGPS height solutions vary by as much as about 35 mm, likely due to variable atmospheric conditions, random walk noise, and other effects not directly related to land-surface-elevation change (Zerbini and others, 2001; Williams and others, 2004; Langbein, 2008) and, for this reason, short-term day-to-day comparisons of CGPS data to characterize land subsidence in the Central Valley is not ideal. Based on the time-series charts in Appendix F, CGPS data are more meaningful in characterizing land subsidence when looking at quarterly and annual trends. Therefore, cumulative subsidence and rates of subsidence were calculated by taking averages of the dataset for each water year. Note: For CGPS data plotted with InSAR data (Figures 2-40 to 43), cumulative subsidence and rates were by daily averages.

In general, CGPS data show subsidence in the NKWSD-SWID regions with relatively modest declines (P544, P545, P563) to the south and west of the study area and much higher decline (P564 and P565) in Wasco and Delano.

Time-Series Data

Time-series data (Appendix F) present cumulative subsidence from approximately 2006 to 2017 with corresponding water level elevation hydrographs observed from nearby wells. Below normal to “critical dry” water years are shaded in yellow, while above normal to “wet” water years are shaded in gray. All wells are within the lower zone or main production groundwater zone unless noted with “upper zone”.

Generally speaking, the variation in subsidence on the time-series is a function of:
• elastic subsidence to inelastic subsidence as well as the lag time of subsidence after the main pumping season,
• the distribution of fine-grained sediments in the subsurface,
• the amount of water pumped from fine-grained units, and
• potential near-surface factors such as shrinking and swelling of some soil types due to precipitation or other factors.

All the factors mentioned above may introduce additional signals or noise to the CGPS data; however, general broad trends are discernible when plotting data with water year type and nearby water levels. In the future, more water level monitoring and pumping data in areas near these CGPS stations may provide finer resolution of data to interpret lag times, elastic changes, and other short-term signals.

Based on the attached time-series, residual subsidence persists after each pumping season (especially in dry years) for relatively long periods of time (several months to over a year). Researchers note that delayed or residual subsidence response may occur in the Central Valley for years after pumping (USGS, 2018b).

The following observations were derived from the time-series data:

• P544 (Twisselman Road) shows increasing subsidence associated with dry years. Subsidence may lag up to 6 months after pumping season, while long-term residual subsidence and elastic rebound is observed from 6 to 18 months. No water level data in nearby pumping zones were available. Only water levels from shallow monitoring piezometers are plotted on this chart.

• P545 (Lerdo Highway) shows increasing subsidence associated with dry years and water level decline in the lower zone. Water levels and some elastic subsidence may recover/rebound within a month of the beginning of a wet water year; however, both elastic and inelastic subsidence lags for at least 6 to 18 months or longer after a dry year. Subsidence rates trend more with lower zone water levels than upper zone water levels. The included upper zone well is located in neighboring BVWSD, is in the upper zone above the “E” Clay or equivalent and may vary over time because of groundwater production in the upper zone that occurs in BVWSD.

• P563 (Buttonwillow Rest Area) data are similar to P545, with subsidence associated with dry years and the rebound from elastic subsidence due to wet year conditions and stabilization of water levels. The subsidence time lag is evident in the elastic recovery from April 2011 to summer 2012. Similar to P545, changes in subsidence rates do not correlate significantly with upper zone water levels. Subsidence rates are associated with decline in water level from the lower zone.

• Data for SWSD Extensometer 25S22E35B001M are collected monthly to quarterly rather than daily, so any small-scale noise, rebound, or recovery aren’t seen in the data. Consequently,
subsidence may be more apparent in the extensometer data while water levels are variable during each year. Continued monitoring may confirm the consequences of residual drawdown during sequential wet years. In general, subsidence or compaction occurs during dry years, and a decrease in the rate of subsidence is observed during wet years.

- P564 (Wasco) within SWID. In general, rates of subsidence increase during dry years and decrease during wet years. Between 2009 to 2011, elastic rebound (recovery) appears to outgain inelastic subsidence. On the other hand, between the wet year 2016 to 2017, subsidence continued but at a low rate even after some recovery of water levels. Note: P564 subsidence data are plotted on a smaller vertical scale (from -2 to 18 inches) than P545 and P563. As a result, smaller monthly changes in subsidence observed in the latter, aren’t as apparent in P564.

- P565 (Delano) north of NKWSD, also plots subsidence on a smaller vertical scale. P565 shows a lesser rate of subsidence between 2006 and 2009 in comparison to P564 but shows a similar rate of decline between 2011 and 2016. Overall, subsidence at P565 increases during dry years and decreases in wet years. A slight elastic rebound is observed in wet years. This plot is consistent with overall regional trends of declining water levels during the drought.

Local Monuments and Surveys

In spring 2012, NKWSD completed installation of 11 benchmark monuments to monitor land subsidence within the district. These monuments were surveyed into the monitoring network in spring 2012 (NKWSD, 2012). Details of these monuments are included in the Existing Network section of this plan.

In July 2017, the monuments were resurveyed in order to measure any changes in elevation during the time period from the initial survey in spring 2012 to July 2017. The data report of these results is included in Appendix G. Data were processed with NGS OPUS Projects software, to utilize observation data from the CORS network and tie into the National Spatial Reference System. Data are listed as Northing and Easting coordinates in the California Coordinate System of 1983 (Zone 5, US Survey feet), and Elevations in the North American Vertical Datum of 1988, which were computed using Geoid Model 128.

Results of the July 2017 monument survey were plotted with CGPS points and InSAR data for comparison; however, InSAR data are only available from 2015-2016 and not for the entire time period from 2012-2017; therefore, InSAR data plotted are underestimating actual change in land surface elevation during the 2012-2017 time period. The results of the survey are presented on Figure 2-44. Subsidence ranged from approximately 0 to 8 inches. Subsidence was greatest in the center of the district in a band running north south, east of Shafter and Wasco. On average, subsidence was about 4.2 inches from 2012-2017. In some cases, an uplift was measured in some monuments in the north and south of the district ranging from 0.4 to 1.5 inches. These data generally agree with the spatial trends observed in InSAR data and the relative magnitude observed in CGPS data. Further data collection may confirm the data agreement between the CGPS, InSAR, and monument surveys.
Remote Sensing

Recent investigations of land surface subsidence include Satellite-based Interferometric Synthetic Aperture Radar (InSAR), aircraft-based L-band SAR or Unmanned Aerial Vehicle Synthetic Aperture Radar (UAVSAR). The data from these remote sensing techniques have been processed by the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL). Reported data have been published in a subsidence study commissioned by the California Water Foundation (LSCE, 2014), and by JPL via the DWR SGMA Data Viewer (DWR, 2018a) and the DWR website (NASA, 2015, NASA, 2016). The InSAR data were processed from a group of satellites including but not limited to: Japanese PALSAR, Canadian Radarsat-2, and European Space Agency’s (ESA) satellite-borne Sentinel-1A. Data reported herein are from 2006 to 2017 with a gap from 2011 to 2014 when satellite outage occurred before the launch of the ESA’s Sentinel satellites in 2014.

Ojha et. al. 2019, compared InSAR vertical displacement time series against CGPS and extensometer data by averaging the value of InSAR pixels within 200 m of each GPS and extensometer station. They found a good agreement between InSAR measurements and CGPS and extensometer data. The average standard deviation of the difference between InSAR and GPS was 0.9 inch, and between InSAR and extensometer data was 0.6 inch (Ojha et. al, 2019). The agreement of InSAR with extensometer measurements indicates that the majority of the compaction measured by InSAR occurs in the same depth intervals as extensometers and that any change or compaction in the subsurface below the average extensometer depth (1300 feet) is negligible.

DWR is currently evaluating the remote sensing data with in-field measurements, such as from CGPS stations, as a means of “ground truthing” the remote sensing data (DWR, 2018b). This plan does not intend to validate the InSAR data, but only to present it as best available regional data. Data gaps are undoubtedly present, and therefore, the discussion below is a qualitative interpretation of the data. Nonetheless, cumulative subsidence and rates of subsidence, based on InSAR data, are also provided in the Table 2-12 above and in the figures 2-40 to 2-43.

Along with InSAR data, the CGPS and extensometer data are plotted as cumulative subsidence on Figures 2-40 through 2-41, and rates of subsidence on Figures 2-42 and 2-43, evaluating spatial distribution of land subsidence. Data from 2007 to 2011 show subsidence ranging from 1.4 to 4.3 inches in CGPS points within SWSD and to the east, and 0 to ~4 inches for InSAR data within SWSD. Data from 2015 to 2016 show subsidence ranging from 0.3 to 3.7 inches in CGPS points within SWSD and to the east, and 0 to ~10 inches for InSAR data within SWSD.

Discussion of Results

Overall, the subsidence data indicate that centers of greatest decline, both historically and recently, occur north of the study area in the adjacent subbasin and propagate outward to the south, west, and southwest into Kern. As a qualitative observation, the CGPS, extensometer, and InSAR data agree with the trends as stated above. From a quantitative standpoint, the magnitude of subsidence reported from
InSAR from 2015 to 2016 is much higher than surrounding CGPS and extensometer data points. In the future, additional monitoring points would be beneficial to corroborate the highest subsidence rates detected by InSAR to the north of SWID.

Based on time-series data, subsidence appears generally to trend with water levels from lower zone wells – deeper wells with screens below confining clays (“E” clay or equivalent), which are more likely to dewater fine-grained beds below the confining units. Consequently, recent subsidence does not trend as closely with upper zone water levels.

Continued monitoring of water levels, pumping, and subsidence, as well as more detailed subsurface lithologic characterization may provide a better dataset for future projection of subsidence. At this time, the calculated rates of subsidence have been posted on the results table and the time-series charts. These historical rates present an estimate of possible future subsidence rates if groundwater extraction continues at the current rate.

**Further Data Availability and Subsidence**

According to USGS, the ESA’s Sentinel satellites collect InSAR data at an approximate weekly rate, and data are available for download and interpretation (personal communication, USGS). These InSAR data are available but will require users support for the interpretation and distribution of the information. Likewise, CGPS data will likely to be available for future use. DWR is currently evaluating the remote sensing data with in-field measurements such as from CGPS stations, as a means of “ground truthing” the data (DWR, 2018b). Continued improvements in data interpretation and processing will benefit remote subsidence monitoring along with continued collection of CGPS and extensometer data. Further discussion of subsidence monitoring will be addressed in the Monitoring Networks section of this report.

**2.3.7 Interconnected Surface Water Systems**

Interconnected surface water systems are surface waters that are hydraulically connected by a continuous saturated zone to an underlying aquifer (DWR, 2016). There are no known natural interconnected surface water systems near NKWSD and SWID since the subsequent impoundment and regulation of flow of the Kern River and groundwater pumping.

Apart from managed surface water to natural drainages in the study area, Poso Creek channel is the only channel that experiences natural recharge from the surrounding highlands. However, Poso Creek is ephemeral and only flows during limited “wet” months of some “wet” years.

**2.3.8 Potential Groundwater Dependent Ecosystems**

SGMA defines a Groundwater Dependent Ecosystem (GDE) as ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. SGMA states that a GSP shall include impacts on GDEs but does not explicitly state the requirements that warrant a GDE to be eligible for protection.
The first step in evaluating a potential GDE is to identify vegetation communities that are typically associated with groundwater, and secondly, to confirm the presence of shallow groundwater that could support potential GDEs. Lastly, is to evaluate any active groundwater pumping that could lead to shallow groundwater level change in the vicinity of potential GDEs.

In NKWSD and SWID, there are no known GDEs. Many of the vegetation communities that could be potential GDEs are likely to be associated with managed wetlands and riparian areas that are supported by a combination of groundwater and imported surface water. In addition, other potential habitats include ephemeral wetlands covered by water seasonally but supported by irrigation deliveries and precipitation, and groundwater recharge basins that are artificially flooded with surface water. Therefore, additional investigation is needed to identify potential locations of vegetation that are dependent on groundwater and not indirectly linked to imported surface water from managed wetlands.

Currently, the best available dataset for evaluating the occurrence of vegetation communities that are typically associated with groundwater is the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (DWR, 2018c). DWR has stated that use of the NCCAG dataset is not mandatory and does not represent DWR’s determination of a GDE. Rather, NCCAG can provide a starting point for the identification of GDEs within a groundwater basin (DWR, 2018c).

The NCCAG dataset maps vegetation with the Poso Creek channel, and therefore, the NCCAG dataset will be discussed in more detail below. However, the Poso Creek is an ephemeral stream that only runs in wet months of very wet years. No known shallow groundwater has been mapped in the Poso Creek channel of NKWSD.

Below is a discussion of the NCCAG dataset. For reference, the NCCAG vegetation and wetlands data are presented in Figures 2-45 and 2-46 respectively. Distribution of mapped NCCAG vegetation occurs in the natural lowlands along Poso Creek.

2.3.8.1 Review of NCCAG Dataset Components

The NCCAG dataset was compiled based on 48 layers of publicly available data sets developed by state or federal agencies that map vegetation, wetlands, springs, and seeps in California (DWR 2019). A technical working group with representatives from DWR, CDFW, and TNC reviewed the datasets compiled to assemble the NCCAG. This dataset attempts to extract mapped vegetation and wetland features that have indicators suggesting dependence on groundwater. The data presented in NCCAG display vegetation polygons that have indicators of GDEs based on published and/or field observations of phreatophytic vegetation characteristics in California, flooding frequency, or areas classified as perennial hydrologic features. A phreatophyte is defined as a “deep-rooted plant that obtains water that it needs from the phreatic zone (zone of saturation) or the capillary fringe above the phreatic zone” (TNC 2018b). The dominance of phreatophytic plant species in a mapped vegetation type is a primary indicator of GDEs. A list of plant species considered to be phreatophytes based on review of peer-reviewed scientific literature on rooting depths, published lists of phreatophytes, expert field
observations, and vegetation alliance descriptions is publicly available (Klausmeyer et al. 2018, TNC 2018a).

While developing the NCCAG dataset of areas with indicators of GDEs, the technical working group attempted to exclude vegetation and wetland types and polygons that are less likely to be associated with groundwater (Klausmeyer et al. 2018). For example, riparian vegetation along perennial mountain streams is generally not in the NCCAG dataset, because although these communities contain species that can act as phreatophytes, vegetation at those sites is generally sustained by surface waters that are not locally interconnected with shallow groundwater aquifers. The working group also attempted to remove any polygons that are not likely to be GDEs where they occurred in areas where they are more likely supported by alternate artificial water sources (e.g. local seepage from agricultural irrigation canals), or where appropriate available data indicated the shallow groundwater depth is located well below the rooting zone (Klausmeyer et al. 2018).

The Vegetation Classification and Mapping Program (VegCAMP) and National Wetland Inventory (NWI) are the vegetation mapping datasets that cover the water districts of interest and a discussion of each dataset follows below.

The VegCAMP dataset is the primary vegetation base layer used for the NCCAG dataset. Fish and Game code Section 1940 directed CDFW to develop and maintain a standardized vegetation dataset for the state of California, which conforms to the U.S. National Vegetation Classification Standards, and to produce a hierarchical classification of vegetation types. VegCAMP is the product of the Survey of California Vegetation (SCV). Vegetation polygon attributes are assigned to the alliance taxon level in the hierarchical classification system, when possible. An “alliance” is a lower taxonomic rank that is based on plant species composition as compared to higher taxon levels that more broadly define the life form (tree, shrub, or herbaceous) and ecological drivers (e.g., climate, regionalism). The alliance-level taxon is a group of diagnostic plant species that repeat across a landscape reflecting regional to sub-regional climate, substrate, hydrology, moisture/nutrient factors, and disturbance regimes. The VegCAMP data also includes polygons of group-level, which are higher level and less specific than alliance level descriptions. Alliances are defined and described in detail by A Manual of California Vegetation (Sawyer et al. 2009).

The VegCAMP vegetation maps are geospatially registered polygons that are digitized on base imagery that meets or exceeds the National Agricultural Imagery Program (NAIP) resolution standards of 1-meter ground sample distance. VegCAMP is considered the highest resolution data source for California vegetation mapping and is therefore used as the basis of the NCCAG dataset. The minimum map unit (MMU) of VegCAMP data is typically 1–2 acres, with a maximum of 10 acres; wetlands identified in VegCAMP have an MMU of 0.25 acre with the minimum polygon width of at least 10 meters (DWR 2018c). Accuracy Assessments are conducted in-field as a form of quality control, to correct any specific and systematic errors prior to map finalization and release. SCV requires every map to be verified and to meet a standard of at least 80 percent overall accuracy between map units and spot
checks, and the maps typically exceed this standard. Data gaps and overlaps are ideally eliminated through geodatabase quality checking of each map (CDFW 2018).

The National Wetland Inventory (NWI) created by the U.S. Fish and Wildlife Service (USFWS) is a mapping tool that identifies wetlands by type (based on the Cowardin classification; Cowardin et al. 1979) and distribution throughout the United States. NWI relies on trained image analysts to digitize wetland habitats, which are identified based on vegetation, visible hydrology and geography. Mapping is completed at 1:24,000 scale (1-inch equals 2000 feet). A margin of error is inherent in the identification of wetlands on imagery; thus, detailed on-the-ground inspection of any site may result in revision of the wetland boundaries or classification established through image analysis (USFWS 2018). In the continental United States, NWI uses a target MMU of 0.5 acre (USFWS 2015). Certain types of “farmed wetlands” and submerged aquatic vegetation found in intertidal and subtidal zones of estuaries are specifically excluded from the NWI dataset.

2.3.8.2 Conclusions

As stated in the introduction of this section, there are no known GDEs in NKWSD and SWID. Although NCCAG data are mapped within the Poso Creek channel, persistent shallow groundwater has not been documented in the channel, which is ephemeral and rarely flows west of SR-99. Based on the data gaps discussed in the above description, a field survey may be warranted to identify some of the NCCAG species listed in the Poso Creek area. In addition, field investigation of any potential shallow water table within the Poso Creek channel may be informative.

2.4 Management Areas within NKWSD and SWID

This management area plan covers the jurisdictions of both NKWSD and SWID as shown in Figure 2-47. Management areas for the districts described in this management area plan are defined as follows:

2.4.1 NKWSD’s Management Areas

The jurisdiction of NKWSD has been divided into two management areas (MA). One management area (NKWSD MA-1) is defined as the “Old District”, referring to the boundaries of NKWSD prior to the annexation of the land that would later become Rosedale Ranch Improvement District (RRID). The other management area (NKWSD MA-2) consists of those portions of RRID that are located outside of the boundaries of the KRGSA but within the RRID boundary.

2.4.1.1 Old District Management Area

The “Old District: management area, in addition to the pre-1966 boundaries of NKWSD, includes those portions of the City of Shafter and McFarland that are within the boundaries of NKWSD. The areas within the cities of Shafter and McFarland that are within the NKWSD are subject to the sustainable management criteria (SMCs), projects, and management actions defined by NKWSD in this Plan.
2.4.1.2 RRID Management Area

RRID in its entirety consists of a total of 9,500 acres, with the majority of its area located south of 7th Standard Road. This area was originally annexed into NKWSD in 1966 without surface water supplies. Subsequently, an irrigation distribution system was built to serve all developed land. In 1980 these lands were organized as an Improvement District, with one of its purposes to contract for water supplies to be distributed to the lands within RRID for either irrigation or for groundwater recharge. Changes in land use and expansion of the City of Bakersfield from 1980 to present have led to a decrease in irrigated acreage in RRID.

The RRID management area consists of about 5,300 acres, which represents the area of RRID that is located outside of the KRGSA’s area (which is coincidental with the City of Bakersfield’s area). The RRID management area is located within the jurisdiction of NKWSD and subject to the SMCs, Projects, and Management Actions defined by NKWSD in this Plan. Figure 2-47 shows the management areas covered in this management area plan. The portion of RRID located within KRGSA is similarly subject to the SMCs, Projects, and Management Actions defined in the KRGSA GSP.

Notwithstanding that, RRID is subject to both KGA’s and KRGSA’s SGMA jurisdiction. NKWSD has the authority and obligation to provide water supplies to the lands within the improvement district, and NKWSD intends to allocate available supplies equally to all such lands. However, since RRID was formed to support agriculture, lands that are converted to urban land uses pursuant to the Bakersfield General Plan will be detached from the improvement district and no longer allocated water from NKWSD.

2.4.2 SWID’s Management Areas

SWID has two management areas. One management area is defined as the lands within SWID’s boundaries, including those portions of the cities of Shafter and Wasco. This management area is included in this management area plan. Undistricted lands located to the south of SWID’s jurisdiction and north of 7th Standard Rd (known as the “7th Standard Annex”) are part of a separate management area. Per the landowner agreement with SWID, this management area is preparing its own management area plan for inclusion in the KGA GSP and as a result is not included in this management area plan.

2.5 District Water Budgets

The following section describes, in detail, the estimation of water budgets for NKWSD management areas and the SWID management area covered in this plan. The water budgets were developed to quantify the inflows and outflows within each district, based on current apparent water supply availability, water demand, and land use information for a recent historical, current, and future (projected) time periods.

For all management areas subject to this plan, the recent historical water budgets were estimated for 1993 through 2015. This time period includes varying hydrologic conditions, changes in water supply
availability, and varying water demand. This period was also selected as reliable data are available for the districts and includes enough variability to evaluate district groundwater level responses.

A similar water budget accounting report was prepared for SWID as part of the original consideration by the U.S. Bureau of Reclamation of SWID’s request for a Friant Division CVP Long Term Water Supply Contract. That report, completed in 1953 and referred to as the “Factual Report”, described certain physical conditions and determined the currently available supply (including various sources of groundwater and the anticipated CVP contract supplies), and the anticipated demand at full development of the District lands to their ultimate commercial uses, primarily agricultural. One of the chief benefits identified in that report, and objectives of the SWID CVP contract, was the stabilization of groundwater supplies resulting from introduction of the CVP water supply. SWID has operated largely in conformance with this budget since introduction of CVP supplies under its contracts in 1959. The Factual Report, incorporated by this reference as fully set forth herein, and its assumptions are relevant to this Plan, and will be referred to in a comparative manner alongside the description of more recent historical, current, and future conditions.

The water budget under current conditions reflects projected long-term averages under current conditions, which includes projects and management actions that have been implemented from 2015 to 2019. The projected future water budgets use a representative period of 1970 to 2009 Kern River hydrology to project the NKWSD contract supply and a period of 1921 to 2003 San Joaquin River hydrology to project the SWID contract supply to determine the average long-term hydrology. Other supply and demand components are based on the historical budget.

Sections 2.5.1 and 2.5.2 outline data for the historical water budget for 1993 to 2015, relying on the inflow into the districts and the outflow out of the districts to determine the implied change in groundwater storage. The data are summarized on a yearly basis and some approximations were necessary due to limited data availability. A description of the demand and supply are presented below.

2.5.1 Demand

Total demand for each districts’ management area is estimated as the sum of Evapotranspiration (ET) of irrigated acreage, surface water outflow, and subsurface outflow. Urban areas were excluded in this demand estimation as urban water demand was included in the City pumping data in Section 2.7.1.3. Land uses other than irrigated acreage and urban areas are assumed to rely solely on precipitation (i.e. ET equals precipitation). Accordingly, those areas were not considered in the estimation of demands.

2.5.1.1 Evapotranspiration of Irrigated Acreage

Land Use

Irrigated acres were based on the 2014 land use data developed by Land IQ, on behalf of DWR. NKWSD’s and SWID’s management areas comprise approximately 60,000 acres (NKWSD “Old
District”, excluding RRID) and 39,000 acres (SWID District Area), respectively. Irrigated acreage estimated by Land IQ in 2014 is in this range (51,423 acres).

The RRID management area consists of approximately 5,300 acres, which is about 55-percent of the total area of the improvement district. According to the 2014 Land IQ data, the total irrigated area within the RRID management area is approximately 4,180 acres. The remainder of the management area consists of about 150 acres of urban use and approximately 970 acres of other land uses. In 2016, NKWSD crop survey data indicate that the management area had about 4,300 irrigated acres. Over time, land use in RRID has changed due to urban land conversion. The permanent conversion of land use from agricultural to urban use accounts for decrease in irrigated acreage, as well as land coming out of cultivation during the most recent drought.

Similar to NKWSD, crop survey data collected by SWID indicated that irrigated acreage remained relatively constant over the years, ranging from 29,912 acres in 2009 to 29,562 acres in 2014 to 28,948 acres in 2017. The irrigated acreage estimated by Land IQ in 2014 was estimated as 29,407 acres which is very close to the SWID-collected land use data. This land use distribution for both NKWSD and SWID is shown in Figures 1-4 and 2-24.

**Evapotranspiration**

Evapotranspiration (ET) was estimated based on the Irrigation Training and Research Center (ITRC) data from 1993 to 2015 based on remote sensing techniques. The 2014 Land IQ land use data was used to extract the ET for the area for each year based on satellite imagery. ET varied from year to year due to the changing crop patterns and climate.

Table 2-13 shows the estimated ET for NKWSD and all of RRID; Table 2-14 shows the estimated ET for SWID based on the 2014 irrigated acreages for 1993 to 2015. NKWSD ET varied from 117.2 thousand acre-feet (TAF) in 1999 to 170.3 TAF in 2015, with an average ET of 141.9 TAF. The estimated ET for all of RRID ranges from 20.7 TAF in 2011 to 29.0 TAF in 2015, with an average estimated ET for the entire improvement district of 25.5 TAF. Similarly, SWID ET varied from 67.7 TAF in 2010 to 95.7 TAF in 1996 with an average ET of 81.2 TAF.

ET for native vegetation is not included in this estimation as it is assumed that the precipitation over the non-agricultural land will result in a net zero demand (i.e. ET will equal precipitation). ET in urban areas is also excluded from the estimate. Rather, it is reflected in the cities’ pumpage.
Table 2-13: Evapotranspiration for Irrigated Acreage within NKWSD and RRID (1993-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>NKWSD Total ET (TAF)</th>
<th>RRID Total ET (TAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>135.8</td>
<td>26.5</td>
</tr>
<tr>
<td>1994</td>
<td>141.1</td>
<td>26.5</td>
</tr>
<tr>
<td>1995</td>
<td>141.8</td>
<td>27.3</td>
</tr>
<tr>
<td>1996</td>
<td>155.4</td>
<td>27.6</td>
</tr>
<tr>
<td>1997</td>
<td>131.4</td>
<td>26.5</td>
</tr>
<tr>
<td>1998</td>
<td>128.3</td>
<td>23.0</td>
</tr>
<tr>
<td>1999</td>
<td>117.2</td>
<td>24.3</td>
</tr>
<tr>
<td>2000</td>
<td>130.6</td>
<td>24.0</td>
</tr>
<tr>
<td>2001</td>
<td>144.4</td>
<td>24.4</td>
</tr>
<tr>
<td>2002</td>
<td>141.9</td>
<td>27.0</td>
</tr>
<tr>
<td>2003</td>
<td>140.3</td>
<td>26.9</td>
</tr>
<tr>
<td>2004</td>
<td>151.6</td>
<td>27.0</td>
</tr>
<tr>
<td>2005</td>
<td>129.8</td>
<td>24.7</td>
</tr>
<tr>
<td>2006</td>
<td>131.6</td>
<td>23.8</td>
</tr>
<tr>
<td>2007</td>
<td>145.3</td>
<td>25.6</td>
</tr>
<tr>
<td>2008</td>
<td>142.7</td>
<td>24.4</td>
</tr>
<tr>
<td>2009</td>
<td>145.1</td>
<td>24.9</td>
</tr>
<tr>
<td>2010</td>
<td>151.7</td>
<td>21.9</td>
</tr>
<tr>
<td>2011</td>
<td>137.4</td>
<td>20.9</td>
</tr>
<tr>
<td>2012</td>
<td>153.9</td>
<td>20.7</td>
</tr>
<tr>
<td>2013</td>
<td>170.3</td>
<td>28.0</td>
</tr>
<tr>
<td>2014</td>
<td>159.0</td>
<td>26.4</td>
</tr>
<tr>
<td>2015</td>
<td>137.4</td>
<td>29.0</td>
</tr>
<tr>
<td>Minimum</td>
<td>117.2</td>
<td>20.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>170.3</td>
<td>29.0</td>
</tr>
<tr>
<td>Average 1993-2015:</td>
<td>141.9</td>
<td>25.5</td>
</tr>
</tbody>
</table>
Table 2-14: Evapotranspiration within SWID (1993-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total ET (TAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>88.8</td>
</tr>
<tr>
<td>1994</td>
<td>92.6</td>
</tr>
<tr>
<td>1995</td>
<td>90.6</td>
</tr>
<tr>
<td>1996</td>
<td>95.7</td>
</tr>
<tr>
<td>1997</td>
<td>84.5</td>
</tr>
<tr>
<td>1998</td>
<td>73.7</td>
</tr>
<tr>
<td>1999</td>
<td>77.2</td>
</tr>
<tr>
<td>2000</td>
<td>79.8</td>
</tr>
<tr>
<td>2001</td>
<td>83.6</td>
</tr>
<tr>
<td>2002</td>
<td>84.2</td>
</tr>
<tr>
<td>2003</td>
<td>84.3</td>
</tr>
<tr>
<td>2004</td>
<td>89.1</td>
</tr>
<tr>
<td>2005</td>
<td>74.5</td>
</tr>
<tr>
<td>2006</td>
<td>71.3</td>
</tr>
<tr>
<td>2007</td>
<td>77.4</td>
</tr>
<tr>
<td>2008</td>
<td>75.8</td>
</tr>
<tr>
<td>2009</td>
<td>75.3</td>
</tr>
<tr>
<td>2010</td>
<td>67.7</td>
</tr>
<tr>
<td>2011</td>
<td>69.0</td>
</tr>
<tr>
<td>2012</td>
<td>81.4</td>
</tr>
<tr>
<td>2013</td>
<td>93.7</td>
</tr>
<tr>
<td>2014</td>
<td>81.1</td>
</tr>
<tr>
<td>2015</td>
<td>76.2</td>
</tr>
<tr>
<td>Minimum</td>
<td>67.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>95.7</td>
</tr>
<tr>
<td>Average 1993-2015</td>
<td>81.2</td>
</tr>
</tbody>
</table>

2.5.1.2 Surface Outflows

In addition to participating in the transfer and exchange programs, NKWSD also periodically banks water in the Subbasin for other agencies and subsequently returns most of the banked supplies. SWID also participates in transfer and exchange programs with NKWSD and SWSD. A summary of NKWSD and RRID historical surface outflows and surface inflows are shown in Table 2-15. A summary of SWID’s historical surface outflows and surface inflows are shown in Table 2-16.

In the following tables, note that over a long period of time transfer and exchange programs are expected to net zero change in groundwater storage (i.e. the quantity of water flowing in and out of the district will balance). This is reflected in the surface outflow components in the projected future water budgets for both NKWSD and SWID (discussed in Section 2.5.4). Additionally, water delivered to Cawelo is wheeled through the Beardsley/Lerdo Canal and nets zero change in groundwater storage. Historical surface outflow and surface inflow volumes are also shown for the entirety of RRID. The RRID
management area covered under this management area plan accounts for 55-percent of the total area, as described in Section 2.4.1 and shown in Figure 2-47.

Table 2-15: Summary of NKWSD and RRID Surface Outflows (1993-2015), in TAF

<table>
<thead>
<tr>
<th>Year</th>
<th>Kern River Runoff Index</th>
<th>NKWSD Outflow</th>
<th>RRID Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>75.8</td>
<td>2.1</td>
<td>—</td>
</tr>
<tr>
<td>1994</td>
<td>56.7</td>
<td>0.0</td>
<td>2.0</td>
</tr>
<tr>
<td>1995</td>
<td>70.9</td>
<td>1.8</td>
<td>0.1</td>
</tr>
<tr>
<td>1996</td>
<td>74.9</td>
<td>2.7</td>
<td>2.1</td>
</tr>
<tr>
<td>1997</td>
<td>73.9</td>
<td>5.0</td>
<td>—</td>
</tr>
<tr>
<td>1998</td>
<td>60.4</td>
<td>4.4</td>
<td>0.2</td>
</tr>
<tr>
<td>1999</td>
<td>68.6</td>
<td>5.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2000</td>
<td>61.3</td>
<td>1.6</td>
<td>0.4</td>
</tr>
<tr>
<td>2001</td>
<td>47.5</td>
<td>—</td>
<td>1.1</td>
</tr>
<tr>
<td>2002</td>
<td>55.1</td>
<td>—</td>
<td>2.5</td>
</tr>
<tr>
<td>2003</td>
<td>60.3</td>
<td>—</td>
<td>0.3</td>
</tr>
<tr>
<td>2004</td>
<td>53.4</td>
<td>—</td>
<td>0.5</td>
</tr>
<tr>
<td>2005</td>
<td>66.3</td>
<td>5.4</td>
<td>—</td>
</tr>
<tr>
<td>2006</td>
<td>78.8</td>
<td>5.0</td>
<td>0.3</td>
</tr>
<tr>
<td>2007</td>
<td>44.4</td>
<td>0.2</td>
<td>2.1</td>
</tr>
<tr>
<td>2008</td>
<td>39.4</td>
<td>—</td>
<td>2.8</td>
</tr>
<tr>
<td>2009</td>
<td>42.3</td>
<td>0.2</td>
<td>5.6</td>
</tr>
<tr>
<td>2010</td>
<td>54.6</td>
<td>1.5</td>
<td>—</td>
</tr>
<tr>
<td>2011</td>
<td>76.2</td>
<td>6.3</td>
<td>0.4</td>
</tr>
<tr>
<td>2012</td>
<td>55.5</td>
<td>—</td>
<td>13.2</td>
</tr>
<tr>
<td>2013</td>
<td>22.1</td>
<td>—</td>
<td>8.9</td>
</tr>
<tr>
<td>2014</td>
<td>12.0</td>
<td>—</td>
<td>4.2</td>
</tr>
<tr>
<td>2015</td>
<td>7.3</td>
<td>—</td>
<td>3.0</td>
</tr>
<tr>
<td>Minimum</td>
<td>7.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>78.8</td>
<td>6.3</td>
<td>13.2</td>
</tr>
<tr>
<td>Average 1993-2015:</td>
<td>54.7</td>
<td>1.8</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Table 2-16: Summary of SWID Outflows (1993-2015), in TAF

<table>
<thead>
<tr>
<th>Year</th>
<th>SWID Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>—</td>
</tr>
<tr>
<td>1994</td>
<td>—</td>
</tr>
<tr>
<td>1995</td>
<td>5.2</td>
</tr>
<tr>
<td>1996</td>
<td>2.6</td>
</tr>
<tr>
<td>1997</td>
<td>8.0</td>
</tr>
<tr>
<td>1998</td>
<td>3.2</td>
</tr>
<tr>
<td>1999</td>
<td>2.2</td>
</tr>
<tr>
<td>2000</td>
<td>—</td>
</tr>
<tr>
<td>2001</td>
<td>5.1</td>
</tr>
<tr>
<td>2002</td>
<td>—</td>
</tr>
<tr>
<td>2003</td>
<td>—</td>
</tr>
<tr>
<td>2004</td>
<td>—</td>
</tr>
<tr>
<td>2005</td>
<td>1.0</td>
</tr>
<tr>
<td>2006</td>
<td>2.1</td>
</tr>
<tr>
<td>2007</td>
<td>—</td>
</tr>
<tr>
<td>2008</td>
<td>2.2</td>
</tr>
<tr>
<td>2009</td>
<td>3.1</td>
</tr>
<tr>
<td>2010</td>
<td>—</td>
</tr>
<tr>
<td>2011</td>
<td>0.5</td>
</tr>
<tr>
<td>2012</td>
<td>0.6</td>
</tr>
<tr>
<td>2013</td>
<td>—</td>
</tr>
<tr>
<td>2014</td>
<td>1.6</td>
</tr>
<tr>
<td>2015</td>
<td>1.4</td>
</tr>
<tr>
<td>Minimum</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>8.0</td>
</tr>
<tr>
<td>Average 1993-2015:</td>
<td>1.7</td>
</tr>
</tbody>
</table>

2.5.1.3 Subsurface Outflows

At this time, there is insufficient data to make a relatively reasonable estimate of subsurface outflow from either NKWSD or SWID, or the proportion of outflow that is native compared with the proportion that results from development and implementation of the districts’ projects. Accordingly, for the purposes of this management area plan, this has been identified as a data gap and will be addressed in future plan updates.
2.5.2 Source of Water Supply

Both NKWSD and SWID primarily receives water through supplemental or imported surface water sources. Native sources such as streambed infiltration are considered minimal. Supplemental water sources for NKWSD include water received from the Kern River, Poso Creek, Oilfield-Produced Water, CVP water and Water Banking Leave-Behind Water. Supplemental water sources for SWID include water received from the CVP and other district water imports, through exchange and transfer programs.

Native sources are available from precipitation, subsurface flow, and runoff. Precipitation over non-agricultural lands is estimated as net zero with no change in water storage as it was assumed that the ET for these non-agricultural lands balances with precipitation. As a result, only precipitation over agricultural lands is used to estimate water supply into the Districts. For the purposes of developing these water budget components for SGMA planning, an assumed precipitation value of 0.42 AF per irrigated acre is used.

The summary of NKWSD and RRID water supply is presented in Table 2-17. The summary of SWID water supply is presented in Table 2-18. The net surface inflows for both Districts are also shown in their respective tables; net surface inflow is calculated as the difference between the surface inflows and the surface outflows (in Table 2-15 and Table 2-16) for each year. These tables do not represent the water supply components attributed to subsurface inflow, surface runoff, or precipitation. Those components of water supply are discussed later in this section.

Additional details regarding the inflows presented in Table 2-17 and 2-18 are provided in the following sections. NKWSD primarily imports surface water using their contract for Kern River water and SWID through their contract with the CVP. The surface water brought in through contracts is used to meet agricultural crop demands. Non-contract water is predominately banked in the Subbasin but is also used for meeting agricultural crop demands (i.e. in-lieu recharge). Other sources of water include wastewater recycled from the cities discussed in section 2.5.2.11.

---

1 It should be noted, however, that the SWID Factual Report described in section 2.5 above was prepared by the U.S. Bureau of Reclamation in anticipation of SWID’s Friant Division CVP supply contract. The SWID Factual Report described then existing conditions including several streambed infiltration sources of supplies, as well as inflows into the District from neighboring areas; these supplies are not considered by this Plan. However, the historic availability of these supplies, and the groundwater pumping within SWID in accordance with the SWID Factual Report for the past 60 years, is noted here for the purpose of identifying supplies that SWID’s project utilizes and may seek to assert additional interests in during updates and or future proceedings if necessary.

2 As noted above, these tables do not include an accounting of historical sources of groundwater that were described by and accounted for within the SWID Factual Report prepared by the U.S. Bureau of Reclamation. Omitting these supplies from the accounting here is done in the interest achieving a consensus water supply budget for basin management purposes at this time; SWID reserves the right to revisit this issue in future updates or other proceedings.
## Table 2-17: NKWSD and RRID Historical Inflows (1993-2015), in TAF

<table>
<thead>
<tr>
<th>Year</th>
<th>Kern River Runoff Index</th>
<th>NKWSD Inflow</th>
<th>NKWSD Outflow</th>
<th>NKWSD Net Inflow</th>
<th>RRID Inflow</th>
<th>RRID Outflow</th>
<th>RRID Net Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>119%</td>
<td>279.5</td>
<td>78.6</td>
<td>200.8</td>
<td>22.7</td>
<td>0</td>
<td>22.7</td>
</tr>
<tr>
<td>1994</td>
<td>47%</td>
<td>171.7</td>
<td>58.7</td>
<td>113.0</td>
<td>1.4</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td>1995</td>
<td>193%</td>
<td>444.3</td>
<td>76.4</td>
<td>367.9</td>
<td>19.1</td>
<td>0</td>
<td>19.1</td>
</tr>
<tr>
<td>1996</td>
<td>144%</td>
<td>354.4</td>
<td>87.9</td>
<td>266.5</td>
<td>14.7</td>
<td>0</td>
<td>14.7</td>
</tr>
<tr>
<td>1997</td>
<td>164%</td>
<td>370.6</td>
<td>95.1</td>
<td>275.5</td>
<td>17.4</td>
<td>0</td>
<td>17.4</td>
</tr>
<tr>
<td>1998</td>
<td>239%</td>
<td>513.7</td>
<td>156.0</td>
<td>357.7</td>
<td>15.1</td>
<td>0</td>
<td>15.1</td>
</tr>
<tr>
<td>1999</td>
<td>60%</td>
<td>249.1</td>
<td>76.4</td>
<td>172.7</td>
<td>5.9</td>
<td>0</td>
<td>5.9</td>
</tr>
<tr>
<td>2000</td>
<td>66%</td>
<td>194.1</td>
<td>63.7</td>
<td>130.4</td>
<td>1.6</td>
<td>0</td>
<td>1.6</td>
</tr>
<tr>
<td>2001</td>
<td>54%</td>
<td>123.8</td>
<td>48.5</td>
<td>75.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>59%</td>
<td>123.8</td>
<td>57.6</td>
<td>66.2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>72%</td>
<td>172.3</td>
<td>60.6</td>
<td>111.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>57%</td>
<td>163.9</td>
<td>53.9</td>
<td>110.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>161%</td>
<td>375.6</td>
<td>80.7</td>
<td>294.9</td>
<td>14.9</td>
<td>0</td>
<td>14.9</td>
</tr>
<tr>
<td>2006</td>
<td>149%</td>
<td>433.1</td>
<td>97.3</td>
<td>335.7</td>
<td>13.4</td>
<td>0</td>
<td>13.4</td>
</tr>
<tr>
<td>2007</td>
<td>35%</td>
<td>142.5</td>
<td>56.1</td>
<td>86.4</td>
<td>0.2</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>2008</td>
<td>72%</td>
<td>132.4</td>
<td>53.0</td>
<td>79.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>65%</td>
<td>141.9</td>
<td>58.7</td>
<td>83.2</td>
<td>1.3</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>2010</td>
<td>127%</td>
<td>240.6</td>
<td>56.3</td>
<td>184.4</td>
<td>3.7</td>
<td>0</td>
<td>3.7</td>
</tr>
<tr>
<td>2011</td>
<td>191%</td>
<td>453.8</td>
<td>87.1</td>
<td>366.6</td>
<td>16.3</td>
<td>0</td>
<td>16.3</td>
</tr>
<tr>
<td>2012</td>
<td>46%</td>
<td>142.0</td>
<td>75.5</td>
<td>66.5</td>
<td>0.3</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>2013</td>
<td>29%</td>
<td>36.3</td>
<td>39.7</td>
<td>-3.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2014</td>
<td>24%</td>
<td>28.0</td>
<td>29.8</td>
<td>-1.8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>19%</td>
<td>26.5</td>
<td>18.5</td>
<td>8.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Minimum: 26.5 18.5 (3.4) 0 0 0

Maximum: 513.7 156.0 367.9 22.7 0 22.7

Average 1993-2015: 231.0 68.1 162.9 6.4 0 6.4
<table>
<thead>
<tr>
<th>Year</th>
<th>Friant Class 1 Allocation</th>
<th>Friant Class 2 Allocation</th>
<th>SWID Inflows</th>
<th>SWID Outflows</th>
<th>SWID Net Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>100%</td>
<td>70%</td>
<td>75.1</td>
<td>0</td>
<td>75.1</td>
</tr>
<tr>
<td>1994</td>
<td>84%</td>
<td>0%</td>
<td>44.2</td>
<td>0</td>
<td>44.2</td>
</tr>
<tr>
<td>1995</td>
<td>100%</td>
<td>100%</td>
<td>73.2</td>
<td>5.2</td>
<td>68.0</td>
</tr>
<tr>
<td>1996</td>
<td>100%</td>
<td>48%</td>
<td>75.6</td>
<td>2.6</td>
<td>73.0</td>
</tr>
<tr>
<td>1997</td>
<td>100%</td>
<td>35%</td>
<td>85.6</td>
<td>8.0</td>
<td>77.6</td>
</tr>
<tr>
<td>1998</td>
<td>100%</td>
<td>100%</td>
<td>55.7</td>
<td>3.2</td>
<td>52.5</td>
</tr>
<tr>
<td>1999</td>
<td>100%</td>
<td>29%</td>
<td>61.8</td>
<td>2.2</td>
<td>59.6</td>
</tr>
<tr>
<td>2000</td>
<td>100%</td>
<td>35%</td>
<td>62.1</td>
<td>0</td>
<td>62.1</td>
</tr>
<tr>
<td>2001</td>
<td>100%</td>
<td>7%</td>
<td>53.9</td>
<td>5.1</td>
<td>48.8</td>
</tr>
<tr>
<td>2002</td>
<td>100%</td>
<td>12%</td>
<td>58.4</td>
<td>0</td>
<td>58.4</td>
</tr>
<tr>
<td>2003</td>
<td>100%</td>
<td>29%</td>
<td>62.3</td>
<td>0</td>
<td>62.3</td>
</tr>
<tr>
<td>2004</td>
<td>100%</td>
<td>8%</td>
<td>56.8</td>
<td>0</td>
<td>56.8</td>
</tr>
<tr>
<td>2005</td>
<td>100%</td>
<td>0%</td>
<td>67.8</td>
<td>1.0</td>
<td>66.8</td>
</tr>
<tr>
<td>2006</td>
<td>100%</td>
<td>0%</td>
<td>70.0</td>
<td>2.1</td>
<td>67.9</td>
</tr>
<tr>
<td>2007</td>
<td>65%</td>
<td>0%</td>
<td>36.4</td>
<td>0</td>
<td>36.4</td>
</tr>
<tr>
<td>2008</td>
<td>100%</td>
<td>5%</td>
<td>52.3</td>
<td>2.2</td>
<td>50.1</td>
</tr>
<tr>
<td>2009</td>
<td>100%</td>
<td>18%</td>
<td>56.3</td>
<td>3.1</td>
<td>53.2</td>
</tr>
<tr>
<td>2010</td>
<td>100%</td>
<td>15%</td>
<td>65.3</td>
<td>0</td>
<td>65.3</td>
</tr>
<tr>
<td>2011</td>
<td>100%</td>
<td>15%</td>
<td>75.9</td>
<td>0.5</td>
<td>75.4</td>
</tr>
<tr>
<td>2012</td>
<td>50%</td>
<td>0%</td>
<td>47.3</td>
<td>0.6</td>
<td>46.7</td>
</tr>
<tr>
<td>2013</td>
<td>62%</td>
<td>0%</td>
<td>32.3</td>
<td>0</td>
<td>32.3</td>
</tr>
<tr>
<td>2014</td>
<td>0%</td>
<td>0%</td>
<td>10.2</td>
<td>1.6</td>
<td>8.6</td>
</tr>
<tr>
<td>2015</td>
<td>0%</td>
<td>0%</td>
<td>3.0</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td>3.0</td>
<td>0.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td>85.6</td>
<td>8.0</td>
<td>77.6</td>
</tr>
<tr>
<td>Average 1993-2015</td>
<td></td>
<td></td>
<td>55.7</td>
<td>1.7</td>
<td>54.0</td>
</tr>
</tbody>
</table>
2.5.2.1 Kern River

The Kern River is the primary source of water to NKWSD and is conveyed from the River into the district through the Calloway Canal and the Beardsley Canal. CWD wheels water through NKWSD Beardsley Canal and pumps water out of the Lerdo Canal. NKWSD receives Kern water through several contracts: the 1952 Agreement, the Kern Delta Settlement Agreement, and the City of Bakersfield Extension Contract (including the Kern River Canal and Irrigating Company supplies). The inflow data in Table 2-17 for NKWSD includes North Kern Contract water along with occasional banking water. This surface inflow also contains Cawelo contract water which is delivered through the Beardsley to the Lerdo and accounted for in the surface outflow volumes shown in both Table 2-15 and Table 2-17. SWID does not receive any water from the Kern River.

2.5.2.2 CVP Water

NKWSD occasionally diverts water from the FKC during wetter years, either through temporary contracts with the Bureau of Reclamation (e.g. Section 215), or more frequently through water banking and exchange programs with CVP contractors such as SWID, DEID, KTWD, and SSJMU. Historically Section 215 water has been available infrequently and for short durations to non-long-term contractors such as NKWSD. These inflow volumes are included in the surface inflow volumes shown in in Table 2-17.

The CVP is the primary source of surface water available to SWID and provides water via the FKC from Millerton Lake (Friant Reservoir). SWID has CVP contracts for 50,000 AF of Class 1 and 39,600 AF of Class 2 water per year. This water is used to meet crop ET demand. In addition, the District receives recaptured Class 1 and Class 2, 16B, and other water when available from the CVP. The non-Class 1 and non-Class 2 water are typically “surplus water” made available during periods of forecasted spill on the Friant Dam. On average, SWID receives approximately 55.7 TAF of deliveries via the Friant-Kern Canal (1993-2015) as shown in Table 2-18.

2.5.2.3 Exchange and Transfer Program

Both NKWSD and SWID participate in a water transfer and exchange program. These inflows and outflows between NKWSD and SWID are accounted for in the annual summary of surface inflows and outflows (Table 2-17 and Table 2-18).

2.5.2.4 Poso Creek

Historically, Poso Creek flows have reached California Highway 99 in about two of every five years (1981-2019, Kern River Annual Hydrographic Reports to 2017. Data provided by Fernando Rizo at NKWSD on April 9, 2019) Starting in 1997, the use of Poso Creek water has been governed by an agreement between NKWSD, CWD, and SWSD, who collectively share the runoff of Poso Creek. Under this agreement, NKWSD receives flows between 135 cfs and 300 cfs and when Poso Creek is flowing at greater than 685 cfs. The inflows and outflows attributed to Poso Creek are included in the
data presented for NKWSD in Table 2-15 and Table 2-17. SWID does not receive any water from Poso Creek.

### 2.5.2.5 Oilfield-Produced Water

In 2015, NKWSD entered into an agreement with the California Resources Corporation (CRC) for the delivery of oilfield-produced water from their Kern Front oilfield operations. The agreement defined a minimum annual quantity of 11,700 AF and a maximum annual quantity of 21,200 AF. While the term of the agreement extends through 2035, it only provides for delivering the minimum quantity through 2025. In the first (partial) year of the agreement in 2015 NKWSD received approximately 2.2 TAF of oilfield-produced water. The volume of oilfield-produced water received by NKWSD is included in the surface inflows presented for the District in Table 2-17. SWID does not receive any oilfield-produced water.

### 2.5.2.6 Water Banking Leave Behind

NKWSD imports water for other districts as banked water. Of the banked water the District keeps a portion of “leave-behind” water, typically of 10%, whereas the rest is returned to the participating agency at a later another period. This “leave-behind” is included as a portion of the surface inflows presented in Table 2-17.

### 2.5.2.7 Precipitation

Precipitation is a source of inflow into the Districts. However, precipitation was only used for the irrigated acreage. Areas outside irrigated acreage such as native vegetation is assumed to net zero in the water budget analysis as it was assumed that the ET/demand is met by the precipitation. Similarly, rural areas were also estimated to net zero in the water budget and were estimated to be minimal user. Through the coordination with all the member agencies of KGA, it was estimated that the average precipitation for the area is 0.42 AF/acre per year. This value is applied as an annual value to the irrigated acreage and will be included in the water budgets presented in this section.

### 2.5.2.8 Inflow to the Groundwater System

For the purposes of developing the water budgets for this plan, an assumed zero net change in groundwater storage is used. This assumption is made in the absence of reliable data. This has been identified as a data gap and will be addressed in subsequent plan updates.

### 2.5.2.9 Agricultural Pumping

Groundwater pumping in both Districts is estimated as the volume of water required to supplement surface water supplies to cover the total ET for the irrigated lands. The historical and projected water budgets assume that agricultural demand (i.e. ET for irrigated lands) is met by groundwater to the extent that others supplies are inadequate. Accordingly, this implied change in groundwater storage reflects the net draw on the groundwater within each District.
As explained previously, banked water is included in the surface water deliveries, but since most of this water will be returned to the banker in a future year, the historical water budget values will be somewhat skewed depending on how much of the banked water has been returned at a given point in time.

2.5.2.10 Urban Pumping

Although the cities of Shafter and of Wasco span over the two districts groundwater pumping records for the cities are not differentiated by district. As a result, it is assumed that urban pumping occurs evenly over urban land use and the amount of urban pumping in each District is based on the percentage of urban land use within the District. Division of Land Resource Protection (DLRP) Farmland Mapping and Monitoring Program (2016) provided more detailed urban land use data compared to the 2014 Land IQ land use data; this land use data was used to estimate urban pumping after adjusting the data to remove spreading ponds and large undeveloped areas in the NKWSD. Table 2-19 provides a summary of urban acreage for City of Shafter and Wasco within the NKWSD and SWID.

Groundwater pumping for the City of Shafter and Wasco is documented for 2005 and 2010 and estimated for 2015 in the 2015 Urban Water Management Plan (UWMP). This data was adjusted to remove Wasco prison from the City of Wasco demand as the City wells do not provide water to the prison. This data was used to estimate the 2005, 2010 and 2015 urban pumping for NKWSD and SWID based on the percentage of urban land use within the District. Table 2-20 provides a summary of City of Shafter and City of Wasco urban pumping for 2005, 2010, and 2015 along with the estimated urban pumping for NKWSD and SWID. As shown in Table 2-20, it was observed that urban pumping decreased in 2015 when compared to 2005 and 2010. This decrease in demand can be attributed to the historical drought experienced in California between 2011 and 2015 and the enactment of urban water restrictions and the promotion of conservation.
Table 2-19: Urban Acreage for the City of Shafter and City of Wasco within NKWSD and SWID

<table>
<thead>
<tr>
<th>Cities</th>
<th>Urban Acreage</th>
<th>Urban Acreage Adjusted¹</th>
<th>% Urban Acreage</th>
<th>% Urban Acreage Adjusted</th>
<th>Adjustment Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shafter</td>
<td>3,984</td>
<td>3,225</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>North Kern Water Storage District</td>
<td>2,028</td>
<td>1,269</td>
<td>39%</td>
<td>39%</td>
<td>Removed Spreading Pond and undeveloped land for analysis in NKWSD</td>
</tr>
<tr>
<td>North Kern Water Storage District - RRID</td>
<td>1</td>
<td>1</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Shafter - Wasco Irrigation District</td>
<td>1,661</td>
<td>1,661</td>
<td>52%</td>
<td>52%</td>
<td></td>
</tr>
<tr>
<td>OUT¹</td>
<td>294</td>
<td>294</td>
<td>9%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Wasco</td>
<td>2,294</td>
<td>2,294</td>
<td>100%</td>
<td>100%</td>
<td>Wasco Prison not supplied by City wells, Excluded from City Demand</td>
</tr>
<tr>
<td>North Kern Water Storage District</td>
<td>60</td>
<td>60</td>
<td>3%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Semitropic Water Storage District²</td>
<td>287</td>
<td>287</td>
<td>12%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Shafter - Wasco Irrigation District</td>
<td>1,948</td>
<td>1,948</td>
<td>85%</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>OUT¹</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

(¹) OUT, Area outside of the areas of interest (Parts of Shafter which are in the undistricted lands)
(²) The Wasco Prison is part of the City of Wasco and is located in SWSD, but does not use city water supply and is excluded from the City Demand Analysis

Table 2-20: City Pumpage Demand (from UWMPs) by Percent Area in District, AF

<table>
<thead>
<tr>
<th>City</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>4,688</td>
<td>4,738</td>
<td>4,311</td>
</tr>
<tr>
<td>Wasco</td>
<td>4,654</td>
<td>4,681</td>
<td>3,456</td>
</tr>
<tr>
<td>North Kern Water Storage District</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>1,844</td>
<td>1,864</td>
<td>1,696</td>
</tr>
<tr>
<td>Wasco</td>
<td>140</td>
<td>140</td>
<td>104</td>
</tr>
<tr>
<td>Shafter-Wasco Irrigation District</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>2,415</td>
<td>2,441</td>
<td>2,221</td>
</tr>
<tr>
<td>Wasco</td>
<td>4,514</td>
<td>4,541</td>
<td>3,352</td>
</tr>
<tr>
<td>Other Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>429</td>
<td>433</td>
<td>394</td>
</tr>
<tr>
<td>Wasco</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2.5.2.11 Urban Recovery

The City of McFarland has a wastewater treatment (WWTP) located in NKWSD. The effluent from the WWTP is applied to agricultural land for beneficial reuse as irrigation water for permanent tree crops in proximity to the WWTP. The historic wastewater flows are shown in Table 2-21. The annual WWTP influent volume ranges from approximately 1,600 AF to 2,200 AF, for an average WWTP influent volume of 1,700 AF. The McFarland WWTP has an average recycling rate of 64%, with the annual recycled water volume ranging from 1,100 AF to 1,200 AF.
Table 2-21: City of McFarland Recycled Water Volumes, in TAF

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Flow</th>
<th>Recycled Water</th>
<th>% of Total Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1.5</td>
<td>1.2</td>
<td>75%</td>
</tr>
<tr>
<td>2012</td>
<td>1.8</td>
<td>1.1</td>
<td>61%</td>
</tr>
<tr>
<td>2013</td>
<td>2.2</td>
<td>1.1</td>
<td>50%</td>
</tr>
<tr>
<td>2014</td>
<td>1.6</td>
<td>1.1</td>
<td>68%</td>
</tr>
<tr>
<td>2015</td>
<td>1.8</td>
<td>1.1</td>
<td>59%</td>
</tr>
<tr>
<td>2016</td>
<td>1.6</td>
<td>1.1</td>
<td>68%</td>
</tr>
<tr>
<td>2017</td>
<td>1.6</td>
<td>1.1</td>
<td>70%</td>
</tr>
<tr>
<td>Average:</td>
<td>1.7</td>
<td>1.1</td>
<td>64%</td>
</tr>
</tbody>
</table>

Notes:
1 Total flow is determined water supply annual production (2011 to 2018)
2 Recycled Water Determined from WWTP Influent Flows (2009 to 2017)

The City of Wasco’s WWTP disperses treated water on 605 acres of city-owned land that surrounds the WWTP to the south and the west (located in SWID) that is strictly used for agriculture. The WWTP produced 1,899 AF in 2005 and 1,866 AF in 2010. The UWMP (2015) estimated that the wastewater collected and treated from 2015 to 2035. The volumes from the UWMP are shown in Table 2-22.

Table 2-22: City of Wasco Recycled Water Volumes, in TAF

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Flow</th>
<th>Recycled Water</th>
<th>% of Total Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>4.7</td>
<td>1.9</td>
<td>40%</td>
</tr>
<tr>
<td>2015 1</td>
<td>3.5</td>
<td>1.7</td>
<td>49%</td>
</tr>
<tr>
<td>2020</td>
<td>4.6</td>
<td>2.1</td>
<td>45%</td>
</tr>
<tr>
<td>2025</td>
<td>6.0</td>
<td>2.4</td>
<td>41%</td>
</tr>
<tr>
<td>2030</td>
<td>7.4</td>
<td>2.8</td>
<td>38%</td>
</tr>
<tr>
<td>2035</td>
<td>9.0</td>
<td>3.2</td>
<td>35%</td>
</tr>
</tbody>
</table>

Notes:
Data is based off of UWMP (2010 to 2035)
1 2015 UWMP updated based on annual pumpage summary tables. 2020 to 2035 maintained rate increase per year as stated in UWMP
2 Percentage of water pumped determined from UWMP

The City of Shafter’s WWTP (operated by the North of the River Sanitation District) receives wastewater from the city which is recycled onto the agricultural fields. The recycled water contributes to recharge outside of the SWID jurisdictional area and is distributed on the un-districted lands to the southwest. Therefore, SWID does not receive any recycled water from the City of Shafter.
2.5.2.12 Historical Water Budget Summaries

The components of the historical water budgets for NKWSD and RRID are summarized in Table 2-23, using the information presented in Table 2-13 through Table 22. The components of the historical water budget for SWID are summarized in Table 2-24. Both tables present the historical water budgets with the assumed precipitation of 0.42 AF per irrigated acre and the assumed subsurface inflow and runoff range of 0.15 AF per acre and 0.30 AF per acre.
Table 2-23: Historical Water Budget Summary for NKWSD and RRID (1993-2015), in AF

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Area (acres)</strong></td>
<td>60,000</td>
<td>9,500</td>
</tr>
<tr>
<td><strong>Irrigated Area (acres)</strong></td>
<td>51,400</td>
<td>8,569</td>
</tr>
<tr>
<td><strong>INFLOWS:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kern River</td>
<td>154,100</td>
<td>6,500</td>
</tr>
<tr>
<td>Poso Creek</td>
<td>3,500</td>
<td>0</td>
</tr>
<tr>
<td>Oilfield Produced Water</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Recycled (City of McFarland WWTP)</td>
<td>1,100</td>
<td>0</td>
</tr>
<tr>
<td>&quot;Other&quot;</td>
<td>7,100</td>
<td>0</td>
</tr>
<tr>
<td>Rainfall</td>
<td>21,600</td>
<td>3,600</td>
</tr>
<tr>
<td><strong>TOTAL INFLOW</strong></td>
<td><strong>187,500</strong></td>
<td><strong>10,100</strong></td>
</tr>
<tr>
<td><strong>OUTFLOWS:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated Area ET</td>
<td>141,900</td>
<td>25,500</td>
</tr>
<tr>
<td>Evaporation from Canals and Spreading Ponds</td>
<td>3,200</td>
<td>0</td>
</tr>
<tr>
<td>M&amp;I Pumping (cities of Shafter and Wasco)</td>
<td>1,800</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL OUTFLOW</strong></td>
<td><strong>146,900</strong></td>
<td><strong>25,500</strong></td>
</tr>
<tr>
<td><strong>&quot;NATIVE YIELD&quot;</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>@ 0.15 af/ac</td>
<td>9,000</td>
<td>1,425</td>
</tr>
<tr>
<td>@ 0.30 af/ac</td>
<td>18,000</td>
<td>2,850</td>
</tr>
<tr>
<td><strong>IMPLIED CHANGE IN GROUNDWATER STORAGE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without Native Yield</td>
<td>40,600</td>
<td>-15,400</td>
</tr>
<tr>
<td>Native Yield = 0.15 af/ac</td>
<td>49,600</td>
<td>-13,975</td>
</tr>
<tr>
<td>Native Yield = 0.30 af/ac</td>
<td>58,600</td>
<td>-12,550</td>
</tr>
</tbody>
</table>
Table 2-24: Historical Water Budget Summary for SWID (1993-2015), in AF

<table>
<thead>
<tr>
<th>SWID Historical Period (1993 - 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (acres)</td>
</tr>
<tr>
<td>Irrigated Area (acres)</td>
</tr>
</tbody>
</table>

**INFLOWS:**
- CVP Supply                        | 55,700 |
- Recycled (City of Wasco WWTP)      | 1,800  |
- "Other"                            | 7,100  |
- Rainfall                           | 12,400 |

**TOTAL INFLOW**                      | 77,000 |

**OUTFLOWS:**
- Irrigated Area ET                  | 81,200 |
- M&I Pumping (cities of Shafter and Wasco) | 5,600  |

**TOTAL OUTFLOW**                     | 86,800 |

**NATIVE YIELD**

<table>
<thead>
<tr>
<th>@ 0.15 af/ac</th>
<th>@ 0.30 af/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11,700</td>
</tr>
</tbody>
</table>

**IMPLIED CHANGE IN GROUNDWATER STORAGE**

<table>
<thead>
<tr>
<th>Without Native Yield</th>
<th>Native Yield @ 0.15 af/ac</th>
<th>Native Yield @ 0.30 af/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>-9,800</td>
<td>-4,000</td>
<td>1,900</td>
</tr>
</tbody>
</table>

### 2.5.3 Projected Water Budget under “Current” Conditions

While the historical base period used in the previous section is consistent with the base period selected for the Subbasin groundwater model, it does not capture the “current” conditions within the Districts. Since 2015, projects and management actions have necessarily been implemented as part of the Districts’ response to the 2012-2016 drought. In addition, some water supply contracts have changed or been added. The following section describes the water budget components for NKWSD and SWID under “current” conditions.
Some of the water budget components developed in the historical water budgets are used in the current water budget. Additional information has been provided by the Districts regarding their new projects. The cities of Shafter and Wasco have also provided updated information with respect to current water supply and demand in their jurisdictions, particularly the City of Shafter, which is supplied with water by Oildale Mutual Water Company (OMWC) for the Southeast Shafter area. This area, within Shafter’s city limits, has historically been agricultural and supplied with water by NKWSD. However, since 2015, the area has undergone land use conversion from agricultural (mostly row crops) to residential, which has been supplied by OMWC. The source for this water is outside of the plan area. The current water budgets are shown in Table 2-25 through Table 2-27. These water budgets represent long-term average annual inflow and outflow under the “current” conditions within the Districts’ management areas.

The average historical ET data from 2013 to 2015 (described in the previous section) is used in the “current” conditions water budgets for the NKWSD and SWID management areas described in this plan. This shortened historical period is considered more representative of the current land use and crop types in NKWSD and SWID’s management areas.

The average current water supply conditions are based on the long-term average supply for the Kern River (for NKWSD) and for the CVP (for SWID). As with the historical water budgets, exchanges and wheeling between NKWSD and SWID with other districts are expected to be a net zero change in supply. Water that is “banked” is considered temporary storage which is not included in the water accounting for the current conditions, with the exception of a leave-behind component (minimum of 10 percent).

To account for subsurface inflow and runoff, NKWSD and SWID are using the KGA range of 0.15 AF per acre to 0.30 AF per acre for the gross acreage of their respective management areas.

**2.5.3.1 Evaluation of Sustainable Yield**

The sustainable yield is the expected amount of water each district is allowed to pump from the Subbasin without seeing significant impacts or undesirable results. The sustainable yield can be used as a tool for each District to manage its performance in reaching groundwater sustainability. While the thresholds, objectives, and milestones of each sustainability indicator are the metric by which the Subbasin will be evaluated, the districts may use the sustainable yield as one way to ensure that they maintain their objectives as described in this plan.

There are two components to sustainable yield: native yield and surface water supply. For the purposes of this plan, native yield is the amount of water, on a long-term average annual basis, which can be pumped from the Subbasin by virtue of “natural” recharge. Based on coordination with KGA, this allowance has been expressed as a range; namely, 0.15 AF per acre and 0.30 AF per acre in the Kern Subbasin. An assumed precipitation volume of 0.42 AF/acre for irrigated lands is also considered to be a component of sustainable yield. The summation of these components provides a range of 0.57 AF per acre to 0.72 AF per acre for irrigated lands. Because precipitation is only accounted for over irrigated
acreage, the native yield for other land uses is 0.15 AF per acre to 0.30 AF per acre. The sustainable yield for land with access to surface water supply is the native yield, plus whatever surface water is available.

In addition to considering the KGA’s assumed sustainable yield range, SWID has also considered its 1953 Factual Report from the Bureau of Reclamation. This report estimates that SWID had 42,000 AF of “present annual local supply” and further estimated that SWID would have a “future local supply” of 28,500 AFY based an anticipated reduction in supply from the south due to increased cropping. SWID budgets in this report, including Table 2-14, do not consider the future local supply identified in the SWID Factual Report.3

3 Notwithstanding this omission, SWID reserves the ability to assert the right of the District, on behalf of its landowners, to the use of these sources of water which were described in the 1953 Factual Report. The fact that SWID is not relying on these sources of groundwater in its current water budget assumptions that underly the management actions described in this plan should not be interpreted as a waiver of SWID’s right to later claim a right to rely on these sources, through a claim of prescriptive groundwater rights or otherwise, in any basin wide groundwater adjudication. SWID is not asserting such rights here because doing so is not necessary for the current purposes of establishing an effective sustainability plan and is consistent with the provision of SGMA that provides that nothing in SGMA nor in any plan adopted pursuant to SGMA is intended to or shall act to alter or determine water rights (CWC §10720.5).
Table 2-25: Current and Future Projected Water Budget Summary for NKWSD, in AF

<table>
<thead>
<tr>
<th></th>
<th>&quot;Current&quot; Conditions</th>
<th>2030 Conditions</th>
<th>2070 Conditions</th>
<th>&quot;Current&quot; Conditions</th>
<th>2030 Conditions</th>
<th>2070 Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated Area (acres)</td>
<td>51,400</td>
<td>49,300</td>
<td>47,500</td>
<td>Based on DWR's 2014 land use survey.</td>
<td>Reduction based on land use change (Ag to Urban; 1,700 acs) and development of additional spreading ponds (400 acs).</td>
<td>Reduction from 2030 conditions based on land use change (Ag to Urban; 1,800 acs).</td>
</tr>
<tr>
<td><strong>INFLOWS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kern River</td>
<td>151,900</td>
<td>149,700</td>
<td>147,500</td>
<td>Based on applying &quot;current&quot; water supply contract provisions to the 40-year (1970-2009) period of Kern River hydrology.</td>
<td>Based on 1.5% climate change reduction applied to that portion of the &quot;current&quot; conditions supplies likely to be impacted by climate change.</td>
<td>Based on 3% climate change reduction applied to that portion of the &quot;current&quot; conditions supplies likely to be impacted by climate change.</td>
</tr>
<tr>
<td>Poso Creek</td>
<td>4,000</td>
<td>3,900</td>
<td>3,900</td>
<td>Based on period of recorded use (1954-2018).</td>
<td>Based on 1.5% climate change reduction from evaluation of Kern River hydrology.</td>
<td>Based on 3% climate change reduction relative to &quot;current&quot; conditions from Kern River hydrology.</td>
</tr>
<tr>
<td>Oilfield Produced Water</td>
<td>4,000</td>
<td>4,000</td>
<td>0</td>
<td>Based on receiving 40% of an estimated average of 10,000 af annually, with remainder allocated to RRID.</td>
<td>Based on receiving 40% of an estimated average of 10,000 af annually, with remainder to RRID.</td>
<td>Considered too speculative to estimate at this time.</td>
</tr>
<tr>
<td>Recycled (City of McFarland WWTP)</td>
<td>1,500</td>
<td>1,500</td>
<td>3,000</td>
<td>Based on average for 2015 and 2016.</td>
<td>Based on General Plan projections of population increase.</td>
<td>Based on General Plan projections of population increase.</td>
</tr>
<tr>
<td>&quot;Other&quot;</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>Allowance for purchases of CVP-FK &quot;wet-year&quot; water under temporary contracts and water banking &quot;leave-behind&quot;.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oktiie MWC</td>
<td>110</td>
<td>2,000</td>
<td>4,100</td>
<td>Based on average for 2015 through 2018.</td>
<td>Projected Supply increase based on expansion of urban land use in SE Shafter (OMWC and City of Shafter)</td>
<td>Projected Supply increase based on expansion of urban land use in SE Shafter (OMWC and City of Shafter)</td>
</tr>
<tr>
<td>Rainfall</td>
<td>21,600</td>
<td>20,700</td>
<td>20,000</td>
<td>Based on coordination with KGA (0.42 af/ac x Irrig. Area).</td>
<td>Based on 0.42 af/ac x 2030 Irrig. Area.</td>
<td>Based on 0.42 af/ac x 2070 Irrig. Area.</td>
</tr>
<tr>
<td>TOTAL INFLOW</td>
<td>188,110</td>
<td>186,800</td>
<td>183,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OUTFLOWS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated Area ET</td>
<td>155,600</td>
<td>155,200</td>
<td>155,300</td>
<td>Based on the average of the 2013-2015 ET data developed by ITRC for the 2014 irrigated area.</td>
<td>Based on 2030 irrigated area and applying a 4% increase to the unit ET from &quot;current&quot; conditions to reflect climate change.</td>
<td>Based on 2070 irrigated area and applying an 8% increase to the unit ET from &quot;current&quot; conditions to reflect climate change.</td>
</tr>
<tr>
<td>Evaporation (from Canals and Spreading Ponds)</td>
<td>3,200</td>
<td>3,200</td>
<td>3,200</td>
<td>Based on water surface area, duration of use, and estimated evaporation depth.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M&amp;I Pumping (cities of Shafter and Wasco)</td>
<td>2,100</td>
<td>4,500</td>
<td>9,800</td>
<td>Based on average for 2015 - 2017.</td>
<td>Based on General Plan projections of population increase.</td>
<td>Based on General Plan projections of population increase.</td>
</tr>
<tr>
<td>TOTAL OUTFLOW</td>
<td>160,900</td>
<td>162,900</td>
<td>168,300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>&quot;NATIVE YIELD&quot;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ 0 af/ac</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Based on coordination with KGA. Unit values of &quot;NATIVE YIELD&quot; applied to total acres within Management Area boundaries (about 60,000 acs).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ 0.15 af/ac</td>
<td>9,000</td>
<td>9,000</td>
<td>9,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ 0.30 af/ac</td>
<td>18,000</td>
<td>18,000</td>
<td>18,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**IMPLIED CHANGE IN GROUNDWATER STORAGE**

<table>
<thead>
<tr>
<th></th>
<th>&quot;Current&quot; Conditions</th>
<th>2030 Conditions</th>
<th>2070 Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Native Yield</td>
<td>27,210</td>
<td>23,900</td>
<td>15,200</td>
</tr>
<tr>
<td>Native Yield = 0.15 af/acre</td>
<td>36,210</td>
<td>32,900</td>
<td>24,200</td>
</tr>
<tr>
<td>Native Yield = 0.30 af/acre</td>
<td>45,210</td>
<td>41,900</td>
<td>33,200</td>
</tr>
</tbody>
</table>

**Explanations**

* Inflow - Outflow + "Native Yield"
Table 2-26: Current and Future Projected Water Budget for RRID, in AF

<table>
<thead>
<tr>
<th></th>
<th>&quot;Current&quot; Conditions</th>
<th>2030 Conditions</th>
<th>2070 Conditions</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Area (acres)</strong></td>
<td></td>
<td></td>
<td></td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td></td>
<td>5,281</td>
<td>4,982</td>
<td>4,085</td>
<td>Reduction based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td><strong>Irrigated Area (acres)</strong></td>
<td></td>
<td></td>
<td></td>
<td>Reduction based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td></td>
<td>4,180</td>
<td>3,680</td>
<td>2,180</td>
<td>Reduction based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td><strong>INFLOWS:</strong></td>
<td></td>
<td></td>
<td></td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>Kern River</td>
<td>3,600</td>
<td>3,500</td>
<td>3,500</td>
<td>Based on 55% of the 1993-2015 average annual diversions to RRID (6,500 afy). Based on 1.5% climate change reduction. Based on 3% climate change reduction relative to &quot;current&quot; conditions.</td>
</tr>
<tr>
<td>Oilfield Produced Water</td>
<td>3,300</td>
<td>3,300</td>
<td>0</td>
<td>Based on receiving 60% of an estimated average of 10,000 af annually, with remainder allocated to NKWSD. Based on receiving 60% of an estimated average of 10,000 af annually, with remainder allocated to NKWSD. Considered too speculative to estimate at this time.</td>
</tr>
<tr>
<td>Rainfall</td>
<td>1,800</td>
<td>1,500</td>
<td>900</td>
<td>Based on coordination with KGA (0.42 af/ac x Irrig. Area). Based on 0.42 af/ac x 2030 Irrig. Area. Based on 0.42 af/ac x 2070 Irrig. Area.</td>
</tr>
<tr>
<td><strong>TOTAL INFLOW</strong></td>
<td>8,700</td>
<td>8,300</td>
<td>4,400</td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td><strong>OUTFLOWS:</strong></td>
<td></td>
<td></td>
<td></td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>Irrigated Area ET</td>
<td>11,300</td>
<td>10,300</td>
<td>6,400</td>
<td>Based on 55% of the 2013-2015 average ET for the 2014 irrigated area (20,500 af). Based on 2030 irrigated area and applying a 4% increase to the unit ET from &quot;current&quot; conditions to reflect climate change. Based on 2070 irrigated area and applying an 8% increase to the unit ET from &quot;current&quot; conditions to reflect climate change.</td>
</tr>
<tr>
<td>Evaporation (from Canals and Regulating Res.)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>Considered to be deminimis on average, however, an allowance of 100 af has been used as a placeholder. Based on the City's projected expansion into the RRID Mgmt Area. Based on the City's projected expansion into the RRID Mgmt Area.</td>
</tr>
<tr>
<td>M&amp;I Pumping (City of Shafter)</td>
<td>270</td>
<td>320</td>
<td>540</td>
<td>Estimated annual supply for SE Shafter Industrial &amp; Residential in RRID Mgmt Area (City of Shafter). Based on the City's projected expansion into the RRID Mgmt Area. Based on the City's projected expansion into the RRID Mgmt Area.</td>
</tr>
<tr>
<td><strong>TOTAL OUTFLOW</strong></td>
<td>11,670</td>
<td>10,720</td>
<td>7,040</td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td><strong>&quot;NATIVE YIELD&quot;</strong></td>
<td></td>
<td></td>
<td></td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>@ 0 af/ac</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>@ 0.15 af/ac</td>
<td>800</td>
<td>700</td>
<td>600</td>
<td>Based on coordination with KGA. Unit values of &quot;Native Yield&quot; applied to total acres within Management Area boundaries.</td>
</tr>
<tr>
<td>@ 0.30 af/ac</td>
<td>1,600</td>
<td>1,500</td>
<td>1,200</td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td><strong>IMPLIED CHANGE IN GROUNDWATER STORAGE</strong></td>
<td></td>
<td></td>
<td></td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>Without Native Yield</td>
<td>-2,970</td>
<td>-2,420</td>
<td>-2,640</td>
<td>= Inflow - Outflow + &quot;Native Yield&quot;                                                                ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>Native Yield = 0.15 af/ac</td>
<td>-2,170</td>
<td>-1,720</td>
<td>-2,040</td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
<tr>
<td>Native Yield = 0.30 af/ac</td>
<td>-1,370</td>
<td>-920</td>
<td>-1,440</td>
<td>ked based on deannexation of lands which convert from Ag to Urban and are annexed to the City of Bakersfield (about 900 acres).</td>
</tr>
</tbody>
</table>
### Table 2-27: Current and Future Projected Water Budget Summary for SWID, in AF

<table>
<thead>
<tr>
<th></th>
<th>&quot;Current&quot; Conditions</th>
<th>2030 Conditions</th>
<th>2070 Conditions</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Irrigated Area (acres)</strong></td>
<td>29,407</td>
<td>27,507</td>
<td>27,007</td>
<td>Based on DWR's 2014 land use survey. Reduction based on land use change (Ag to Urban; 1,500 acs) and development of additional spreading ponds (400 acs). Reduction from 2030 conditions based on land use change (Ag to Urban; 500 acs).</td>
</tr>
<tr>
<td><strong>INFLOWS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVP</td>
<td>68,900</td>
<td>79,200</td>
<td>82,800</td>
<td>Based on applying &quot;current&quot; water supply contract provisions to the long-term average CVP data. Based on 1.5% climate change reduction applied to that portion of the &quot;current&quot; conditions supplies likely to be impacted by climate change. Based on 3% climate change reduction applied to that portion of the &quot;current&quot; conditions supplies likely to be impacted by climate change.</td>
</tr>
<tr>
<td>Recycled (City of Wasco WWTP)</td>
<td>1,700</td>
<td>2,900</td>
<td>3,700</td>
<td>Based on average for 2015 and 2016. Based on General Plan projections of population increase. Based on 1.5% climate change reduction applied to that portion of the &quot;current&quot; conditions supplies likely to be impacted by climate change. Based on General Plan projections of population increase.</td>
</tr>
<tr>
<td>&quot;Other&quot;</td>
<td>0</td>
<td>5,000</td>
<td>5,000</td>
<td>Allowance for purchases of CVP-FK &quot;wet-year&quot; water under temporary contracts and water banking &quot;leave-behind.&quot; Based on General Plan projections of population increase.</td>
</tr>
<tr>
<td>Rainfall</td>
<td>12,400</td>
<td>11,600</td>
<td>11,300</td>
<td>Based on coordination with KGA (0.42 af/ac x Irrig. Area). Based on 0.42 af/ac x 2030 Irrig. Area. Based on 0.42 af/ac x 2070 Irrig. Area.</td>
</tr>
<tr>
<td><strong>TOTAL INFLOW</strong></td>
<td>83,000</td>
<td>98,700</td>
<td>102,800</td>
<td></td>
</tr>
<tr>
<td><strong>OUTFLOWS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated Area ET</td>
<td>83,700</td>
<td>80,600</td>
<td>83,000</td>
<td>Based on the average of the 2013-2015 ET data developed by ITRC for the 2014 irrigated area. Based on 2030 irrigated area and applying a 4% increase to the unit ET from &quot;current&quot; conditions to reflect climate change. Based on 2070 irrigated area and applying an 8% increase to the unit ET from &quot;current&quot; conditions to reflect climate change.</td>
</tr>
<tr>
<td>M&amp;I Pumping (cities of Shafter and Wasco)</td>
<td>5,500</td>
<td>10,900</td>
<td>15,900</td>
<td>Based on average for 2015 - 2017. Based on General Plan projections of population increase. Based on General Plan projections of population increase.</td>
</tr>
<tr>
<td><strong>TOTAL OUTFLOW</strong></td>
<td>89,200</td>
<td>91,500</td>
<td>98,900</td>
<td></td>
</tr>
<tr>
<td><strong>&quot;NATIVE YIELD&quot;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ 0 af/ac</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>@ 0.15 af/ac</td>
<td>5,800</td>
<td>5,800</td>
<td>5,800</td>
<td>Based on coordination with KGA. Unit values of &quot;Native Yield&quot; applied to total acres within Management Area boundaries (about 60,000 acs).</td>
</tr>
<tr>
<td>@ 0.30 af/ac</td>
<td>11,700</td>
<td>11,700</td>
<td>11,700</td>
<td></td>
</tr>
<tr>
<td><strong>IMPLIED CHANGE IN GROUNDWATER STORAGE</strong></td>
<td></td>
<td></td>
<td></td>
<td>= Inflow - Outflow + &quot;Native Yield&quot;</td>
</tr>
<tr>
<td>Without Native Yield</td>
<td>-6,200</td>
<td>7,200</td>
<td>3,900</td>
<td></td>
</tr>
<tr>
<td>Native Yield = 0.15 af/ac</td>
<td>-400</td>
<td>13,000</td>
<td>9,700</td>
<td></td>
</tr>
<tr>
<td>Native Yield = 0.30 af/ac</td>
<td>5,500</td>
<td>18,900</td>
<td>15,600</td>
<td></td>
</tr>
</tbody>
</table>
As shown in Table 2-25, the implied average annual change in groundwater storage is positive for NKWSD under “current” conditions; ranging from 27.1 TAF without consideration of native yield, to 45.1 TAF with the maximum allowance for native yield. Accordingly, NKWSD would not be expected to have to reduce demand under “current” conditions.

Table 2-26 provides the current condition water budget for the RRID management area. The RRID management area covers 55-percent of the total area of RRID, with the remainder of the Improvement District located in the KRGSA. NKWSD water supplies that are available to RRID (specifically excluding supplies received through the 1952 Agreement) will be allocated equally to agricultural areas throughout RRID (including areas within KRGSA) until these areas are converted to urban land uses pursuant to the Bakersfield General Plan. Lands that are urbanized will be detached from the Improvement District and will no longer be allocated water from NKWSD. The RRID management area water budget is consistent with this allocation procedure.

The surface inflow to the RRID management area averages about 3.6 TAF per year from 1993 to 2015. While the historical water budget in all of RRID has been negative for the historic period of 1993 to 2015, changes in land use from 2015 to present have resulted in an overall reduction in groundwater pumping for the area. Water supplied for residential, industrial, and other non-agricultural use generally comes from the City of Bakersfield or the City of Shafter, even though the land is still within RRID. Given the 0.15 AF per acre to 0.30 AF per acre range for the native yield allowance, the implied average annual change in groundwater storage for the RRID management area is negative under “current” conditions; ranging from -2.7 TAF without consideration of native yield, to -900 AF with the maximum allowance for native yield.

Based on the data in Table 2-27, the implied average annual change in groundwater storage for SWID is negative under “current” conditions in the absence of projects. However, when current projects (which were implemented after 2015) are counted, SWID is shown as being nearly balanced; the average annual change in groundwater storage for SWID ranges from -400 AF when 0.15 AF per acre is considered for the native yield allowance to 5.5 TAF with the maximum allowance for native yield. As with the current water budget calculations for NKWSD, the native yield range of 0.15 AF per acre to 0.30 AF per acre, with an assumed precipitation of 0.42 AF per irrigated acre are used for SWID’s current water budget.

### 2.5.4 Projected Water Budgets under Future Conditions

Projected water budgets were prepared for 2030 and 2070 conditions. Adjustments were made, as necessary, to the budget items for “current” conditions. In particular, adjustments were necessary to reflect projected climate change, anticipated or known changes in water supply contracts, and changes in land use.

Current water demands for agriculture in NKWSD (155.6 thousand acre-feet) and in SWID (83.7 thousand acre-feet) are based on the most recent crop demand (2013 to 2015 ITRC based ET).
Notwithstanding the conversion of current agricultural land to urban uses in both Districts pursuant to the Shafter and Wasco General Plans (urban water demand is expected to increase as shown in Table 2-28), crop demand is expected to remain relatively consistent through the 2070 water budget due to projected increases in ET resulting from climate change.

Table 2-28: Projected Groundwater Pumpage within Districts Projected Water Demand, AF

<table>
<thead>
<tr>
<th>City</th>
<th>2015</th>
<th>2030</th>
<th>2070</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>4,117</td>
<td>5,802</td>
<td>10,540</td>
</tr>
<tr>
<td>OMWC</td>
<td>200</td>
<td>206</td>
<td>412</td>
</tr>
<tr>
<td>Wasco</td>
<td>3,456</td>
<td>7,415</td>
<td>35,722</td>
</tr>
<tr>
<td><strong>North Kern Water Storage District</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>1,696</td>
<td>2,283</td>
<td>4,564</td>
</tr>
<tr>
<td>OMWC</td>
<td>200</td>
<td>206</td>
<td>412</td>
</tr>
<tr>
<td>Wasco</td>
<td>104</td>
<td>222</td>
<td>1072</td>
</tr>
<tr>
<td><strong>Shafter-Wasco Irrigation District</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter</td>
<td>2,221</td>
<td>3,450</td>
<td>5,976</td>
</tr>
<tr>
<td>Wasco</td>
<td>3,352</td>
<td>7,393</td>
<td>11,017</td>
</tr>
</tbody>
</table>

The projected demand for the cities of Shafter and Wasco is expected to increase based on population growth. However, since recent population increases (and water demands) in the cities have lagged projections in their respective UWMPs, the projections have been adjusted by matching the 2015 base period to actual pumping data and then following the UWMP projections from 2015 at a constant rate going forward. The City of Wasco is expected to increase demand by 22% every 5 years and the City of Shafter is expected to increase demand by 10% every year starting in 2015. These values will be adjusted as more data become available.

2.5.4.1 Supply

Kern River water supplies under 2030 and 2070 conditions are reduced relative to “current” conditions to reflect climate change. The application of climate change guidance provided by DWR resulted in long-term average Kern River runoff declining by about 1.5% under 2030 conditions and 3% under 2070 conditions, all relative to “current” conditions.

Projected water supplies under SWID’s CVP contract were based on the “Future Friant Supplies Model”, which estimates SWID’s supplies from the following categories: Class 1, Class 2, Other, 16B, Recapture Class 1, and Recapture Class 2 (the accumulation of these estimates is shown in Table 2-32). Other SWID surface water supplies (e.g. “leave behind” from banked water) are assumed to net zero with the District demand over the long term and are not included in the projected water budgets. Procedures related to future surface supplies for both NKWSD and SWID are outlined in Appendix B. In summary, it is expected that the Districts will receive a lower than historical amount of water from the CVP and the Kern River due to environmental restrictions and regulations, as well as climate change.
The projected water budgets under future conditions relied on the same native yield allowance used for the historical and “current” water budgets. Recycled water from the McFarland and Wasco WWTPs is expected to increase as shown in Table 2-29.

Table 2-29: City Projected Recycled Water, in TAF

<table>
<thead>
<tr>
<th></th>
<th>Total Groundwater Pumped</th>
<th>% of Total Flow</th>
<th>Recycled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NKWSD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of McFarland:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>1.8</td>
<td>59%</td>
<td>1.1</td>
</tr>
<tr>
<td>2030</td>
<td>2.3</td>
<td>64%</td>
<td>1.5</td>
</tr>
<tr>
<td>2070</td>
<td>4.6</td>
<td>64%</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>SWID</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Wasco:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>3.5</td>
<td>49%</td>
<td>1.7</td>
</tr>
<tr>
<td>2020</td>
<td>4.6</td>
<td>45%</td>
<td>2.1</td>
</tr>
<tr>
<td>2025</td>
<td>6.0</td>
<td>41%</td>
<td>2.4</td>
</tr>
<tr>
<td>2030</td>
<td>7.4</td>
<td>38%</td>
<td>2.8</td>
</tr>
<tr>
<td>2035</td>
<td>9.0</td>
<td>35%</td>
<td>3.2</td>
</tr>
<tr>
<td>2070</td>
<td>9.9</td>
<td>37%</td>
<td>3.7</td>
</tr>
</tbody>
</table>

The City of McFarland is expected to increase its recycled water from 1.1 TAF in 2015 to 3.0 TAF in 2070. This projection is based on the existing city data for the WWTP and the population growth trends presented in the City of McFarland’s General Plan. The City of Wasco is expected to increase its recycled water from 1.7 TAF in 2015 to 3.7 TAF in 2070. This projection is based on the UWMP population growth trends applied to the actual recycled water volumes for 2015.

2.5.4.2 Projected Water Budget

The Districts’ projected water budgets, presented in Table 2-25 through Table 2-27, have been developed based on the projected water supply and water demand outlined in the preceding sections. All of these tables develop the implied average annual change in groundwater storage based on a native yield allowance ranging from 0.15 AF per acre to 0.30 AF per acre, which is the same approach which was used for the previously presented historical and projected “current” conditions water budgets.

For NKWSD, Table 2-25 shows a positive change in storage in both 2030 and 2070 conditions, across all native yield allowances, ranging from 15.2 TAF for no native yield considered in 2070 to 41.9 TAF for the maximum native yield allowance in 2030. The decrease in positive storage from 2030 in 2070 indicates that it is expected that NKWSD will have a lesser amount of supply than was available historically or “current” conditions.
The projected water budget for RRID, shown in Table 2-26, shows a slightly negative implied change in groundwater storage for all native yield allowances considered at 2030 and 2070. While land conversion trends from agricultural use to urban and industrial use lead to a reduction in groundwater pumping for the RRID management area, the oilfield-produced water currently supplied to the District and projected to continue beyond 2030 is not projected to be available in 2070. This projected future overdraft is addressed with the addition of recharge for the RRID management area, as described in Section 5 of this Plan.

Similar to NKWSD the projected future water budget for SWID in Table 2-27 is based on the long-term average conditions for the District’s supply and demand. The implied change in groundwater storage for the projected future conditions at 2030 and 2070 is positive throughout all considered native yield allowances. The implied change in groundwater storage ranges from 7.2 TAF for no considered native yield allowance in 2030 to 18.9 TAF for the maximum native yield allowance in 2030. While the implied change in storage at 2070 conditions is still positive, it decreases from 2030 to 2070 due to projected increases in urban demand.

The projects and management actions to be implemented to reach sustainability by 2040 are outlined in Section 6.

### 2.6 Existing Monitoring Programs

As described in earlier sections of this management area plan, there are existing groundwater management plans and programs. These plans and programs also include monitoring points and protocols, which have been used as a source of data for the development of the “umbrella” Basin Setting and this management area plan. The existing monitoring programs are described herein.

#### 2.6.1 Existing Water Level Monitoring

The umbrella-level GSP describes existing water level monitoring networks at a generalized regional scale. These networks include the Kern Fan Monitoring Committee (KFMC), Kern County Water Agency (KCWA) groundwater monitoring, and water level data reported to CASGEM. These regional networks benefit data collection and inform NKWSD and SWID on water level changes occurring in the Subbasin. The umbrella-level GSP provides details on the KFMC, KCWA, CASGEM networks, and an approximate number of wells and locations of monitoring throughout the Subbasin. This section focuses on groundwater monitoring at the local-level, and provides a brief description of the monitoring network, well types, well construction, participants in local monitoring, and figures with locations.

#### 2.6.2 Groundwater Level Monitoring

Both NKWSD and SWID use water level monitoring data from supply/production wells in the district to report on local and regional groundwater level conditions. Historically, water levels in supply wells have been measured twice a year, in both the “spring” and “fall”, with the timing of
these measurements intended to coincide with the annual water level high and low, respectively. NKWSD also monitors groundwater levels in a subset of its wells on a monthly basis.

NKWSD owns over 100 supply wells from which to gauge water levels. In addition, private landowners in the district have also reported water level monitoring data over the years. Some of these district-owned and privately-owned well data are reported to CASGEM, KCWA, and to the monitoring committee for the Semitropic Water Storage District Water Banking Project (Semitropic Water Banking Monitoring Committee). A figure and table of the NKWSD monitoring network is included in Appendix H as an excerpt of the 2012 NKWSD Groundwater Management Plan (GWMP) (Figure 14 and Table 7 of the NKWSD GWMP). Additionally, excerpts of the NKWSD CASGEM monitoring plan, and a map and accompanying list of NKWSD wells from the Semitropic Water Banking Monitoring project are included in Appendix H.

NKWSD also collects water level data from shallow dedicated monitoring wells equipped with transducers to monitor the movement of water through its spreading basins. Water level sensors were installed to provide a “continuous” record of measurements because of the large fluctuations that can occur during recharge operations. Water levels in these wells are measured monthly. These shallow monitoring wells are more fully described in excerpts of the 2012 GWMP which is included in Appendix H.

SWID is also a member of the Semitropic Water Banking Monitoring Committee. SWID routinely measures groundwater levels in more than 60 privately owned supply wells in the District. Data are collected in the spring and fall of each year with much of the data reported to the Semitropic Water Bank Monitoring Committee, KCWA, and CASGEM. A list of wells in the SWID monitoring network, excerpted from SWID’s 2007 GWMP, is included in Appendix H.

**Semitropic Water Storage District Water Banking Project Monitoring Committee**

Groundwater elevations in SWID and NKWSD are monitored in coordination with the monitoring committee for the Semitropic Water Storage District Water Banking Project. The Semitropic Water Banking Monitoring Committee is made up of Semitropic Water Storage District, Southern San Joaquin Municipal Utility District, Cawelo Water District, Shafter-Wasco Irrigation District, North Kern Water Storage District, Rosedale-Rio Bravo Water Storage District, and Buena Vista Water Storage District, with Kern County Water Agency and Department of Water Resources working alongside the monitoring committee. The committee submits biennial monitoring reports which first began in 1995 and have continued to the present. The reports include groundwater elevation maps, discussion of groundwater flow trends, groundwater quality, land subsidence, and time series data on hydrographs. A summary is presented in Table 2-30 below.
Table 2-30: Summary of Monitoring Committee

<table>
<thead>
<tr>
<th>Monitoring Network</th>
<th>Number of Wells Monitored</th>
<th>Date Range</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWSD Water Banking Monitoring Committee</td>
<td>29 SWSD monitoring wells ~ 65 supply wells SWSD, ~53 wells NKWSD, ~8 wells in BVWSD, ~11 wells in SWID, a few wells RRBWSD, and SSJMUD</td>
<td>1995 to present</td>
<td>Biennial Groundwater Monitoring Report for the Semitropic Water Storage District Water Banking Project.</td>
</tr>
</tbody>
</table>

Locations of wells in the monitoring network are included in the figure in Appendix F.

The benefit of the monitoring committee is in coordination of water level data collection and reporting, which provides more understanding of water levels at the boundaries between NKWSD, SWID, and neighboring districts. Data that are a result of this coordination, including groundwater contour maps, hydrographs, and subsidence data, are presented in the Groundwater Conditions section of this report (Section 2.3).

Many of the wells in the committee’s monitoring network are included in the future monitoring network for this Management Area Plan.

2.6.3 Existing Land Subsidence Monitoring

The KGA GSP describes existing land subsidence monitoring networks at a generalized regional scale. These networks include Borehole Extensometers, Continuous GPS (CGPS), Leveling Surveys, and Remote Sensing. These regional networks benefit data collection and inform SWSD on land subsidence changes occurring in the Subbasin. The KGA GSP and the Groundwater Conditions section of this report (Section 2.3.6) provide details on these networks and status of data usability and collection. This section focuses on land subsidence monitoring at the local-level. Details on data availability and locations are provided below.

2.6.3.1 Local Land Subsidence Monitoring

As a part of the Semitropic Water Banking Monitoring Committee, land subsidence has been monitored and data reported in the biennial reports prepared by Schmidt and Associates. The monitoring network includes SWSD’s borehole extensometer, as well as nearby continuous GPS points P545, P563, and P564. These GPS stations are maintained, and data are processed and reported, by affiliates of UNAVCO [https://www.unavco.org/instrumentation/networks/status/pbo](https://www.unavco.org/instrumentation/networks/status/pbo) and SOPAC [http://sopac-csrc.ucsd.edu/index.php/sopac/](http://sopac-csrc.ucsd.edu/index.php/sopac/). A location map of the existing land subsidence monitoring network is included in Appendix F.
Details including data for the CGPS points and extensometer, and benefits and frequency of the data, are further discussed in the Groundwater Conditions of this report. In general, CGPS points record daily to sub-daily frequency, while the extensometer is currently set up for manual measurements that require periodic visits to record data values. While CGPS points record near continuous data, their limitations are in that they measure land surface deformation referenced to a datum but cannot measure discrete intervals in the subsurface. On the other hand, the borehole extensometer can measure a discrete interval from the bottom of the extensometer to ground surface, thus providing a more accurate approximation of compaction in the intervals subject to groundwater pumping.

In spring 2012, NKWSD completed installation and the surveying of 11 benchmark monuments to monitor land subsidence. These monuments are a part of the land subsidence monitoring network of NKWSD (Figure 2-48). A figure depicting this network is included in Appendix F. The monuments (see adjacent photo) were surveyed in 2012 and have been measured recently to monitor the potential effects of land subsidence in NKWSD. The initial or baseline survey was performed by a licensed land surveyor and included establishment of vertical and horizontal locations for each of 11 monuments, with NAD 83 for horizontal coordinates and NAVD 88 for vertical. The survey relied on geodetic surveying methods using high-precision GPS surveying equipment. Each of the monuments was observed twice and at different times of the day, for a minimum time of one hour. The primary control was provided by NGS CORS stations located outside of the target area to ensure a stable and repeatable survey. The following CORS stations were used to verify and constrain both the horizontal and vertical control: ARM2, BKR2, P545, P563, P564, P565, and P567. The methods were designed to provide accuracy of +/-0.05 feet at 95 percent relative to the primary control (NKWSD, 2012).

Details of the data collected from these monuments is included in the Groundwater Conditions section of this report (Section 2.3.6).

### 2.6.3.2 Remote Sensing Land Subsidence Monitoring

NASA and DWR have collected remote sensing data (INSAR and UAVSAR) on a regional scale to better understand the lateral and temporal extent of subsidence within the study area. The methodology and approach for collecting and processing the data has varied over the last decade as refinements have been made. NASA and DWR are working together to field calibrate these
remote sensing data with CGPS points to better understand the quantitative estimates of land subsidence that have been reported.

The existing monitoring data are available for some date ranges and therefore are discussed further in the Groundwater Conditions of this report. In addition, the umbrella-level GSP also provides details on INSAR and UAVSAR reporting and availability. As remote sensing data continue to be available, it will be used for the monitoring network of this Groundwater Sustainability Plan.

**Summary of Land Subsidence Monitoring**

Below is a table (Table 2-31) of currently available land subsidence monitoring for the study area.

<table>
<thead>
<tr>
<th>Type</th>
<th>Stations</th>
<th>Range of Available Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borehole Extensometers</td>
<td>24S/22E-35B001</td>
<td>December 2013 to present</td>
<td>SWSD</td>
</tr>
<tr>
<td>InSAR / UAVSAR</td>
<td>Remote Satellite Imagery</td>
<td>Recent, Range of freely accessible data: 2007 to 2011 2014 to present</td>
<td>Areal extent varies depending on dataset. Not always extensive across the Subbasin. Post-processed data available from (Farr, et. al., 2016), JPL, and USGS.</td>
</tr>
</tbody>
</table>
2.6.3.3 Existing Groundwater Quality Monitoring

NKWSD is actively engaged in groundwater quality monitoring throughout its management area through existing monitoring networks. As shown in Table 2-15, North Kern collects samples from 101 wells in accordance with guidelines of AB 3030 and the FKC Pump-In program. Additionally, NKWSD collaborates with other regional and state agencies to better characterize its groundwater quality. A summary of each of the NKWSD’s local and regional efforts and programs are discussed in this section. Groundwater quality in NKWSD is monitored by a network of dedicated monitoring wells, production wells, and domestic wells. Table 2-32 summarizes the types of monitoring program implemented within NKWSD.

Table 2-32: Types of Monitoring Programs Implemented within the District

<table>
<thead>
<tr>
<th>Well Type</th>
<th>Number of Wells</th>
<th>Monitoring Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NKWSD</td>
<td>SWID</td>
</tr>
<tr>
<td></td>
<td>Production</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>Monitoring</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Public Water system Wells</td>
<td>7 17</td>
</tr>
</tbody>
</table>

North Kern’s Water Quality Monitoring Program:

North Kern’s water quality monitoring, including water sampling and analytical chemical testing, aims at identifying the suitability of groundwater for various uses. Under the District’s monitoring programs, water samples are collected annually from a representative network of 101 North Kern owned production wells, and four dedicated monitoring wells located throughout its service area. These wells are screened at discreet intervals to monitor groundwater quality across both confined and unconfined aquifers. Figure 2-25 shows the location of these wells, as shown in the Water Quality section of this plan’s Basin Setting.

Sampling recommended by AB-3030 monitors water quality for in-District groundwater uses. This program is focused on constituents relevant to irrigation water analysis, which is a limited group of general minerals (Agricultural Water Management Plan, 2014).

In 2015, the monitoring program was expanded to comply with Central Valley Project’s (CVP) FKC Pump-In Policy. North Kern augmented its existing groundwater quality testing both in terms of the frequency of sampling and the number of additional drinking water constituents tested. As
a requirement of North Kern’s participation in CVP’s Pump-In Program, 22 production wells were identified, and sampled for Title 22 regulated inorganics, at least once every three years. During active recovery years, North Kern uses a selection of these wells to pump-back water into the Friant Kern Canal.

Active recovery involves production wells belonging to both the District and some landowners. The sampling program that complies with CVP’s policy further enhances the District’s monitoring network. Depending on the type of hydrological year, approximately 80 to 90 production wells are sampled each year. During wet years, most of the production wells are not in operation due to the availability of surface water; therefore, they are not sampled. For example, the District did not sample any production wells in the hydrologically wet year of 2017. Alternatively, extensive sampling was conducted during the hydrologically dry years of 2009, 2013, and 2016. Table 2-33 summarizes the constituents monitored as part of the District’s existing monitoring network.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Minerals</td>
<td>Triennially</td>
</tr>
<tr>
<td>Inorganic Chemicals</td>
<td>Triennially</td>
</tr>
<tr>
<td>Hexavalent Chromium</td>
<td>Triennially</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>Triennially</td>
</tr>
<tr>
<td>Boron</td>
<td>Triennially</td>
</tr>
<tr>
<td>1,2,3-TCP</td>
<td>Triennially</td>
</tr>
</tbody>
</table>

As discussed in North Kern’s 2014 AWMP, the collected data is used to provide the basis for identification of long-term water quality trends. This data was used to characterize Groundwater Quality Conditions (Section 2.3.5). Trends prepared for this evaluation indicate that minimal degradation has occurred since the monitoring program was implemented.

**SWID’s Water Quality Monitoring Program**

As discussed earlier, SWID does not directly monitor groundwater quality in its management area. However, it uses the data collected by the municipalities (Public Water Systems, or PWS) within its boundary to monitor groundwater quality. The PWS within SWID are included in Table 2-34 below.

**Kern Subbasin Water Quality Monitoring Efforts**

With the objective of identifying and implementing specific programs as needed to reflect changing conditions in the Subbasin, NKWSD and SWID established a Groundwater Monitoring Committee that includes Semitropic W.S.D (as the lead agency) and five other neighboring water
districts. The Kern County Water Agency and DWR are interested parties and periodically participate in the Committee activities. One of the committee’s key objectives is to control degradation of groundwater quality and enhance quality where practicable (SWSD GWMP, 2003). Since its inception in 1994, this committee has been preparing a biennial monitoring report that provides a comprehensive study of the underlying groundwater with the objective of identifying and implementing specific programs as needed to reflect changing conditions in the basin. The biennial report characterizes the groundwater quality based on the collected data from Semitropic’s monitoring network, and the five neighboring water districts.

Additionally, NKWSD is an active member of the Kern Fan Monitoring Committee and other regional groundwater quality monitoring programs. These programs are briefly described below. Groundwater quality data from these programs will be used by the District for SGMA monitoring purposes.

**Irrigated Lands Regulatory Program**

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 with a focus on protecting surface waters; groundwater regulations were added in 2012. The Kern River Watershed Coalition Authority (KRWCA) implements the ILRP program in the Subbasin. Data collected and reported as a part of ILRP are provided to the SWRCB and are available in the GeoTracker database for download and use. The KRWCA’s primary group is made up of 10-member agencies representing approximately 1.5 million acres of irrigated land, out of which 7% of the irrigated acreage is under NKWSD and SWID’s jurisdiction.

**California Drinking Water Information System Database (SDWIS)**

Routine water quality monitoring data is also available from the eight Public Water Systems (PWS) within SWSD boundaries. These systems are required to routinely sample for Title 22 regulated constituents. These water systems were identified through the Groundwater Ambient Monitoring and Assessment (GAMA) database. Water quality data is available through SDWIS. This program provides data for an additional 12 wells. Table 2-34 summarizes the PWSs identified within NKWSD and SWID boundaries.
<table>
<thead>
<tr>
<th>Water System Number</th>
<th>Water System Name</th>
<th>District</th>
<th>Type</th>
<th>Number of Connections</th>
<th>Population Served</th>
<th>Service Area</th>
<th># Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA1502826</td>
<td>B&amp;J Land Company</td>
<td>NKWD</td>
<td>NC</td>
<td>1</td>
<td>T=225; NT=5</td>
<td>Other Transient</td>
<td>1 Well</td>
</tr>
<tr>
<td>CA1503384</td>
<td>South Valley Farms – Beech Hueller</td>
<td>NKWD</td>
<td>NTNC</td>
<td>5</td>
<td>75</td>
<td>Industrial/Agricultural</td>
<td>1 well</td>
</tr>
<tr>
<td>CA1503642</td>
<td>Weeks Roses Water System</td>
<td>NKWD</td>
<td>NTNC</td>
<td>1</td>
<td>25</td>
<td>Industrial/Agricultural</td>
<td>1 Well</td>
</tr>
<tr>
<td>CA1510019</td>
<td>Shafter, City of</td>
<td>NKWD/SWID</td>
<td>C</td>
<td>4720</td>
<td>19100</td>
<td>Residential</td>
<td>6 Wells</td>
</tr>
<tr>
<td>CA1503290</td>
<td>The Garlic Company</td>
<td>NKWD</td>
<td>NTNC</td>
<td>1</td>
<td>120</td>
<td>Industrial/Agricultural</td>
<td>2 wells</td>
</tr>
<tr>
<td>CA1503657</td>
<td>Kimberlina Housing unit</td>
<td>NKWD</td>
<td>NC</td>
<td>8</td>
<td>26</td>
<td>Residential</td>
<td>1</td>
</tr>
<tr>
<td>CA1502033</td>
<td>Golden State Vintners - Franzia</td>
<td>NKWD</td>
<td>NC</td>
<td>1</td>
<td>NT=20; T=13</td>
<td>Industrial/Agricultural</td>
<td>1</td>
</tr>
<tr>
<td>CA1510021</td>
<td>Wasco, City of</td>
<td>SWID</td>
<td>C</td>
<td>4915</td>
<td>22690</td>
<td>Residential</td>
<td>5 Wells</td>
</tr>
<tr>
<td>CA1502133</td>
<td>Treehouse California Almonds</td>
<td>SWID</td>
<td>NTNC</td>
<td>3</td>
<td>35</td>
<td>Industrial</td>
<td>1 Well</td>
</tr>
<tr>
<td>CA1502164</td>
<td>Llanas Camp Four System Water</td>
<td>SWID</td>
<td>C</td>
<td>55</td>
<td>NT=3; R=31; T=20</td>
<td>Residential</td>
<td>1 Well</td>
</tr>
<tr>
<td>CA1504001</td>
<td>Wonderful Nurseries</td>
<td>SWID</td>
<td>NTNC</td>
<td>1</td>
<td>250</td>
<td>Other Transient</td>
<td>1 Well</td>
</tr>
<tr>
<td>CA1510801</td>
<td>Wasco State Prison Reception Center</td>
<td>SWID</td>
<td>C</td>
<td>1768</td>
<td>4857</td>
<td>Institution</td>
<td>2 wells</td>
</tr>
<tr>
<td>CA1500426</td>
<td>Rose Villa Apartments</td>
<td>SWID</td>
<td>C</td>
<td>32</td>
<td>65</td>
<td>Other Residential</td>
<td>1 Well</td>
</tr>
</tbody>
</table>

*C = Community water system  
NTNC = Nontransient non-community water system  
TNC = Transient non-community water system  
NT = Nontransient  
T = Transient  
R = Residential
2.7 Existing Water Resource Programs

2.7.1 Management Plans

The State of California has pre-SGMA programs for the management of groundwater supply and quality. These programs are managed at various levels of government by existing public agencies, either individually or collaboratively with neighboring agencies within the same groundwater basin. The following section provides an overview of these programs and the elements addressed in each.

2.7.1.1 Groundwater Management Plans

In 1992, the State of California passed the Groundwater Management Act (AB 3030). This legislation provided guidelines for the agencies and districts to provide planned and coordinated monitoring, operation, and administration of groundwater basins with the goal of long-term sustainability. There are several types of Groundwater Management Plans.

**Pre-SB 1938 Plans:** These plans, typically adopted before 2002, could be prepared by a local agency in a Bulletin 118-designated basin on a voluntary basis. The voluntary components of these plans include:

- The control of saline water intrusion.
- Identification and management of wellhead protection areas and recharge areas.
- Regulation of the migration of contaminated groundwater.
- The administration of a well abandonment and well destruction program.
- Mitigation of conditions of overdraft.
- Replenishment of groundwater extracted by water producers.
- Monitoring of groundwater levels and storage.
- Facilitating conjunctive use operations.
- Identification of well construction policies.
- The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- The development of relationships with state and federal regulatory agencies.
- The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

**SB 1938 Plans:** These plans were generally adopted during or after 2002, incorporating the elements of the Pre-SB 1938 Plans. With the passage of SB 1938, the following components were required as part of any Groundwater Management Plan:
Basin Management Objectives: The Groundwater Management Plan shall include Basin Management Objectives relating to the monitoring and management of groundwater levels within the groundwater basin, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin.

Agency Cooperation: The local agency shall prepare a plan to involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin.

Mapping: The local agency shall prepare a map that details the area of the groundwater basin, as defined in DWR’s Bulletin 118, and the area of the local agency, that will be subject to the Groundwater Management Plan, as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a Groundwater Management Plan.

Monitoring Protocols: The local agency shall adopt monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence (in basins for which subsidence has been identified as a potential problem), and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin.

Located outside Bulletin 118 Groundwater Basins: Plans located outside DWR Bulletin 118 alluvial groundwater basins will incorporate the above components and shall use geologic and hydrologic principles appropriate to those areas.

**AB 359 Plans:** When AB 359 was enacted in 2013, it required additional technical components related to groundwater recharge areas and modification to several of the existing groundwater management plan adoption procedures in place as part of SB 1938. The additional technical components are as follows:

- The groundwater projects to which these requirements apply include projects that are part of an integrated regional water management program or plan.
- Groundwater projects require a description of how recharge areas identified in the plan substantially contribute to the replenishment of the groundwater basin and a map identifying the recharge areas, as defined, for the groundwater basin to be included in a groundwater management plan for purposes of the state funding requirements.
- Require the local agency to provide the map of the recharge areas to local planning agencies and notify the department and other interested persons when a map is submitted to those local planning agencies.

NKWSD adopted an AB 3030 GMP in 1993, which was then replaced by its SB 1938-compliant GMP, adopted in 2012. SWID adopted a SB 1938 GMP in 2007.
2.7.1.2 Agricultural Water Management Plans

The Water Conservation Act of 2009 (SB X7-7) requires that agricultural water suppliers serving more than 25,000 irrigated acres adopt and submit to DWR an Agricultural Water Management Plan (AWMP). These plans include reporting on implementation status of Efficient Water Management Practices (EWMPs) within the supplier’s service area. Areas which are served by recycled water deliveries only are excluded from the total amount of irrigated acreage. In the Emergency Drought Measures enacted by the State of California in 2015, agricultural water suppliers serving 10,000 irrigated acres or more were required to prepare and submit an AWMP to DWR. The Emergency Drought Measures also included requirements for information beyond the requirements of SB X7-7.

NKWSD prepared its 2015 AWMP update to include the Emergency Drought Measures requirements. This AWMP was adopted in January 2016. To comply with the requirements of SB X7-7, SWID prepared an addendum for its existing GMP to include the specific requirements of the Water Conservation Act of 2009 and the Emergency Drought Measures. This addendum was adopted in 2015.

2.7.1.3 Urban Water Management Plans

The Urban Water Management Planning Act requires that urban water suppliers with a usage of over 3,000 AFY or that serve more than 3,000 urban connections must adopt an Urban Water Management Plan (UWMP). This plan is to ensure that the urban water supplier adequate addresses water supplies for existing and future demands. These plans were first required in 2005, with updates to be prepared and submitted by urban water suppliers every five (5) years.

Both the cities of Shafter and Wasco have adopted their own UWMPs. The City of Shafter’s UWMP was subsequently updated in 2015 and expressly does not consider the role and impacts of SGMA. However, the plan does state that future updates may address SGMA elements. The City of Wasco’s 2010 UWMP was updated in 2015 and makes no reference to SGMA.

In addition to the two cities having their own respective UWMPs, the Oildale Mutual Water Company adopted its own UWMP for its service area within the Subbasin. While much of the OMWC’s service area is located within the KRGSA (and covered under that GSP), the portion that is located within the KGA’s jurisdiction is located in NKWSD. OMWC provides service to the area within the limits of the City of Shafter known as either “Southeast Shafter” or “7th Standard Road.” This portion of OMWC’s service area obtains its water entirely from groundwater wells, owned and operated by OMWC, within this service area. Oildale Mutual’s UWMP references SGMA and measures to be taken to encourage water conservation by its customers.
2.7.1.4 Integrated Regional Water Management Plans

In 2002, the Regional Water Management Planning Act (SB 1672) created the Integrated Regional Water Management (IRWM) Program. The IRWM Program is used as a collaborative effort to identify and implement water management solutions on a regional scale that increase regional self-reliance, reduce conflict between agencies and users, and manage water to concurrently achieve social, environmental, and economic objectives. By collaborating on projects, participants in the IRWM Program can provide these benefits and meet their water supply and quality goals. In the Kern County Subbasin, there are two IRWM Plans: the Poso Creek IRWM Plan and the Kern County IRWM Plan. NKWSD and SWID are both participants in the Poso Creek IRWM Plan, which was adopted in 2007.

2.7.1.5 Irrigated Lands Regulatory Program

The Tulare Lake Basin General Order (Order R5-2013-0120) was passed by the RWQCB in 2006. This order requires that any irrigated land having the potential to discharge to surface water or groundwater must comply with the requirements set by the RWQCB. Compliance includes membership in a Coalition or obtaining coverage through an Individual Order from the RWQCB. SSJMUD is a member of the Kern River Watershed Coalition Authority, which was formed in 2011.

2.7.1.6 Groundwater Export Ordinance

Kern County adopted a groundwater export ordinance in 1998, which requires a Conditional Use Permit (CUP) for export of water to areas both outside the County and within watershed areas of underlying aquifers in the County. The ordinance applies only to the southeastern drainage of the Sierra Nevada and Tehachapi mountains in the South Lahonten Hydrologic Region in eastern Kern County.

2.7.1.7 Title 22 Drinking Water Program

The Division of Drinking Water regulates public drinking water systems, which include municipal and state small water systems. In addition to the cities of Delano and McFarland, there are several state small systems and multi-parcel/multi-connection systems in SSJMUD’s jurisdiction. These systems are required to comply with the standards set forth in Title 22 of the California Code of Regulations. For single parcel/single-connection systems, Kern County Environmental Health Services provides regulation and oversight to meet the requirements of Title 22.

2.7.2 Conjunctive Use Programs

 Conjunctive use or “the coordinated use of surface water and groundwater” has been used for many years in Kern County, for the benefit of water users, to allow for flexibility in the way water is delivered, whether climatic conditions allow for imported surface water, or if groundwater is needed in any given year. Conjunctive use is further described by the Water
Education Foundation with the following: “In its passive form, also called in-lieu conjunctive use, surface water is used in wet years and groundwater is used in dry years. In active conjunctive use, surface water is directly injected into aquifers and wells to be used as needed as part of groundwater banking” (Water Education Foundation, 2019).

NKWSD and SWID have participated in conjunctive use programs, for both in-lieu and direct recharge banking activities to enhance the flexibility of water supplies to meet the water demands of their respective stakeholders and in partnership with other districts in the Poso Creek region.

2.7.2.1 NKWSD Conjunctive Use Program

Although NKWSD’s southern boundary is located less than 10 miles from the current location of the Kern River channel (NKWSD’s northern boundary is 25 to 30 miles north of the channel), as a result of topography and groundwater conditions, historically, seepage of Kern River water was confined nearly exclusively to the area comprising the historical River fan and River seepage was not considered as contributing to the groundwater supply of NKWSD (NKWSD “Report to the State Engineer on Feasibility of Project” (August 15, 1950)(“Project Report”). As a consequence, in the late 1800s two large capacity canals were constructed to convey or “import” surface water from the Kern River into the area that became NKWSD (in 1935) to support the development of agriculture.

Although intermittent flows of Kern River water in the canals promoted the development of agriculture in NKWSD, flows were insufficient to offset declining groundwater levels underlying the District associated with the expanding use of deep well turbine pumps during the first half of the 20th century (in NKWSD and adjacent areas). In response, as described in its Project Report, NKWSD conceptualized the development of a project that would increase and firm Kern River water supplies and manage these supplies through development of groundwater “recharge and recovery” facilities (i.e., “conjunctive use”). In 1952 the District acquired the perpetual right to water accruing to various pre-1914 Kern River water rights and initiated development of conjunctive use facilities to manage water accruing to these rights. The principle objective of the District’s project was to stabilize groundwater levels and maintain “economic pumping lifts” for District landowners.

Historical Kern River surface water supplies available to NKWSD through the pre-1914 rights have ranged from less than 10,000 acre-feet (AF) in a very dry year to nearly 400,000 AF in a very wet year. For the purpose of groundwater recharge, in addition to in lieu deliveries, NKWSD principally makes use of about 1,500 acres of recharge basins (additional recharge occurs through unlined canals and through irrigation return flow) and more than 200,000 AF of water has been directed into recharge basins during these years. During dry years, deliveries of surface water to irrigation (in-lieu) are greatly reduced and groundwater pumping is significant. Recovery of previously recharged groundwater by the District’s 100 wells has ranged from zero
to more than 100,000 AF in one year, and wells owned by landowners have recovered an approximately equivalent volume.

NKWSD has successfully operated its conjunctive use project for over 60 years and can demonstrate a favorable (positive) water budget over this period (see Section 2.4). Nevertheless, groundwater levels have generally declined and it is consequently critical that NKWSD work closely with neighboring districts to ensure long-term regional groundwater sustainability under SGMA.

2.7.2.2 SWID Conjunctive Use Program

SWID was formally organized in September 21, 1937, by Shafter and Wasco area farmers after careful studies of the needs and problems peculiar to the area. The District’s purpose was to find ways and means of replenishing rapidly dwindling underground water supplies. With the start of construction of Friant Dam on November 5, 1939 a future source of water for the District became a definite possibility.

The District formally applied to the United States Bureau of Reclamation (USBR) for Central Valley Project water for land within the District boundaries on February 5, 1946. The USBR provided a “Factual Report” for SWID in 1953. This Report estimated that 28,500 AF per year of ground water supplies historically flowed from the south into SWID and proposed surface water supplies needed to balance water supply with water demands. Water service to the District would be from the Friant-Kern Canal, which passes close to the eastern District boundary.

On February 11, 1955 the Board of Directors of the Shafter-Wasco Irrigation District executed a contract with the United States providing for a water service contract for 50,000 acre-feet of Class I water and 39,600 acre-feet of Class II water and a repayment contract for the construction of a distribution system. The project provided for groundwater replenishment by irrigation delivery of surface water in-lieu of deepwell pumping.

Although the project was designed by the USBR to be sustainable for groundwater conditions, groundwater use outside the District has led to a continued decline in groundwater elevations over time.
Figure 2-1

NKWSD AND SWID
SGMA JURISDICTIONAL AREAS

SGMA Jurisdictional Area
- North Kern Water Storage District (NKWSD)
- Shafter - Wasco Irrigation District (SWID)
Management Area (Within Jurisdictional Area but outside this Management Plan Area)
- SWID MA-2 (Plan Prepared by Others)

Adjacent Jurisdiction
- Cawelo GSA
- Semitropic WSD GSA
- McFarland GSA
- Kern River GSA
- Rosedale Rio-Bravo WSD
- Southern San Joaquin MUD
- City of Shafter
- City of Wasco
- Kern County Subbasin Boundary

Other Features
- Highway
- Waterway
- Major Conveyance

SOURCE: DWR, Kern County, Stakeholder Input.
Federal Regulations).


**Criteria of 40 CFR §146.4,** primacy productive limits are not suitable.

**Per 40 CFR §144.3,** exempted aquifers are not USDWs. Based on differences between average surface elevation and minimum depth of productive limit.

**Elevation to hydrocarbons and the top of exempted aquifers are approximately 3,000 micromhos per centimeter (Page-1973).**

**Elevation Contour of Specific Conductance (3,000 micromhos per centimeter) or ~2,000 mg/L TDS.**

**Hydrocarbon elevations from primacy productive limits represent US DEQH.**

**Elevation of Base of Freshwater (Approximately 3,000 micromhos) in the San Joaquin Valley, California (R.W. Page 1973).**

**SOURCE:** Base of Fresh groundwater (Approximately 3,000 micromhos) in the San Joaquin Valley, California (R.W. Page 1973).
Federal Regulations). Based on criteria of 40 CFR §146.4, primacy productive limits are not suitable for hydrocarbons and the top of exempted aquifers are productive limit. The difference between average surface elevation and minimum depth of productive limit.

Notes:

(Approximate) Elevation of ~10,000 mg/L TDS. Hydrocarbon elevations from primary productive limits represent difference between average surface elevation and minimum depth of productive limit. Elevation to hydrocarbons and the top of exempted aquifers are generalized. Refer to the report table for details. Exemptions are subject to change as applications are approved.

Per 40 CFR §144.3, exempted aquifers are not USDWs. Based on criteria of 40 CFR §146.4, primary productive limits are not suitable for USDWs.


Datum is Mean Sea Level.
NOTE: Although contacts with the Top of San Joaquin Formation (Mio-Pliocene Marine Deposits) are reported in Oil and Gas records for some of this cross section, facies changes are likely occurring and can cause difficulty in correlation along the cross section.
- Undivided Tertiary: sandstone, shale, conglomerate, breccia and ancient lake deposits
- Plio-Pleistocene: sandstone, shale and gravel deposits; mostly loosely consolidated
- Miocene: sandstone, shale, conglomerate and fanglomerate; moderately to well consolidated
- Quaternary: older alluvium, lake, playa and terrace deposits
- Pleisto-Holocene: alluvium, lake, playa and terrace deposits
- Syncline, concealed
- Anticline, concealed
- Fault, concealed
- Fault, approx. located
- Fault, certain

Geologic Units:
- Q - Pleistocene-Holocene: alluvium, lake, playa, and terrace deposits; unconsolidated and semi-consolidated
- Qoa - Quaternary: older alluvium, lake, playa and terrace deposits
- Q感应 - Plio-Pleistocene: sandstone, shale, and gravel deposits; mostly loosely consolidated
- Mc/M - Miocene: sandstone, shale, conglomerate and fanglomerate; moderately to well consolidated
- TC - Undivided Tertiary: sandstone, shale, conglomerate, breccia and ancient lake deposits

Kern County Subbasin Boundary
Highway
Waterway
Major Conveyance

North Kern Water Storage District and Shafter-Wasco Irrigation District
Management Area Plan
Kern County, California

AUGUST 2019 DRAFT FIGURE 2-11
HYDROLOGIC SOIL GROUPS

Management Plan Area
- North Kern Water Storage District
- Shafter-Wasco Irrigation District

Hydrologic Group - Dominant Condition
- A - High Infiltration (Sands or Gravels)
- B - Moderate Infiltration (Fine to coarse Soils)
- C - Slow Infiltration (Moderately Fine to Fine Soils)
- C/D - Very Slow Infiltration (Clay Soils)
- D - Very Slow Infiltration
- No Data

Kern County Subbasin Boundary
- Highway
- Waterway
- Major Conveyance


Kern County, California

AUGUST 2019 DRAFT FIGURE 2-13
FIGURE 2-17

LOCATION OF TURNOUTS SERVING NKWSD AND SWID

- Southwestern Irrigation District (SWID)
- North Kern Water Storage District (NKWSD)

Major Conveyance:
- Friant-Kern Canal
- Lined
- Unlined

Management Plan Area:
- North Kern Water Storage District
- Shafter-Wasco Irrigation District

Source of Imported Water:
- Central Valley Project (CVP)
- State Water Project (SWP)
- SWP & Kern River
- Kern River

Kern County Subbasin Boundary
GSA Boundaries
Highway
Waterway

Source: USGS NHD, Kern County

North Kern Water Storage District and Shafter-Wasco Irrigation District Management Area Plan

Kern County, California

AUGUST 2019
Figure 2-24

Land Use

- Agriculture
- Riparian Vegetation
- Native Vegetation
- Commercial
- Industrial
- Residential
- Urban Landscape
- Urban
- Surface Water
- Vacant

Management Plan Area

- North Kern Water Storage District
- Shafter-Wasco Irrigation District

MAXIMUM SODIUM CONCENTRATIONS

FIGURE 2-30

Representative Well
Max Sodium (ppm)
28 - 34
35 - 69
> 70

Management Plan Area
North Kern Water Storage District
Shafter-Wasco Irrigation District
Kern County Subbasin Boundary
Highway
Waterway
Major Conveyance

SOURCE: NKWSD
rsnyder

North Kern Water Storage District and Shafter-Wasco Irrigation District Management Area Plan
Kern County, California

AUGUST 2019 DRAFT
SOURCE: Natural Communities Commonly Associated with Groundwater (NCCAG - 2018)
NCCAG WETLANDS

Management Plan Area
- North Kern Water Storage District
- Shafter-Wasco Irrigation District
- Kern County Subbasin Boundary

Highway
Waterway
Major Conveyance

SOURCE: Natural Communities Commonly Associated with Groundwater (NCCAG - 2018)

Kern County, California

FIGURE 2-46
3. Sustainable Management Criteria

3.1 Sustainability Goals

SGMA requires that a sustainability goal be defined for the basin (CWC §10727(a)) and the GSP emergency regulations further clarify that the sustainability goal be defined on a basin-wide basis. NKWSD and SWID, working with the KGA and other GSAs in the Subbasin have developed the following sustainability goals for the Subbasin:

Sustainable management in the Kern County Subbasin will result from the implementation of projects and management actions at the member agency level of each GSA to maintain its groundwater use to the sustainable yield of the basin, operate at or above established measurable objectives, and above established minimum thresholds. The sustainable yield, measurable objectives, and minimum thresholds in the Subbasin have been established based on the technical information presented in the Basin Setting of this KGA GSP and the technical information developed by each member agency and presented in their management area plans.

The projects and management actions proposed by the member agencies of the KGA include a variety of water supply development and demand management actions that collectively will bring the Subbasin sustainability over the 20-year implementation period.

The Subbasin will continuously monitor groundwater conditions, as required by SGMA, and will continue coordination among the KGA member agencies and all other GSA’s in the Subbasin to identify the potential for or presence of undesirable results. The coordination process established in the development of the this GSP and memorialized in the coordination agreement will ensure that the Subbasin is managed as a unit and that the districts within the Subbasin work collaboratively towards sustainability.

3.2 Undesirable Results

Undesirable results for each sustainability indicator have been developed through a collaborative process with all GSAs in the Subbasin, compliant with GSP emergency regulations, which states that undesirable results are to be defined consistently throughout the basin (23-CCR § 354.20). The definitions of undesirable results provide flexibility for each management area within the Subbasin to define minimum thresholds that constitute significant and unreasonable impacts to the beneficial uses and users of groundwater within the specific management areas.

The definitions of undesirable results for the Subbasin are described in the KGA GSP and are repeated here with additional information regarding causes and effects of each sustainability indicator for the NKWSD and SWID management areas.
### 3.2.1 Undesirable Results for Chronic Lowering of Groundwater Levels

The basin-wide definition of undesirable results for chronic lowering of groundwater levels is as follows:

*The point at which significant and unreasonable impacts over the planning and implementation horizon, as determined by depth/elevation of water, affect the reasonable and beneficial use of, and access to, groundwater by overlying users.*

This is determined when the minimum threshold for groundwater levels are exceeded in at least three (3) adjacent management areas that represent at least 15% of the Subbasin or greater than 30% of the Subbasin (as measured by each management area). Minimum thresholds shall be set by each of the management areas through their respective Management Area Plans, minimum thresholds, measurable objectives, and interim milestones.

Within the Subbasin, a management area will be considered an undesirable results watch area for lowering of groundwater levels when it exceeds its minimum threshold criteria, as determined by each management area. Within the NKWSD and SWID management areas, a management area will be considered an undesirable results watch area when 51% of the representative monitoring sites in a management area violate their minimum threshold for groundwater levels. If multiple undesirable results watch areas meet the criteria for a Subbasin undesirable result, as defined above, the Subbasin would be considered to be experiencing an undesirable result.

#### 3.2.1.1 Potential Cause of Undesirable Results

A potential cause of the undesirable result of chronic lowering of groundwater levels in NKWSD and SWID management areas is a continued or increased reliance on groundwater pumping due to the reduction of imported water supplies. As the primary use of groundwater in NKWSD and SWID is for agriculture, increased groundwater pumping could also occur if new land is put into agricultural production or if water use per acre on existing irrigated land increases. Volume of water pumped by municipal and industrial users is relatively minimal when compared to the volume of water used for agricultural production. No significant development is anticipated in NKWSD and SWID based on the review of the current General Plans.

#### 3.2.1.2 Potential Effects of Undesirable Results

The primary potential effect of the chronic lowering of groundwater levels on the beneficial uses and users of groundwater in NKWSD and SWID may include groundwater well dewatering and increased pumping lift. Well dewatering is detrimental to wells as it can lead to increased maintenance costs (e.g., well rehabilitation/redevelopment and pump lowering) and reduced well lifespan due to corrosion of well casings and screens. Increased pumping lift results in more energy use necessary per unit volume of groundwater pumped and corresponding higher pumping costs, as well as increased wear and tear on well pump motors, and reduced well efficiency.
3.2.2 Undesirable Results for Reduction of Groundwater Storage

The basin-wide definition of undesirable results for reduction of groundwater storage is as follows:

*The point at which significant and unreasonable impacts, as determined by the amount of groundwater in the basin, affect the reasonable and beneficial use of, and access to, groundwater by overlying users over an extended 10-year drought period.*

*This is determined when the volume of storage (above the groundwater level minimum thresholds) is depleted to an elevation lower than the groundwater level minimum threshold in at least three (3) adjacent management areas that represent at least 15% of the Subbasin or greater than 30% of the Subbasin (as measured by the acreage of each management area).*

*Minimum thresholds shall be set by each of the management areas through their respective Management Area Plans.*

Within the Subbasin, a management area will be considered an undesirable results watch area for reduction in storage when it exceeds its minimum threshold criteria, as determined by each management area. Within the NKWSD and SWID management areas, a management area will be considered an undesirable results watch area for reduction in groundwater storage when 51% of the representative monitoring sites in a management area violate their minimum threshold for groundwater levels, since water elevations serve as a proxy for reduction of groundwater storage. If multiple undesirable results watch areas meet the criteria for a Subbasin undesirable result, as defined above, the Subbasin would be considered to be experiencing an undesirable result.

3.2.2.1 Potential Cause of Undesirable Results

Reduction of groundwater storage is generally correlated to chronic lowering of groundwater levels. Therefore, the potential causes of undesirable results due to reduction in groundwater storage are generally the same as the potential causes listed above for the undesirable results due to chronic lowering of groundwater levels.

3.2.2.2 Potential Effects of Undesirable Results

NKWSD and SWID have defined the undesirable result of reduction of groundwater storage as the reduction of available groundwater volumes needed to support a 10-year drought period, similar to that experienced over the 2006 to 2016 period. The volume of groundwater storage needed to support a 10-year drought is above the minimum threshold for chronic lowering of groundwater levels, therefore groundwater elevations below this minimum threshold would have the same effects on beneficial uses and users in NKWSD and SWID as chronic lowering of groundwater levels.

3.2.3 Undesirable Results for Degraded Water Quality

The basin-wide definition of undesirable results for degraded water quality is as follows:
The point at which significant and unreasonable impacts over the planning and implementation horizon, as caused by water management actions, that affect the reasonable and beneficial use of, and access to, groundwater by overlying users.

This is determined when the minimum threshold for a groundwater quality constituent of concern is exceeded in at least three (3) adjacent management areas that represent at least 15% of the Subbasin or greater than 30% of the designated monitoring points within the Subbasin. Minimum thresholds shall be set by each of the management areas through their respective Management Area Plans.

Within the Subbasin, a management area will be considered an undesirable results watch area for degraded water quality when it exceeds its minimum threshold criteria, as determined by each management area. Within the NKWSD and SWID management areas, a management area will be considered an undesirable results watch area for degraded water quality when 51% of the representative monitoring sites in a management area violate their minimum threshold for groundwater levels, since groundwater levels serve as a proxy for degraded water quality. If multiple undesirable results watch areas meet the criteria for a Subbasin undesirable result, as defined above, the Subbasin would be considered to be experiencing an undesirable result.

3.2.3.1 Potential Cause of Undesirable Results

Potential causes of undesirable results for degraded water quality vary throughout the Subbasin and within the Districts. Water quality in the Districts has been historically sustainable. In the future, water quality can be degraded by a significant increase in groundwater pumping or unforeseen point source contamination issues caused by natural or human activity.

3.2.3.2 Potential Effects of Undesirable Results

An undesirable result for degraded water quality could affect beneficial users. This could potentially reduce the amount of usable supply delivered to groundwater users and require the need for treatment systems, which could potentially have a negative economic effect.

3.2.4 Undesirable Results for Land Subsidence

The basin-wide definition of undesirable results for land subsidence is as follows:

The point at which significant and unreasonable impacts, as determined by a subsidence rate and extent in the basin, that affects the surface land uses or critical infrastructure.

This is determined when subsidence results in significant and unreasonable impacts to critical infrastructure as indicated by monitoring points established by a basin wide coordinated GSP subsidence monitoring plan.

It is generally recognized that land subsidence is occurring within the Subbasin and also within NKWSD and SWID. However, within NKWSD and SWID management areas described in this management area plan, no impacts to critical infrastructure have been identified. The lowering of groundwater levels within the NKWSD and SWID areas could potentially contribute to
subsidence, as can the groundwater pumping from neighboring areas. As no impacts to critical infrastructure have been identified and because it is not clearly understood how groundwater pumping in different areas of the basin affects subsidence, NKWSD and SWID have identified land subsidence as a data gap. As a result, no minimum thresholds are established for land subsidence at this time. NKWSD and SWID will work cooperatively with the KGA and other GSAs in the Subbasin to collect additional data and develop a better understanding of the causes (amount and locations of groundwater pumping) and impacts to critical infrastructure. Minimum thresholds will be adopted by NKWSD and SWID at such time that a clear understanding of the causes and effects can be developed.

### 3.2.4.1 Potential Cause of Undesirable Results

Land subsidence can be caused by several mechanisms, but the mechanism most relevant to sustainable groundwater management is the depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the potential causes of the undesirable results of land subsidence are generally the same as the potential causes listed above for undesirable results due to chronic lowering of groundwater levels.

### 3.2.4.2 Potential Effects of Undesirable Results

Potential effects of land subsidence include damage to critical infrastructure including pipelines, roads, building, water conveyance systems, and flood control facilities. Damage to these systems could impact water delivery to surface water, resulting in increased groundwater use. Of primary concern to the Districts, especially to SWID, is the impact of subsidence to the Friant Kern Canal. Subsidence affecting the canal is from groundwater pumping to the north of the Subbasin.

### 3.2.5 Undesirable Results for Seawater Intrusion

The location of the Subbasin, as it is described in the KGA GSP’s basin setting and the basin setting of this management area plan demonstrates that seawater intrusion is not under consideration for this management area or for the Subbasin at large because the Kern County Subbasin is located more than 60 miles from the nearest body of seawater. This separation precludes the possibility of seawater intrusion.

### 3.2.6 Undesirable Results for Interconnected Surface Water

Due to the historic groundwater pumping in the Subbasin and the Tulare Lake Basin, in general, the groundwater elevations have lowered such that interconnected surface streams no longer exist in the KGA portions of the Subbasin. This information is presented in the KGA GSP basin setting and the basin setting in this management area plan.

### 3.3 Minimum Threshold

The following section sets the minimum threshold for each of the sustainability indicators applicable to the NKWSD and SWID management areas. Thresholds are discussed as a proposed
minimum groundwater elevation that would exhibit undesirable results if groundwater elevations fall below the proposed thresholds for any sustainability indicator. Of the six sustainability indicators, seawater intrusion and interconnected surface water are not issues within the Districts, as indicated in the Basin Setting.

In accordance to §354.28 (d), the District’s thresholds with respect to groundwater elevations are used as a proxy for identifying undesirable results in groundwater storage, groundwater water quality, and land subsidence. Although groundwater storage in the basin is plentiful, it becomes uneconomical to obtain groundwater at certain depths. Therefore, NKWSD and SWID have elected to maintain approximately 10-years of groundwater storage (by volume) above the minimum threshold for groundwater elevation to manage a 10-year operational drought, similar to the 2006-2016 historical period. With respect to water quality, water levels cause changes in concentration of constituents at different depths of water level per location. Subsidence is known to be caused by the dewatering clay layers (from water level decline) and can be represented by groundwater levels.

The minimum threshold values are determined by separating the basin underlying the NKWSD and SWID management areas into different hydrogeologic zones (HZs), areas with similar hydrologic and geologic conditions. The creation of the HZs was closely coordinated with those districts adjacent to NKWSD and SWID management areas. Figures in Appendix D shows the distribution of HZs across the Districts. Spring water level data spatially representative of individual HZs were plotted together and a linear trend was projected from 2006 to 2016 (historic 10-year drought period). Within the District’s, all HZ groundwater elevation plots show a declining groundwater slope during the 2006-2016 period. This 10-year period was then projected to 2040 with a unique equal slope for each HZ to estimate the resulting groundwater level if the 2006-2016 conditions persisted for the 20-year implementation period from 2020 through 2040. This methodology was chosen as it would represent a worst-case condition and present a case which could be evaluated by the District’s stakeholders to understand what level of impact would be considered significant and unreasonable to individual stakeholder within each HZ. As previously stated, this methodology represents a worst-case scenario in terms of imported water supply deliveries and local hydrology. Figure 3-1 shows the change in groundwater elevation from 2015 to 2040 for North of the Kern River.

The 2040 conditions are set as the minimum threshold value. Figure 3-2 shows the estimated minimum thresholds in NKWSD and SWID management areas respectively. The projected 2040 water levels indicate the expected change to groundwater level with hydrology maintaining the 2006 to 2016 trend through 2040. This trend represents a worst-case scenario in which the District does not implement any management actions, or projects to mitigate pumping beyond what currently exists and is the case landowners/stakeholders were presented to determine which impacts would be significant and unreasonable. Through a series of workshops and individual meetings between the District’s staff and landowners, the results of this projected future condition were reviewed with District’s stakeholders. Based on the review and feedback from
landowners and stakeholders, the District adopted the minimum thresholds and measurable objectives described in the following section.

### 3.3.1 The Chronic Lowering of Groundwater Levels

Minimum threshold values for chronic lowering of groundwater levels in NKWSD and SWID are shown in Table 3-1 and Table 3-2 respectively. The minimum threshold values vary within the different management areas (and throughout the Subbasin) due to hydrology and the projected decreases in water levels, determined in each HZ. One management area contains multiple minimum thresholds depending on the hydrologic gradients and spatial distribution of the representative monitoring sites as shown in the tables above.

**Table 3-3-1: Minimum Threshold for Chronic Lowering of Groundwater Levels in the NKWSD**

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Minimum Threshold (ft MSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North Kern Water Storage District</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Kern District Well</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88-03-009</td>
<td>35.492</td>
<td>-119.171</td>
<td>-127</td>
</tr>
<tr>
<td>88-09-009</td>
<td>35.536</td>
<td>-119.233</td>
<td>-141</td>
</tr>
<tr>
<td>88-21-005</td>
<td>35.588</td>
<td>-119.227</td>
<td>-131</td>
</tr>
<tr>
<td>88-29-014</td>
<td>35.623</td>
<td>-119.224</td>
<td>-133</td>
</tr>
<tr>
<td>99-00-003</td>
<td>35.442</td>
<td>-119.133</td>
<td>-72</td>
</tr>
<tr>
<td>99-00-081</td>
<td>35.576</td>
<td>-119.282</td>
<td>-192</td>
</tr>
<tr>
<td>99-22-084</td>
<td>35.638</td>
<td>-119.312</td>
<td>-213</td>
</tr>
<tr>
<td><strong>Proposed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Site 3</td>
<td></td>
<td></td>
<td>-239</td>
</tr>
<tr>
<td>Well ID</td>
<td>Latitude</td>
<td>Longitude</td>
<td>Minimum Threshold (ft MSL)</td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>-----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Shafter-Wasco Irrigation District City of Shafter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 15 Active AG</td>
<td>35.470</td>
<td>-119.279</td>
<td>-147</td>
</tr>
<tr>
<td>Well 7 Inactive</td>
<td>35.508</td>
<td>-119.278</td>
<td>-163</td>
</tr>
<tr>
<td>City of Wasco</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>35.602</td>
<td>-119.365</td>
<td>-259</td>
</tr>
<tr>
<td>9</td>
<td>35.583</td>
<td>-119.332</td>
<td>-222</td>
</tr>
<tr>
<td>Proposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Site 1</td>
<td></td>
<td></td>
<td>-186</td>
</tr>
<tr>
<td>Proposed Site 2</td>
<td></td>
<td></td>
<td>-215</td>
</tr>
</tbody>
</table>

Both NKWSD and SWID believes that the proposed minimum groundwater elevation will not cause undesirable results in the basin. District’s will reevaluate the threshold based upon the District’s ability to implement projects and management actions and, if necessary, will adjust the minimum threshold if they are able, to prevent causing an undesirable result in the basin.

In determining the minimum threshold, the impact of lowering water levels to the proposed minimum threshold was analyzed by using available well construction data for agriculture, municipal, and domestic wells. The well impact analysis of the equivalent minimum threshold average values (represented as depth to water values) for each HZ was used to determine that a portion of the existing wells are impacted to varying extents. Most wells are expected to be operational (even with a decrease in efficiency) as the bottom of the screens remain in the water. This can be observed in Figure 3-3 for SWID agricultural wells, Figure 3-4 for NKWSD agricultural wells, Figure 3-5 for NKWSD domestic wells, Figure 3-6 for SWID domestic wells, and Figure 3-7 for SWID municipal wells. No municipal wells are currently located within NKWSD. The portion of the City of Shafter located in NKWSD is serviced by OMWC’s wells, which are located outside of this management area plan’s plan area.

Although the data presented is a subset of the total wells in the Districts’ management areas, it is reasonable to assume that many wells will maintain operation even at the proposed minimum threshold values. The projected minimum threshold depths to water were reviewed with landowners within both NKWSD and SWID, along with the well impact analysis, to determine if it would be economical to mitigate the impacts of agricultural, domestic, and municipal wells.

It was determined that at the average 2040 water levels, impacts to agricultural wells could and would be mitigated by landowner to the extent that declining groundwater levels was created by localized actions by those landowners. It was determined that none of the identified agricultural water wells within the NKWSD and SWID management areas would be dewatered, however in many instances water levels near the minimum threshold would require lowering of pump bowls.

It was also identified that if water levels were to fall to levels near the minimum threshold then
mitigation would be necessary to address the impacts to the few impacted domestic wells in the area. Any further decrease in water level below the established minimum threshold would create a significant and unreasonable impact to overlying groundwater users and would cause an undesirable result. In normal operating conditions, the extent of impact to wells is expected to be less as water levels are expected to be at higher elevations than the minimum threshold. However, the analysis determined it is possible for the District to drop water levels to the established minimum threshold values and not have undesirable results that cannot be mitigated.

3.3.2 Groundwater Storage

The minimum threshold for groundwater storage was set in conjunction with the minimum threshold for the groundwater level. In this Subbasin groundwater storage is not a significant issue regarding water supply since there is enough storage in the Subbasin to use beyond the set minimum threshold, but access is reduced based on what is economical to currently extract. The minimum thresholds impact to groundwater users for reduction of groundwater storage are the same as those for the chronic lowering of groundwater based on the ability to economically access the water and the proposed water levels are not expected to cause an undesirable result.

3.3.3 Degraded Water Quality

A minimum threshold for degraded water quality has not been set because historical data used to evaluate groundwater conditions does not indicate lowered water levels, at least at levels observed to date, resulting in degraded water quality. Regardless, groundwater sampling will continue: monitoring sites and parameters were strategically selected to inform on future degradation. As defined in Section 4, Monitoring Network, water quality sampling coincides with groundwater levels. This approach is expected to provide clear correlations between water quality and groundwater levels. Because historical data does not reveal any trends showing an undesirable result, no minimum threshold has been established for water quality.

3.3.4 Subsidence

The minimum threshold for land subsidence is set equivalent to the chronic lowering of groundwater levels minimum threshold. Land subsidence currently occurs and is expected to continue with lowering of groundwater levels. The proposed water levels are unknown to cause an undesirable result regarding subsidence. In the future, when more consistent and better calibrated data is available, it may be necessary to adjust the minimum threshold dependent on what new information is available. Information needed are specifically the magnitude of subsidence around facilities and infrastructure, which are areas that may cause a significant economic problem affecting water users and others. In the future, minimum thresholds will be derived from monitoring programs implemented to increase the available data in suspected critical areas and to calibrate spatial data available.

Current data available for the Subbasin indicates that subsidence varies throughout the Subbasin. Within the jurisdictional areas of NKWSD and SWID, higher rates of subsidence occur in the
northwestern portion of NKWSD and in the area along the border between NKWSD and SWID. While these rates of subsidence are higher than the rest of the area covered in this management area plan, they have not been identified as significant or unreasonable.

### 3.4 Measurable Objectives and Interim Milestones

The measurable objective is established in accordance to regulation §354.30 (d), groundwater elevations can serve as the value for multiple sustainability indicators where the representative value is a reasonable indicator for multiple measurable objective. As with the minimum threshold, measurable objective values were not established for depletion of interconnected surface water and sea water intrusion as these are not applicable to the basin.

The measurable objective values are determined in the same manner as explained in Section 3.3 for the minimum threshold with the exception that the measurable objective is set at 2030 water levels per the methodology described above. For the NKWSD and SWID management areas, the measurable objective is the adopted goal to maintain groundwater levels at or above the interpolated 2030 water levels. The measurable objective is a ten-year rolling average of the groundwater elevation at any given monitoring site, that represents the proposed groundwater elevation at which NKWSD and SWID plan to maintain for sustainability.

Figure 3-8 shows the change in groundwater elevations from 2015 to 2030 for North of the Kern River. Setting the measurable objective at the 2030 water level was determined based on the margin of safety giving the District’s an approximate storage of 10-years (may vary significantly) of water supply in the instance the District is faced with a similar water supply situation as experienced during the 2006 to 2016 drought. Figure 3-2 shows the measurable objectives along with minimum thresholds in NKWSD and SWID management areas respectively.

The interim milestones are the points at which the District plans to set their water level to reach the sustainability goal at the district level within 20 years of the plan implementation. The milestones are set every five years and are based on a linear trend to reach the measurable objective values by 2040, as shown in Figure 3-9 and 3-10 for NKWSD and SWID management areas respectively. The District will implement projects and management actions to maintain a path along the interim milestones and to meet the measurable objectives. The time frame for implementation of management actions and projects are discussed in this section.

### 3.4.1 The Chronic Lowering of Groundwater Levels

The measurable objective for the chronic lowering of groundwater levels is set at projected 2030 water levels and are monitored at the specific monitoring points. The measurable objective in each management area are monitored at various location. The established measurable objective values are determined from the 2030 water level contours and are shown for each representative monitoring point as shown in Table 3-3 and 3-4 for NKWSD and SWID management area respectively.
The proposed measurable objective will allow the District to operate in a worst-case scenario drought condition (2006 to 2016 conditions) and maintain operation before approaching the minimum threshold for an approximated 10 years. Prior to 10 years, the District would have the ability to implement projects or perform emergency actions to reduce pumping.

The measurable objective, like the minimum threshold values vary within the different management areas (and the basin) due to hydrology and the projected decrease in water level determined in each HZ subzone. One Management area contains multiple measurable objectives dependent on hydrologic gradients and spatial distribution.

The interim milestones were determined trending a linear trend to reach the measurable objective by 2040. The steps to reach the measurable objectives will be set by the interim milestones which are checked every five years during the plan’s implementation. At these points, projects and management actions will be taken to reduce the reliance on groundwater supply. Section 5 contains details of the projects and management actions which will be used to achieve the interim milestones every five- years. A linear interpolation between the 2015 spring groundwater levels and the measurable objective (2030 water level projections) are used in setting the interim milestones.

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Measurable Objective (ft MSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Kern Water Storage District</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Kern District Well</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88-03-009</td>
<td>35.492</td>
<td>-119.171</td>
<td>-52</td>
</tr>
<tr>
<td>88-09-009</td>
<td>35.536</td>
<td>-119.233</td>
<td>-66</td>
</tr>
<tr>
<td>88-21-005</td>
<td>35.588</td>
<td>-119.227</td>
<td>-56</td>
</tr>
<tr>
<td>88-29-014</td>
<td>35.623</td>
<td>-119.224</td>
<td>-57</td>
</tr>
<tr>
<td>99-00-003</td>
<td>35.442</td>
<td>-119.133</td>
<td>4</td>
</tr>
<tr>
<td>99-00-081</td>
<td>35.576</td>
<td>-119.282</td>
<td>-114</td>
</tr>
<tr>
<td>99-22-084</td>
<td>35.638</td>
<td>-119.312</td>
<td>-135</td>
</tr>
<tr>
<td>Proposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Site 3</td>
<td></td>
<td></td>
<td>-154</td>
</tr>
</tbody>
</table>
Table 3-4: SWID Measurable Objective for SWID

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Measurable Objective (ft MSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shafter-Wasco Irrigation District</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Shafter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 15 Active AG</td>
<td>35.470</td>
<td>-119.279</td>
<td>-68</td>
</tr>
<tr>
<td>Well 7 Inactive</td>
<td>35.508</td>
<td>-119.278</td>
<td>-85</td>
</tr>
<tr>
<td>City of Wasco</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>35.602</td>
<td>-119.365</td>
<td>-171</td>
</tr>
<tr>
<td>9</td>
<td>35.583</td>
<td>-119.332</td>
<td>-141</td>
</tr>
<tr>
<td>Proposed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Site 1</td>
<td></td>
<td></td>
<td>-108</td>
</tr>
<tr>
<td>Proposed Site 2</td>
<td></td>
<td></td>
<td>-134</td>
</tr>
</tbody>
</table>

3.4.2 Groundwater Storage

The measurable objective for the reduction in groundwater storage is based on the measurable objective for the chronic lowering of groundwater levels. In setting the measurable objective at the 2030 projection and the minimum threshold at the 2040 water level projection (based on the historical drought), approximately 10 years of storage is available to the District before reaching the minimum threshold, this was set as a factor of safety. A linear interpolation between the 2015 spring groundwater levels and the measurable objective (2030 water level projections) are used in setting the interim milestones.

3.4.3 Degraded Water Quality

The measurable objective for degraded water quality is based on the measurable objective of chronic lowering of groundwater levels. A linear interpolation between the 2015 spring groundwater levels and the measurable objective (2030 water level projections) are used in setting the interim milestones. While this data shows a significant decrease in water level, impacts to water quality cannot be quantified because available data does not indicate that water quality degrades when water levels decline in the Districts.

3.4.4 Land Subsidence

The measurable objective for land subsidence at this time is based on the measurable objective of chronic lowering of groundwater levels. As mentioned in Section 3.3.4 the magnitude and severity of subsidence is unknown, and data is needed to be collected to ensure the set reasonable measurable objective and minimum threshold. The data will be reviewed at the five-year intervals. A linear interpolation between the 2015 spring groundwater levels and the measurable objective (2030 water level projections) are used in setting the interim milestones.
3.5 Margin of Operational Flexibility

The margin of operational flexibility between the measurable objectives and the minimum thresholds is a designated 10-year drought water supply. The flexibility in the system is the amount of time to implement projects to bring in additional surface water supply or to reduce groundwater demand to maintain groundwater levels above the minimum thresholds. Table 3-3-3 shows an example of the District’s operational flexibility to maintain above the minimum thresholds through voluntary management actions, such as a fallowing or land retirement program.

**Table 3-3-3. Example District Operational Flexibility**

<table>
<thead>
<tr>
<th>Sustainability Component</th>
<th>Categories of Projects &amp; Management Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Demand</td>
<td>Incentives of pumping reduction</td>
</tr>
<tr>
<td></td>
<td>Fees for landowner excess pumping</td>
</tr>
<tr>
<td></td>
<td>Water Market Response</td>
</tr>
<tr>
<td></td>
<td>Buy Back Program</td>
</tr>
<tr>
<td>Water Supply</td>
<td>Import Water Supply</td>
</tr>
<tr>
<td></td>
<td>Recharge Projects</td>
</tr>
<tr>
<td></td>
<td>Surface Water Capture</td>
</tr>
<tr>
<td></td>
<td>Other Projects</td>
</tr>
</tbody>
</table>

In instances where voluntary programs are not being utilized or are proven to be ineffective in the reduction of groundwater demand, more drastic measures will be taken. These measures may include mandatory pumping reduction and land fallowing. In instances where neighboring management areas differ on their sustainable management criteria, having a greater difference between the measurable objective and the minimum threshold will allow for more operational flexibility within the Districts so they may take action prior to reaching the minimum threshold and/or potentially negatively affecting adjacent management areas. In addition, neighboring management areas which approach their minimum thresholds may have less impact on the Districts’ management areas due to the larger range between the measurable objective and the minimum threshold for a given representative monitoring site, which allows for approximately 10-years of water level decline.

3.6 Potential Effects beyond Management Area

The setting of the minimum thresholds and measurable objectives in the GSP area described in this management area plan is coordinated with neighboring Districts to maintain a similar water level gradient as 2015 conditions. It is not expected to severely affect areas outside of the Districts in terms of significantly changing the surrounding water levels either lower, or higher,
than conditions of neighboring Districts’ plans. Also, the change in groundwater storage is correlated with the change in groundwater levels and is not expected to cause severe impact to neighboring Districts or GSAs.

Subsidence is a potential impact to neighboring Districts, GSAs, and subbasins. This extent is currently unknown, and more data needs to be collected to determine where the impacts may occur and what is contributing to these impacts.

Water quality data used to characterize groundwater conditions does not indicate that water quality degrades when groundwater levels decline. Regardless, a sampling program has been established to monitor changes in water quality related to water levels. No minimum threshold or measurable objective is set because degradation has not been observed.

Degraded water quality within NKWSD and SWID is defined as an increasing trend in salinity (sodium and chloride) that potentially threatens agriculture viability within the district; or concentrations of nitrate, arsenic or hexavalent chromium exceeding the respective drinking water standard, because of declining water levels. While these constituents are present throughout the district, the overall trends indicate lower concentrations with lower water levels. In contrast, higher concentrations are typically observed with higher water levels.
Minimum Thresholds and Measurable Objectives

Monitoring Well
- Old District Management Area
- Shafter-Wasco I.D.

Management Plan Area
- North Kern Water Storage District (NKWSD)
- Shafter-Wasco Irrigation District (SWID)

Management Area
- NKWSD MA-1
- NKWSD MA-2
- SWID MA-1

Kern County Subbasin Boundary

Other Features
- Highway
- Waterway
- Major Conveyance

North Kern Water Storage District and Shafter-Wasco Irrigation District Management Area Plan

Kern County, California

FIGURE 3-2

AUGUST 2019
HZ 02-03 Well Impact Analysis
(Agricultural Wells - 16)

Estimated Percentages

<table>
<thead>
<tr>
<th>Year</th>
<th>Top of Screen Dewatered (AG)</th>
<th>Bottom of Screen Dewatered (AG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>56%</td>
<td>0%</td>
</tr>
<tr>
<td>2030</td>
<td>81%</td>
<td>0%</td>
</tr>
<tr>
<td>2035</td>
<td>81%</td>
<td>0%</td>
</tr>
<tr>
<td>2040</td>
<td>81%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Figure 3-3
HZ 05-03 Well Impact Analysis
(Agricultural Wells - 70)

2016 Avg Water Level

Estimated Percentages

<table>
<thead>
<tr>
<th>HZ05-3</th>
<th>Top of Screen Dewatered (AG)</th>
<th>Bottom of Screen Dewatered (AG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>49%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>63%</td>
<td>0%</td>
</tr>
<tr>
<td>2030</td>
<td>74%</td>
<td>3%</td>
</tr>
<tr>
<td>2035</td>
<td>91%</td>
<td>3%</td>
</tr>
<tr>
<td>2040</td>
<td>96%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Blank Casing
Perforations
Avg Water Level

Figure 3-4
HZ 02-03 Well Impact Analysis
(Domestic Wells - 2)

2016 Avg Water Level

Estimated Percentages

<table>
<thead>
<tr>
<th>Year</th>
<th>Top of Screen Dewatered (Domestic)</th>
<th>Bottom of Screen Dewatered (Domestic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>2030</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>2035</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>2040</td>
<td>100%</td>
<td>50%</td>
</tr>
</tbody>
</table>
HZ 05-03 Well Impact Analysis
(Domestic Wells - 31)

2016 Avg Water Level

Estimated Percentages

<table>
<thead>
<tr>
<th>Year</th>
<th>Top of Screen Dewatered (Domestic)</th>
<th>Bottom of Screen Dewatered (Domestic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>35%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>58%</td>
<td>3%</td>
</tr>
<tr>
<td>2030</td>
<td>65%</td>
<td>23%</td>
</tr>
<tr>
<td>2035</td>
<td>81%</td>
<td>39%</td>
</tr>
<tr>
<td>2040</td>
<td>84%</td>
<td>39%</td>
</tr>
</tbody>
</table>

Figure 3-6
HZ 05-03 Well Impact Analysis
(Municipal Wells - 5)

2016 Avg Water Level

Estimated Percentages

<table>
<thead>
<tr>
<th>Year</th>
<th>Top of Screen Dewatered (Municipal)</th>
<th>Bottom of Screen Dewatered (Municipal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>40%</td>
<td>0%</td>
</tr>
<tr>
<td>2030</td>
<td>60%</td>
<td>0%</td>
</tr>
<tr>
<td>2035</td>
<td>60%</td>
<td>20%</td>
</tr>
<tr>
<td>2040</td>
<td>60%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Figure 3-7
This Page Left Blank Intentionally
North Kern Water Storage District and Shafter- Wasco Irrigation District Management Area Plan

Kern County, California

AUGUST 2019
DRAFT

FIGURE 3-8

Projected 2030 Groundwater Elevation Contour (MSL)

GW drop 2015-2030
-94 - -68
-136 - -95
-155 - -137
-189 - -156
-206 - -190

Kern County Subbasin Boundary
Highway
Waterway
Major Conveyance

Source: GEI (2019)
4. Monitoring Networks

This chapter describes the objectives, design, rationale, monitoring protocols, and data reporting requirements of the monitoring network to be implemented. This chapter discusses any data gaps, and a plan for assessment and future improvement to the monitoring network to fill data gaps.

The monitoring network and protocols are designed to collect data of sufficient quality, frequency, and distribution to characterize the groundwater and surface water conditions, along with water budget components in NKWSD and SWID, and to evaluate changing conditions due to water management actions and future water supply projects.

4.1 Monitoring Network Objectives

The monitoring networks in NKWSD and SWID are designed to meet the following monitoring objectives of this plan:

- Monitor impacts of groundwater pumping on beneficial uses and users of groundwater,
- Monitor progress toward measurable objectives of this plan relative to minimum thresholds,
- Collect data to quantify annual changes in water budget components of the study area, and
- Monitor changes in groundwater conditions relative to the sustainability indicators.

The monitoring network design relative to these four objectives are discussed in this chapter. These objectives will monitor the following pertinent sustainability indicators:

- Groundwater potentiometric surfaces or groundwater levels,
- Groundwater storage,
- Groundwater quality, and
- Land subsidence.

4.1.1 Water Level Monitoring as a Key Sustainability Indicator

As described in Section 3 of this management area plan, groundwater elevation is the key sustainability indicator for undesirable results in the Subbasin because lowering of groundwater levels leads to:

- increased groundwater well pumping costs,
- decrease in groundwater storage,
• increased land surface subsidence most notably where fine-grained units and active groundwater overdraft are present, and

• potential changes in groundwater quality.

The groundwater level monitoring network is the key to informing the progress of the management areas objectives for all sustainability indicators. While water levels are the key sustainability indicator for which minimum thresholds have been established, the monitoring network continues to include data collection stations for water quality, land subsidence, and other water budget components such as water demand and water supply inputs. The following sustainability indicators are not pertinent to this management area plan: seawater intrusion and depletions of interconnected surface water. Seawater intrusion is not anticipated to be a problem since the District is several miles from the ocean. For details on depletions of interconnected surface water, please refer to section 2.3.7.

4.2 Monitoring Progress toward Measurable Objectives

The monitoring network will inform progress of sustainable management to reach interim milestones and measurable objectives. As described in Section 5.3 of this management area plan, groundwater levels are the primary indicator for which minimum thresholds have been set, and for which interim milestones and measurable objectives will be compared. However, all sustainability indicators identified in this management area plan and in the KGA Umbrella GSP are included in the monitoring network. As groundwater level monitoring progresses, effects on other indicators can be evaluated. Tracking the progress of water levels as well as other indicators will inform the effectiveness of water management actions and implemented projects. The details for how the measurable objectives and minimum thresholds were developed for groundwater levels are described in Section 3 of this plan.

Monitoring the progress toward reaching interim milestones and measurable objectives will provide information needed to evaluate whether adjustments to management actions and the monitoring networks are required. Table 3-1 to 3-4 shows the minimum thresholds and measurable objectives for each monitoring site included as part of this management area plan’s network. As stated in §354.34(g)(3), minimum thresholds, measurable objectives, and interim milestones will be established at each monitoring site or representative monitoring site. Where needed, interim milestones for groundwater levels or other sustainability indicators may be adjusted in the five-year updates in order to maintain the objectives of this management area plan.

4.2.1 Potential Impacts to Beneficial Uses and Users of Groundwater

The monitoring network to be implemented will provide data to monitor the impacts of sustainable groundwater management on beneficial uses and users of groundwater, as well as secondary impacts such as land subsidence. A summary of potential impacts is included below (Table 4-4-1).
Table 4-4-1. Potential Impacts of Overdraft with Corresponding Monitoring

<table>
<thead>
<tr>
<th>User Group</th>
<th>Potential Impacts</th>
<th>Monitoring and Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated Agriculture</td>
<td>• Increased pumping costs and maintenance</td>
<td>• Water level monitoring</td>
</tr>
<tr>
<td></td>
<td>• Decrease in groundwater storage</td>
<td>• Incorporate data into the subbasin model to monitor</td>
</tr>
<tr>
<td></td>
<td>• Decrease in groundwater storage</td>
<td>storage outlooks with interim milestones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased salinity in the upper and migration into the lower zone</td>
</tr>
<tr>
<td>Industrial, Commercial, and Residential Wells</td>
<td>• Increased pumping costs and maintenance</td>
<td>• Water level monitoring</td>
</tr>
<tr>
<td></td>
<td>• Well Dewatering</td>
<td>• Incorporate data into the subbasin model to monitor</td>
</tr>
<tr>
<td></td>
<td>• Decrease in groundwater storage</td>
<td>storage outlooks with interim milestones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased Arsenic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water quality monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased TCP and Nitrates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water quality monitoring in lower aquifer zone</td>
</tr>
<tr>
<td>Public Facilities</td>
<td>Damaged infrastructure</td>
<td>Land subsidence monitoring</td>
</tr>
<tr>
<td>Groundwater Dependent Ecosystems</td>
<td>• Decline in shallow groundwater levels</td>
<td>• Water level monitoring</td>
</tr>
<tr>
<td>(Preliminary NCCAG mapped dataset)</td>
<td>• Reductions in shallow groundwater storage due to</td>
<td>• Confirm NCCAG mapped areas by field survey and evaluation</td>
</tr>
<tr>
<td></td>
<td>groundwater pumping</td>
<td>• If applicable, compare pumping in the upper and lower zone with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>water levels in the shallow zone</td>
</tr>
</tbody>
</table>
4.2.2 Monitoring Network for Water Budget Components

One of the objectives of the monitoring network is to monitor the water budget components in order to quantify the change in water budget over time. This aspect of the network will rely on local monitoring stations for water levels, but also regional weather stations and remote sensing methods for consumptive use. In addition, water supply and exports accounting are required to monitor the water budget components. These aspects of the network are briefly described below.

4.2.2.1 Water Inflow to the Subbasin

As described in the water budget section of the report, water inflow to the Subbasin within the Districts includes:

1. Surface water supplies (both imported and natural), that satisfies consumptive use, or becomes managed or unmanaged direct recharge to the Subbasin,
2. Precipitation, and
3. Subsurface inflow

4.2.2.2 Surface Water Diversions

NKWSD monitors all water received via the Calloway Canal, Beardsley Canal, Friant-Kern Canal, Poso Creek, banking partners, and neighboring districts, at conveyance interties. SWID monitors imported surface water from the Friant-Kern Canal, and water deliveries from other Districts outlined in the water budget. Both Districts perform monitoring using metering, or other gauging methods. Other surface water diversions, if any, from ephemeral Poso Creek may also be gauged seasonally.

All imported surface water into the Districts, whether it is contracted and will be used for direct consumptive use, other exchanges, in-lieu banking, oil produced water, or direct recharge counts as water inflow to the Subbasin. Surface water diversions and imports are monitored by the Districts and are available annually to be incorporated in data evaluation.

4.2.2.3 Precipitation

Depending on the water year, precipitation may account for recharge as well as consumptive use in the Subbasin. It is a component of water budget accounting that is monitored by weather stations. The following weather stations (Table 4-2) may be used for monitoring purposes in or near the Subbasin. Online weather station data are updated daily to monthly.
Table 4-2. Weather Stations within the Vicinity.

<table>
<thead>
<tr>
<th>Station Name</th>
<th>ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation (feet msl)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shafter</td>
<td>CIMIS 5</td>
<td>35.532556</td>
<td>-119.281790</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td>Delano</td>
<td>CIMIS 182</td>
<td>35.8330</td>
<td>-119.255960</td>
<td>300</td>
<td>Just north of Subbasin.</td>
</tr>
</tbody>
</table>

Source: https://cimis.water.ca.gov/Stations.aspx

4.2.2.4 Subsurface Inflow

Historical quantities of groundwater inflow to the Subbasin underlying the study area have been estimated in various regional models, calculated in local studies by Darcian Law, and may be estimated in the future by water budget accounting.

As the groundwater model of the study area continues to be refined, groundwater inflow calculations may become more accurate. In addition, annual water budget accounting as well as semiannual water elevation monitoring, contouring and gradient estimating, will continue to provide data to support estimates of groundwater inflow.

4.2.3 Water Leaving the Subbasin

As described in the water budget section of the report, water outflow or removal from the Subbasin within the Districts includes:

1. Consumptive use from crop demand, other vegetation, evaporation, and other beneficial use such as water recreation, domestic use, municipal or industrial use, etc.;

2. Exported water or “Pump Back”; and


4.2.3.1 Consumptive Use

Sources of water for consumptive use include diverted surface water, precipitation, and groundwater. As described in the water budget section of this plan, consumptive use from crop demand, other vegetation, and evaporation has been calculated from remote sensing techniques (GEI, 2017; ITRC-METRIC) with periodic ground truthing. The Districts continues to use remote sensing methodology to further quantify consumptive use within the study area for monitoring (Land IQ, 2019). The Subbasin will continue to coordinate techniques and methodology for monitoring consumptive use to update water budget components for the Subbasin.

4.2.3.2 Exported Water, “Pump back” Water

The Districts monitor water that leaves the study area for banking partners or exchanges by metering or other gauging methods. These data are included in annual accounting of the water budget and will continue to be available in the future.
4.2.3.3 Subsurface outflow

Historical quantities of groundwater outflow to the Subbasin underlying the study area have been estimated in various regional models, calculated in local studies by Darcian Law, and estimated by water budget accounting.

As a model of the study area is refined, groundwater outflow calculations may become more accurate. In addition, annual water budget accounting as well as semiannual water elevation monitoring, contouring and gradient estimating, will continue to provide data to support estimates of groundwater outflow.

4.3 Monitoring Network Design

The monitoring network design considers the use of existing monitoring networks, and the coverage required to monitor areas within the Districts with current and projected groundwater use to adequately demonstrate the short-term, seasonal, and long-term trends in groundwater and related surface water conditions. The network to be implemented is also designed to have new locations installed for data collection to fill pertinent data gaps in groundwater conditions.

As discussed previously, the monitoring network is designed to collect data with respect to the applicable sustainability indicators in the study area: groundwater levels and reduction of groundwater storage, degraded water quality, and land subsidence. Seawater intrusion and interconnected surface waters are not applicable sustainability indicators in the study area, as described in the basin setting chapter of this report, and are therefore, not included in the design of this monitoring network. A brief summary of the network design is introduced below, along with details of monitoring of the sustainability indicators.

4.3.1 Monitoring Frequency Design

The monitoring frequency is outlined in the protocols for monitoring sustainability indicators. In general, monitoring will occur semi-annually for groundwater and monthly for land subsidence at Continuous Global Positioning System (CGPS) stations with co-located groundwater gauging. This frequency provides sufficient short-term, seasonal, and long-term data to evaluate the effectiveness of management actions.

4.3.2 Spatial Density Design

The spatial density of the monitoring network design accounts for three management areas: NKWSD’s management area No. 1 encompasses the original District located exclusively north of 7th Standard Road, excluding the Rosedale Ranch Improvement District (RRID). NKWSD Management Area No. 2 is the RRID, the majority of which is located south of 7th Standard Road, excluding the portion of RRID that is covered by Kern River GSA SWID’s management area No. 1 is the District jurisdictional boundary. The undistricted lands to the south of SWID are a separate management area (SWID Management Area No. 2) that are discussed in a separate
management area plan and is not included in this management area plan. The management areas for both NKWSD and SWID are shown in Section 2.6.

The management areas in NKWSD monitoring network includes predominately agricultural lands and portions of the City of McFarland and City of Shafter. The management area in the monitoring network designed for SWID includes predominately agricultural lands, in addition to the Cities of Shafter and Wasco’s urban areas.

The spatial distribution of the water level monitoring sites is presented in Figure 4-1 and, for land subsidence, the monitoring area plan shown in Provost & Pritchard Subsidence Monitoring Survey report, which is included in Appendix G of this management area plan. For additional details on the spatial density for each of the monitoring sites, refer to the sections below on the monitoring of sustainability indicators.

4.3.3 Rationale for Design

Rationale regarding the design of the monitoring network is provided in the sections below dedicated to each sustainability indicator. In general, monitoring stations were chosen based on the following scientific rationale:

- Aquifer representation – Per DWR guidelines §354.34, monitoring wells were chosen to represent each underlying aquifer under the jurisdiction of the District.
- Potential impacts to beneficial users of groundwater
- Availability of site-specific historical data and technical information
- Spatial and vertical representation
- Identification of dedicated monitoring wells
- Site accessibility

Additionally, this study led to the identification of data gaps within the monitoring network, which resulted in identifying locations to install supplemental (or future) monitoring wells.

4.4 Monitoring Network

4.4.1 Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage

The monitoring network consists of 14 wells spread across both NKWSD and SWID management areas included in this Plan. Of these 14 wells, 8 wells are located in NKWSD MA-1, and the remaining six are in SWID MA-1. As evidenced in Figure 4-1, these 14 wells have been spatially distributed to provide adequate coverage throughout the management areas. Tables 4-3 and 4-4 identify the location, type, and construction details, NKWSD and SWID management area respectively. For NKWSD MA-1, the selected wells are predominately District
agricultural supply wells, whereas the monitoring network for SWID MA-1 is currently made up of domestic wells in the cities of Shafter and Wasco.

4.4.1.1 Rationale

The District’s monitoring network design and site selection for monitoring the groundwater levels was based on the same rationale outlined in section 4.3.3 of this chapter.

Since the District’s owns both agricultural production wells, and monitoring wells, an additional column has been added in the table to indicate the level of compliance with the DWR Best Management Practices guidelines for monitoring networks (DWR, 2016). The level of compliance has been categorized into the following:

- Interim wells (originally designed and constructed as agricultural production wells) were selected for the network to provide adequate spatial distribution until a permanent dedicated monitoring well can be installed. These interim wells generally have water level gauging data reported historically; however, not all of them have available well construction data. Interim wells selected were chosen based on spatial location to fill gaps in the monitoring network.

- Future installation – To identify sites for future installation of wells, one rationale was to select areas in which no current dedicated monitoring wells exist and where spatial coverage was desired. For example, the northwestern portion of NKWSD MA-1 does not have any beneficial pumping of groundwater, therefore, no interim well was identified. Similarly, the central portion of SWID MA-1 does not have any wells that could be included as part of this monitoring network. Therefore, to overcome this data gap, this monitoring network proposes drilling one dedicated monitoring well in the northwestern portion of NKWSD MA-1, and two dedicated monitoring wells in the central portion of SWID MA-1. The future monitoring locations will be finalized after site evaluation has occurred.
### Table 4-3: NKWSD Water Level & Water Quality Monitoring Network

<table>
<thead>
<tr>
<th>Well No.</th>
<th>DMS ID</th>
<th>T-R-S</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Coord Source</th>
<th>Monitoring Type</th>
<th>Owner</th>
<th>GSP Well Monitoring Status</th>
<th>To be replaced</th>
<th>GSP Parameters Type</th>
<th>Year Constructed</th>
<th>Borehole Depth (ft)</th>
<th>Well Depth (ft)</th>
<th>Perforated Interval (ft)</th>
<th>Annular Seal (ft)</th>
<th>Casing Diameter (in)</th>
<th>Aquifer Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-03-009</td>
<td>RMW-145</td>
<td>28S-26E-16U</td>
<td>35.492142</td>
<td>-119.170817</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>1954</td>
<td>--</td>
<td>725</td>
<td>300-725</td>
<td>16”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>88-09-009</td>
<td>RMW-146</td>
<td>27S-25E-36L</td>
<td>35.530413</td>
<td>-119.230314</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>2005</td>
<td>--</td>
<td>1003</td>
<td>490-1003</td>
<td>18”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>88-21-005</td>
<td>RMW-147</td>
<td>27S-25E-12R</td>
<td>35.587778</td>
<td>-119.226935</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>1991</td>
<td>--</td>
<td>1100</td>
<td>560-980</td>
<td>18”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>88-29-014</td>
<td>RMW-148</td>
<td>26S-25E-36H</td>
<td>35.623163</td>
<td>-119.224495</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>2005</td>
<td>--</td>
<td>1000</td>
<td>500-1000</td>
<td>18”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>99-03-003</td>
<td>RMW-149</td>
<td>28S-26E-36N</td>
<td>35.442408</td>
<td>-119.131177</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>1954</td>
<td>--</td>
<td>704</td>
<td>300-704</td>
<td>16 1/2”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>99-09-081</td>
<td>RMW-150</td>
<td>27S-25E-16Q</td>
<td>35.576360</td>
<td>-119.281784</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>1954</td>
<td>--</td>
<td>800</td>
<td>341-800</td>
<td>18”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>99-22-084</td>
<td>RMW-151</td>
<td>26S-25E-35H</td>
<td>35.630001</td>
<td>-119.312440</td>
<td>District</td>
<td>Supply Well</td>
<td>NKWSD</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>1953</td>
<td>--</td>
<td>800</td>
<td>340-800</td>
<td>18”</td>
<td>Main Production</td>
<td></td>
</tr>
<tr>
<td>Future</td>
<td>RMW-152</td>
<td>26S-25E-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Future</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4-4: SWID Water Level & Water Quality Monitoring Network

<table>
<thead>
<tr>
<th>Well No.</th>
<th>DMS ID</th>
<th>T-R-S</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Coord Source</th>
<th>Monitoring Type</th>
<th>Owner</th>
<th>GSP Well Monitoring Status</th>
<th>To be replaced</th>
<th>GSP Parameters Type</th>
<th>Year Constructed</th>
<th>Borehole Depth (ft)</th>
<th>Well Depth (ft)</th>
<th>Perforated Interval (ft)</th>
<th>Annular Seal (ft)</th>
<th>Casing Diameter (in)</th>
<th>Aquifer Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shafter Well 7 Inactive</td>
<td>28S-25E-10</td>
<td>35.507996</td>
<td>-119.277661</td>
<td>Supply Well</td>
<td>City of Shafter</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>700</td>
<td>500-700</td>
<td>150</td>
<td>Main Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shafter Well 15</td>
<td>28S-25E-28</td>
<td>35.470462</td>
<td>-119.279183</td>
<td>Supply Well</td>
<td>City of Shafter</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>750</td>
<td>500-750</td>
<td>Main Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasco 2A</td>
<td>27S-24E-02</td>
<td>35.601558</td>
<td>-119.365154</td>
<td>Supply Well</td>
<td>City of Wasco</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>828</td>
<td>457-818</td>
<td>Main Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasco 9</td>
<td>27S-24E-13</td>
<td>35.583233</td>
<td>-119.332163</td>
<td>Supply Well</td>
<td>City of Wasco</td>
<td>Interim</td>
<td>Yes</td>
<td>WL and WQ</td>
<td>709</td>
<td>-709</td>
<td>Main Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future</td>
<td>27S-24E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Future</td>
<td></td>
</tr>
<tr>
<td>Future</td>
<td>27S-25E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Future</td>
<td></td>
</tr>
</tbody>
</table>
The monitoring network for each respective aquifer zone considers where active groundwater production occurs and where aquifer zones are present. For example, as described in the basin setting of this chapter, no pumping for beneficial uses occurs in the upper zone and is therefore classified as *de minimis*, consequently, the monitoring network does not include any monitoring of this zone (refer to the basin setting of this chapter for details on extent of the Corcoran clay). Therefore, congruous to the pumping occurring in the aquifer zones, all wells included in this monitoring network will monitor the lower zone.

### 4.4.1.2 Monitoring Frequency for Groundwater Conditions

The monitoring network will be capable of collecting sufficient data to demonstrate seasonal, short-term (1 to 5 years) and long-term (5 to 10 years) trends in groundwater and related surface conditions and yield representative information about groundwater conditions as necessary to evaluate plan implementation. In general, water level monitoring will be seasonal to evaluate groundwater elevations during spring time (seasonal high prior to summer irrigation demands) and fall (seasonal low after the summer irrigation demands).

### 4.4.1.3 Spatial Density

In general, the monitoring network well density follows the recommendation of 4 to 10 wells per 100 square miles (DWR, 2016), in active groundwater production zones. Table 4-5 below lists the well density for the network with interim wells and with future installation of monitoring wells. The well density is listed in relation to the three management areas.

<table>
<thead>
<tr>
<th>Management Area</th>
<th>Area (Sq. miles)</th>
<th>Corresponding minimum number of wells recommended in DWR BMP</th>
<th>Monitoring wells included as part of the network</th>
</tr>
</thead>
<tbody>
<tr>
<td>NKWSD (MA-1)</td>
<td>96</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>SWID (MA-2)</td>
<td>60</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

### 4.4.1.4 Data Gaps

While the monitoring network provides a good spatial coverage of the entire District, the interim wells identified lack well construction details and require confirmation of perforation intervals. As referenced in § 352.4 of the regulations, “If an Agency relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a Plan, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, or demonstrate to the Department that such information is not necessary to understand and manage groundwater in the basin.”
Overall, the majority of each District’s monitoring wells are screened in the lower aquifer zone. Few details are known of wells screened in the upper aquifer zone. Of the supply wells completed in the upper zone or completed in both the upper and lower zones, many lack well construction details and require confirmation of perforation intervals and their relation to upper and lower aquifers. The extents of the Corcoran clay (shown in the Basin Setting) was primarily used to determine where upper and lower aquifers exist and does not indicate with absolute certainty that a shallower aquifer does not exist in the central and east portions of NKWSD.

Additionally, the monitoring network does not identify any wells within NKWSD MA-2 due to lack of District owned wells in that area.

The description of steps to fill this data gap has been identified in section 4.5 below.

### 4.4.2 Seawater Intrusion

Seawater intrusion is not applicable to this management area plan.

### 4.4.3 Degraded Water Quality

The District proposes to utilize the same network of wells that were identified as part of the groundwater level monitoring network.

#### 4.4.3.1 Rationale

Since the District’s monitoring network comprises wells for both water quality and level monitoring, the same rationale elaborated in section 4.3.4.1 applies here.

#### 4.4.3.2 Spatial Density

As described in section 4.3.4.3 and evidenced in Table 4-5, the monitoring network well density follows DWR’s BMP recommendation of 4 to 10 wells per 100 square miles, in active groundwater production zones.

#### 4.4.3.3 Data Gaps

The data gaps identified in section 5.3.4.4 are also applicable here.

### 4.4.4 Land Subsidence

Both NKWSD and SWID will coordinate with KGA on a Subbasin wide land subsidence monitoring. For further details on the land subsidence monitoring network, please refer to the KGA GSP.

#### 4.4.4.1 Rationale

Discrete monitoring stations are paired with water level monitoring points to record changes in land subsidence over time with respect to groundwater. The monitoring network is designed to take advantage of available data from CGPS and remote sensing sources. Most importantly, as
the network consistently collects data for several years, an understanding of the long-term effects of groundwater extraction on local land subsidence will improve.

### 4.4.4.2 Land Subsidence Spatial Density

District’s currently has an existing land subsidence monitoring network comprised of one CGPS point located on the border of NKWSD and SWID north of the City of Wasco, P564. In addition to the CGPS point, NKWSD has benchmark monitoring stations which are monitored at District well sites predominately near the Friant-Kern Canal. The Friant-Kern Canal subsidence monitoring stations also exist north east to NKWSD and near the intersection of the canal and Poso Creek, and a District extensometer that are roughly spaced 15 miles away from each other. Interferometric Synthetic Aperture Radar (InSAR) data has been used to evaluate land subsidence in between these monitoring points. The InSAR data has historically had large gaps over the District during certain time periods, example seen in the Basin Setting Figure 2-21 the center of NKWSD is missing data. The spatial coverage of land subsidence point data has adequate coverage in NKWSD with the CGPS point and the District and Friant-Kern Benchmark data.

Future coordination with other Subbasin stakeholders will be critical to provide input on regional basin-wide remote sensing surveys to continue to provide coverage between subsidence monitoring points.

### 4.4.4.3 Data Gaps

The NKWSD and SWID have only one CGPS point near a shared border of the District’s Boundaries north of the City of Wasco. NKWSD as mentioned above appears to have adequate spatial coverage of point data. The SWID has no currently known subsidence monitoring stations located within the District and the most relevant CGPS points are P564, (located on border of NKWSD and SWID) P545, (west of SWID) and P563 (located southwest of SWID The northeast and central parts of the District do not currently have discrete point stations for The InSAR regional data has been used to fill in the gaps between the point monitoring stations monitoring subsidence, rather InSAR regional data has been used. Based on InSAR data, these areas appear to experience greater subsidence relative to adjacent portions of the District where subsidence point stations are located. (Extensometer, P545, and P563). If deemed appropriate, in the future, installation of discrete point stations such as NGS-type concrete survey monuments or CGPS stations, may be useful control points to compare with InSAR data in the northeast and central parts of SWID.

### 4.4.5 Depletion of Interconnected Surface Water

Depletion of interconnected surface water is not applicable to the basin.
4.5 Monitoring Protocols and Reporting Standards

The District’s monitoring protocols for collection of groundwater levels and water quality samples will generally follow the Groundwater Monitoring Protocols, Standards, and Sites BMP produced by DWR (DWR, 2016a). The protocols and standards for monitoring and reporting requirements are provided below. For detailed description of monitoring protocols and reporting standards, please refer to the KGA GSP.

4.6 Monitoring Network Improvement Plan

A monitoring network improvement plan with an assessment of improvements is required every five years. This improvement plan contains areas of data gaps in the initial monitoring network, in which additional data or monitoring sites are needed.

The network assessment conforms with § 354.38 and is required for every five-year update. It includes:

1. An evaluation of uncertainty of the data and whether there are data gaps including in the number of monitoring sites, the frequency of monitoring, and whether the monitoring stations comply with the minimum standards of a monitoring network.

2. A description of the location and reason for data gaps in the network, and any local issues and circumstances that limit or prevent monitoring.

3. A description of how data gaps will be filled before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

4. Plans for network revisions to adjust the monitoring frequency and density of monitoring sites to better assess the effectiveness of management actions, if there are:
   a. Minimum threshold exceedances,
   b. Highly variable spatial or temporal conditions,
   c. Adverse impacts to beneficial uses and users of groundwater, or
   d. The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

4.6.1 Assessment of Network Improvements

An assessment of the monitoring network is provided below to discuss future improvements.
4.6.1.1 Water Level, Groundwater Storage, and Water Quality Monitoring Network Assessment Plan to fill Data Gaps

As indicated previously in the data gaps section, construction details of the interim well need to be determined to improve on the monitoring network. This will be mitigated by conducting downhole well surveys and desktop surveys to fill in the well construction details gap.

Within the next five years, the plan to fill data gaps in the water level monitoring network include:

- Coordination with cities for access to use wells in monitoring network.
- Assess if interim wells are compliant with monitoring well standards.
- Assess the feasibility of a future permanent well installation in the central portion of SWID and the western extents of NKWSD to fill the data gaps in the management area coverage.
- Rank or prioritize future installation sites and reject any redundant monitoring sites if any.
- Assess the need to increase coverage of the future monitoring network, further than currently recommended.
- Identify existing SGMA compliant wells in NKWSD MA-2 or install dedicated monitoring wells to be included as part of the monitoring network.
- Finalize future monitoring network and develop a schedule for station installation.
- Continue evaluating the monitoring network for data gaps.

4.6.1.2 Land Subsidence Network Assessment

As described in the data gaps section of the land subsidence network, the northeast and central parts of the SWID do not currently have does not have discrete point stations for monitoring subsidence inside the District. Rather, InSAR regional data has been used to provide coverage between discrete monitoring stations. A better understanding of subsidence in SWID the northeast and central parts of the District are needed to better evaluate land subsidence as a sustainability indicator. In addition, the NKWSD has many benchmark stations used to analyze subsidence which proper management needs to be done in order to be suitable for continued subsidence monitoring.

Based on InSAR data, the northeast area of the district has experienced greater subsidence relative to adjacent portions of the District where subsidence point stations are located (Extensometer, P545, and P563) data near the CGPS point appear relatively similar for one time period and is missing data for another, seen in Basin Setting (Figure 2-21). If deemed appropriate, in the future, installation of discrete point stations such as NGS-type concrete survey monuments or CGPS stations, may be useful control points to compare with InSAR data in the northeast and central parts of SWID and use of existing points in NKWSD.
Alternatively, as described in the Basin Setting, various groups have or are comparing InSAR data with monitoring point stations (CGPS and extensometer) to evaluate the effectiveness of using InSAR in lieu of monitoring stations. A better understanding and continued monitoring of subsidence by remote sensing such as InSAR and point station data are needed to further this evaluation.

As described in the Basin Setting, reduction in storage as potentially an undesirable result, has been documented from land subsidence in the San Joaquin Valley. In order to evaluate potential changes in storage, water level data with subsidence data from stations such as CGPS or extensometers are needed. This evaluation requires reliable co-located groundwater monitoring stations within the vicinity of the subsidence stations.

**Plan to fill Data Gaps**

Within the next five years, the plan to fill data gaps in the subsidence monitoring network include:

- Assess the Friant Kern Benchmark Stations as use in the Future monitoring network.
- Assess the North Kern Monitoring Stations as use in the Future Monitoring Network.
- Evaluate future benchmark monitoring sites co-located with future well monitoring network, especially in the northeast and central portions of SWID, where monitoring stations are not currently present.
- Assess the existence of, or ability to install, co-located water level monitoring stations with CGPS and extensometers, to better evaluate water levels with subsidence monitoring data.
- Continue to collect data to evaluate InSAR data in relation to discrete point stations such as CGPS and extensometers, to assess the feasibility of using InSAR or other remote sensing data as a supplement for data gaps in the monitoring station network.
5. Projects, Management Actions, and Adaptive Management

5.1 Sustainability Goal

The sustainability goal of both NKWSD and SWID is to balance the average annual inflow and outflow of water in their respective districts so that a negative change in groundwater does not occur; thus, preventing the lowering of groundwater levels beyond 2040. This section describes projects and management actions to meet this sustainability goal for NKWSD and SWID in a manner that can be maintained over the planning and implementation horizon. The projects and management actions presented here represent the best available engineering and analysis completed to-date. This list will be updated throughout the planning and implementation period to reflect analyses and new emerging opportunities.

5.2 Projects and Management Actions Processes

The following sections describe the processes required for projects and management actions to be implemented, the sustainability indicator addresses and an overview of the expected benefits. A summary list of the projects and management actions considered by NKWSD and SWID are provided in Table 5-1 and Table 5-2 respectively.

5.2.1 Goals and Objectives

Per Section 354.44 of the GSP Emergency Regulations, plans are to include projects and management actions to address any existing or potential undesirable result for the identified relevant sustainability indicators. NKWSD and SWID plan to implement projects and management actions that will meet the measurable objectives of the following sustainability indicators: (1) chronic lowering of groundwater levels, (2) reduction of groundwater storage, (3) degraded water quality, and (4) land subsidence. Implementation of each project and management action will address the chronic lowering of groundwater levels. Since groundwater levels are used as proxy for identifying undesirable results in groundwater storage, groundwater quality, and land subsidence, each project and management action may also address the other three sustainability indicators. Tables 5-1 and 5-2 provides an indication of the sustainability indicators that may be addressed by the proposed management action.

5.2.2 Circumstances for Implementation

Given the circumstances of conditions described in the basin setting of this management area plan, NKWSD and SWID have already begun implementation of certain projects and management actions. Projects and management actions will be implemented as seen fit by the
Districts and certain management actions will be implemented as soon as 2020 following the adoption of this management area plan.

When feasible, the Districts will construct projects to bring in supplemental water to the basin and implement management actions to reduce pumping of groundwater. Tables 5-1 and 5-2 provide a timeline for each management action’s implementation and the circumstances for which each will be implemented.

### 5.2.3 Public Noticing

The public notice and outreach processes for the Districts consist of notified public board meetings, discussion with landowners within the Districts’ boundaries, and the CEQA process each project and management action may undergo before implementation. Both NKWSD and SWID provide public noticing by posting all board meeting notices, agendas, and minutes on their websites (see Section 1.2) according to the Brown Act.

### 5.2.4 Permitting and Regulatory Process

Permitting and regulatory requirements vary for the different projects and management actions NKWSD and SWID plan to implement. While these requirements are similar for the Districts’ project and management actions, specific requirement will depend on the type of project, which could be recharge and infrastructure projects as well as administrative actions that incentivize reduced groundwater pumping. The following is a list of the types of permitting at the federal, state, and county level that could apply, but not necessarily, to all management actions.

- **Federal**
  - If federal grants are used, National Environmental Policy Act (NEPA) documentation is required;
  - National Pollution Discharge Elimination System (NPDES) stormwater program permit;

- **State**
  - California Environmental Quality Act (CEQA) documentation is required for all project and management actions. These documents include one or more of the following: Initial Study, Categorical Exemption, Negative Declaration, Mitigated Negative Declaration, and Environmental Impact Report;

- **Regional**
  - San Joaquin Valley Air Pollution Control District (SJVAPCD) permit and regulations;

- **Local/County**
  - Encroachment Permits;
- Kern County Grading Permit;
- Kern County Well Permit;
- Kern County Supplemental Well Permit.

### 5.2.5 Implementation and Timetable Status

The current status of each project and management action is included in Tables 5-1 and 5-2. Since most projects and management actions are in the conceptual phase of development, timeline for implementation is estimated and subject to change depending on project need and supplemental water availability. NKWSD and SWID will begin to implement management actions to reduce groundwater extractions as soon as 2020 and will continue to implement based on their estimated timeline.

The status of each project and management action is also provided in Tables 5-1 and 5-2. Each project and management action are designated as follows:

- **Conceptual:** The project or management action is identified but has not undergone significant planning, engineer or feasibility analyses.
- **Not yet started:** This project or management action as undergone some initial evaluations but has advanced to an implementation phase. The management action will likely require additional feasibility analyses.
- **Initiated:** The project or management action has undergone initial planning and feasibility assessments and being advanced to implementation.
- **Ongoing:** The project or management action is part of an ongoing effort by the District and will continue to be implemented to meet the sustainability goals of the District.

### 5.2.6 Expected Benefits

Tables 5-1 and 5-2 provide the estimated benefits for each project and management action the Districts plan to implement. As previously stated, most of the proposed actions are in their conceptual phase of development; therefore, a range has been provided for the estimated benefits each action is expected to yield.

### 5.2.7 Source and Reliability of Water Outside of NKWSD and SWID

NKWSD and SWID will bring in supplemental water from outside their districts to support projects and management actions. While not all projects and management actions require source water from outside the district, there are several that do. As discussed in Section 2 of this management area plan, NKWSD’s primary source of water is supplied by the Kern River and SWID’s primary source of water is supplied by the CVP, which will help support existing and future projects and management actions in each district, respectively. In addition, the District will be seeking other sources of water and will continue to participate in various surface water
transfer and exchange programs as well as explore purchasing markets in the Central Valley to support their effort to achieve groundwater sustainability by 2040.

5.2.8 Legal Authority Required

NKWSD and SWID are each a Member Agency under the KGA GSA. Under the JPA with KGA, each district maintains its authority over in-district services and projects. Thus, NKWSD and SWID have the legal authority to implement projects and management actions in order to achieve groundwater sustainability.

5.2.9 Estimated Costs and Funding

As previously stated, most of the projects and management actions are in their conceptual phase of development; therefore, costs may not be available. Where costs have been estimated, they are subject to change as the project or management action undergoes more detailed analysis.

In regard to funding, the Districts have been successful in securing grants through various government agencies for past projects. Both Districts will continue these efforts and apply for various funding sources at all levels of government in order to implement project and management actions.

5.3 NKWSD Projects Planned as Part of GSP Implemented Regardless of Conditions

- Calloway Canal and Water Delivery Improvements
- Expanded Water Banking Program
- Groundwater Banking Conveyance Improvements to NKWSD Recharge and Recovery
- Beneficial Reuse of Oilfield Produced Water
- SCADA Automation and Evapotranspiration Measurement Improvements
- Poso Creek Weir

5.3.1 Calloway Canal and Water Delivery Improvements: Lining Snow Rd. to 7th Standard Rd.

Calloway Canal Improvements is part of NKWSD’s continued effort to concrete line the Calloway Canal from the northern terminus of the CVC (west of Coffee Road) to Calloway Canal Intertie (CVC Intertie Canal) to 7th Standard Road. Lining Calloway Canal reduces seepage and allows the efficient delivery of water supplies from the west side of the San Joaquin Valley into NKWSD for recharge. It also accommodates the possible future conveyance of supplies from NKWSD back to the CVC and the California Aqueduct. This project is part of the Poso Creek IRWM Plan. The current phase of this project consists of concrete lining approximately 6,500 linear feet of currently unlined portion of the Calloway Canal between Snow Road and 7th Standard Road (at NKWSD’s District Boundary) to increase surface water
reliability and prevent seepage. This portion lies outside the service areas of the District and overlies a portion of the regional groundwater basin that is of diminished quality due to past industrial and petrochemical seepage.

This project also includes installation of advanced metering, SCADA, and telemetry improvements for the District’s 100 production wells (collectively known as “Water Delivery Improvements, or WDI). Each flowmeter will include a totalizer capable of measuring the volume of groundwater pumped through the wells. Further, water level sensors will also be installed in each of the District’s production wells and four additional monitoring wells to quantify the depth-to-water data. Additionally, the District proposes to implement telemetry upgrades at each of the production well sites, each of the monitoring well sites, and remote Terminal Unity (RTUs-used to measure canal levels) sites. The water delivery improvements for integrating these District sites with NKWSD’s Supervisory Control and Data Acquisition (SCADA) setup.

5.3.2 Expanded Water Banking Program

The District adopted its project in 1950 and initiated operation of one of the first large “conjunctive use” projects in California. The District recharges wet-period surface water supplies in available groundwater storage and subsequent recovers it during times of need (typically, dry periods) -- is an essential component of NKWSD’s conjunctive management. This is currently facilitated by approximately 1,550 acres of direct recharge ponds and about 100 deep wells, along with two large canals for water conveyance.

Despite the successes, regional water supply and demand imbalances and particularly the 2012-2016 Kern River and state drought resulted in historically low groundwater levels underlying the District. Due to historically low groundwater levels, requirements under SGMA, and potential reductions in its historical water supplies, NKWSD is proposing a new program to increase its existing conjunctive use (or water banking) facilities and subsequently expand these facilities. Phase I of this program would primarily rely on unused capacity in existing facilities which is available from time to time (with some additional conveyance) and would seek to increase the utilization of the District’s proven recharge and recovery assets. Phase II would involve the construction of additional direct recharge and recovery facilities to further expand water banking in the District. Both the District and District landowners will receive water supply benefits from this program.

5.3.3 Groundwater Banking Conveyance Improvements to NKWSD Recharge and Recovery

To support recovery and improve return capacity of additional supplies recharged under the District’s current banking program and the Expanded Water Banking Program, the District is planning drill and equip replacement wells and connect existing wells to NKWSD’s pipeline network. The proposed project involves the drilling and equipping of three replacement wells and connecting two other deeps wells (five total) to NKWSD’s existing network to improve
return capacity of recharged water for the District’s neighbors. Proposed project is to construct the necessary pipelines to connect five deep wells to the District’s recovery network system that improves the capacity to return water supplies to multiple districts in the region during dry years.

5.3.4 Beneficial Reuse of Oilfield Produced Water

In 2015, the District acquired produced oilfield water from California Resources Corporation (CRC) operations in the Kern Front Oilfield. NKWSD has made beneficial reuse of oilfield produced water by blending produced water with other surface supplies for irrigation use. CRC discharges 28 acre-feet per day of produced water from CRC’s Kern Front Oil Field to NKWSD. The blended water is used directly for irrigation or is discharged to spreading basins in NKWSD for groundwater recharge. The current Waste Discharge Requirement (WDR) permit, issued by the Central Valley RWQCB, allows for the use of up to 21,000 AFY of oilfield produced water for beneficial reuse. If the District chooses to initiate another contract with a different entity, a new Report of Waste Discharge would need to be prepared to either update the existing WDR or acquire a new WDR.

5.3.5 SCADA Automation and Evapotranspiration Measurement Improvements

The proposed project includes the installation of Supervisory Control and Data Acquisition (SCADA) Automation software along with evapotranspiration (ET) measurement stations. This project is divided into two components, the purpose of the first component is to remotely monitor and control the District owned and operated groundwater wells and Canal level transmitters. This SCADA software will have the capability to:

- Record and analyze all data transmitted from the well and canal sites;
- Generate instantaneous reports for groundwater pumped, depth to water, and other water quality parameters;
- Reduce and eliminate manned patrols; provide constant monitoring, system wide; and
- Automatically react to alarms and events by performing emergency shutdowns or other control actions.

The second component of this project is to install evapo-transpiration (ET) stations in strategic locations within the District. The District anticipates that the crop specific ET measurements will help the District and its growers to correlate the ET and the applied water. The ET measurements will serve as a management tool for the growers to efficiently reduce their applied water, which is a critical step in reducing the amount of groundwater pumped.

The reduction in applied water will also indirectly benefit pumping costs and enhance nutrient management in crop root zone.
5.3.6 Poso Creek Weir

NKWSD plans to construct a weir on the Poso Creek flood channel to divert water into their facilities. The District currently has an earthen plug that works to divert water; however, the plug is not reliable and has proven to be inefficient for the District. Implementation of this project will provide a more reliable management of flows, allow water to be measured as it is diverted, and reduce the velocity and sediment loading prior to diversion. Diverted water will be used to increase groundwater banking activities in NKWSD to help prevent further lowering of groundwater levels.

5.4 RRID Projects Planned as Part of GSP Implemented Regardless of Conditions

Given the circumstances of conditions described in the Basin Setting, the District may implement projects as early as 2020. RRID has identified the following projects to accomplish groundwater sustainability within the district:

- Expanded Recharge
- Allocation of Available NKWSD Supplies

5.4.1 Expanded Recharge

This project will involve the construction of direct recharge facilities and on-farm spreading to maximize recharge capability. To ensure adequate delivery of supplies to the RRID management area, water delivery infrastructure improvements will be included in this project. Improvements to existing NKWSD conveyance will be made before on-farm recharge occurs.

5.4.2 Allocation of Available NKWSD Supplies

A portion of NKWSD’s Kern River supplies and a portion of the oilfield produced water for beneficial reuse will be allocated to NKWSD’s Rosedale spreading facility for RRID’s benefit when NKWSD does not require it as supplies for their current projects.

5.5 SWID Projects planned as part of GSP that will be implemented regardless of conditions

- Diltz Intertie Lateral Piping and WMI
- Bell Recharge Project
- Kimberlina Recharge Project
- Leonard Avenue Conveyance Improvement Project
- Improved Water Level Measurement of District Recharge Facility
5.5.1 *Diltz Intertie Lateral Piping and Water Management Improvements*

The proposed project includes installing pressurized pipe laterals to connect the Diltz Intertie mainline to serve 380 acres of irrigated land. Project will consist of a 1.5-mile long, 30 cfs, 36-inch diameter, bi-directional, intertie pipeline, which will allow for the efficient conveyance of surface water supplies to spreading ground facilities located in SWID.

5.5.2 *Bell Recharge Project*

Implementation of this project includes the construction of a 12 cfs conveyance improvement along SWID’s existing distribution system that will allow CVP-Friant supply to be delivered from the FKC to the Bell Recharge site. Bell project will allow for delivery of surface water to the new Bell Recharge facilities form the CVP, for increased water storage.

5.5.3 *Kimberlina Recharge Project*

Implementation of this project in 2016 included the construction of a 285-acre site that would allow SWID to recharge at a rate of up to 53 cfs when water is available from the district’s contracts for CVP water. The site is located adjacent to the Calloway Canal and is currently in use.

5.5.4 *Leonard Avenue Conveyance Improvement Project*

This project involves the construction of 1.5 miles of pipeline to connect SWID with SWSD. Implementation of a new pipeline will provide SWID with the operational flexibility to absorb surface water when it is available for delivery to SWSD’s distribution system, connecting the supply to in-lieu and direct recharge facilities in SWSD, generally during wet periods, so that water delivered can later be recovered for irrigation in peak-demand months, or dry periods.

5.5.5 *Improved Water Level Measurement of District Recharge Facility*

Proposed project includes the construction of a 400 to 500-feet deep, 8-inch diameter PVC monitoring well and the conversion of an existing older well to an 800-feet deep, 6-inch diameter monitoring well both equipped with both water-level sensors and located within the District’s recharge facility. Both monitoring wells will help manage and collection information on groundwater levels which can be used to document site performance as well as monitor the effects on the groundwater aquifer levels.

The current 270-acre recharge facility will have three extraction wells to return banked water from the spreading ground. New monitoring wells will aid in SWID’s groundwater management and mitigation of any adverse effects from groundwater extraction.

5.6 **NKWSD and SWID Management Actions planned as part of GSP**

Per Section 354.4 of the GSP Emergency Regulations, the following sections details managements actions both NKWSD and SWID will take in their respective districts in order to
achieve groundwater sustainability by 2040. NKWSD and SWID have identified the following management actions (MAs):

- Expansion of In-Lieu Recharge
- On-Farm Efficiency/Deficit Irrigation Practices Incentive Program
- On-Farm Recharge Activities Incentive Program
- Subsurface Recharge Feasibility Study
- Conversion of Agricultural Land to Urban Use
- Urban Water Conservation Program
- In-District Allocation Structure
- Voluntary Land Fallowing
- Pumping Restrictions

Under the JPA agreement with KGA, each District maintains its authority over in-district services and projects. Thus, NKWSD and SWID have the legal authority to implement these management actions if they so decide.

### 5.6.1 Expansion of In-Lieu Recharge

Both NKWSD and SWID have access to imported surface water to supply their respective jurisdictional areas. However, there are instances in which growers have historically opted to pump groundwater, rather than receiving deliveries of surface water from the district which services their properties. When this occurs, the districts must either use that water for groundwater recharge or enter into exchanges with other districts (either in the Subbasin or in another basin).

While this may be an economic decision for the grower, it has the potential to cause local impacts to groundwater in the district over the long-term. To prevent local impacts to groundwater due to the use of groundwater over available surface water, the districts may explore a fee structure in which growers with access to surface water may be assessed for the use of groundwater when surface water is available for use. The fees collected for such activities would be applied to the expansion of existing recharge projects or the development of new recharge projects to accommodate the additional surface water that would be brought into the district to replace the additional groundwater pumped. The adoption of a fee structure to facilitate the expansion of in-lieu recharge would require approval of the district’s Board of Directors.

This Management Action is in the preliminary stages of consideration by the districts. It has not been formally adopted but is under consideration.
5.6.2 On-Farm Efficiency/Deficit Irrigation Practices Incentive Program

As agricultural water service providers, both NKWSD and SWID comply with all provisions of SB 7 (amending Division 6, Part 2.55 of the Water Code) passed into law in November 2009 regarding agricultural water conservation and management. Efficient management practices in the law, related to SGMA objectives, include volumetric water pricing, incentives for conjunctive use and increased groundwater recharge, and development of an overall water budget. AB 1668 and SB 606 passed in 2018 did not materially add to these objectives, save for those districts serving between 10,000 and 25,000 acres who must now prepare water management plans under the newer laws.

While these new laws do not require water use objectives or savings thresholds, they do encourage more efficient use of water by the agricultural sector and its suppliers. Within their respective jurisdictions, NKWSD and SWID will encourage improvements to individual farming operations that address water use efficiency and/or groundwater protection through incentive programs.

5.6.3 On-Farm Recharge Incentive Program

In wet years, when the districts have utilized the full capacity of their respective recharge basins and spreading grounds, it may be necessary for the districts to seek other locations for the application of available surface water for groundwater recharge. The districts will develop an incentive program to encourage landowners to take delivery of available surface water that is in excess of customer demand and the districts’ capacity for recharge projects for application to fallow land and/or over-irrigation of crops to facilitate further groundwater recharge. Landowners will receive a groundwater credit in exchange for participation in this program, for their use. To implement an on-farm recharge incentive program, both NKWSD and SWID must develop the guidelines of the program for their respective areas and obtain approval from their respective Board of Directors.

5.6.4 Subsurface Recharge Feasibility Study

Both NKWSD and SWID have been approached by landowners within their respective districts about the efficacy and use of subsurface recharge methods. While subsurface recharge is being tested by landowners in NKWSD and neighboring districts, neither NKWSD nor SWID have taken an official position on the use of such methods. Before the implementation of district-wide programs, the districts will conduct a feasibility study to evaluate whether or not these practices are appropriate for the hydrogeologic conditions and/or land uses within their respective jurisdictions. The scope of the feasibility study is yet to be determined, but it will include an evaluation of subsurface recharge methods, the soil types located within each district, the effectiveness of subsurface recharge compared to other recharge methods, and its compatibility with existing land uses. As opposed to the districts doing their own feasibility studies, the districts could cooperatively work with the landowners who are operating this system in NKWSD to evaluate the potential for this type of recharge program.
5.6.5 Conversion of Agricultural Land to Urban Use

As described in the General Plans for the cities of Shafter and Wasco, anticipated population growth is expected to lead to changes in land use within the limits of each city and in the Sphere of Influence for each city. The conversion of land use from agricultural to urban use generally leads to an overall reduction in surface and groundwater use due to the decreased demand, in terms of volume per unit area. The cities of Shafter and Wasco and their respective spheres of influence have a projected increase of 5,000 acres in urban use. This land conversion has an estimated reduction of water demand to NKWSD of 15,000 AFY and a water demand reduction of approximately 2,600 AFY to SWID.

While these areas are described as part of each city’s sphere of influence in their respective General Plans, the lands which are anticipated to convert from irrigated agricultural use to urban use are still zoned for Agricultural use in either the city or county zoning. In order to develop these lands for urban use, the land would have to be re-zoned for the proposed, non-agricultural use. In order to obtain the required zoning change, the landowner(s) would be required to prepare a zoning change application, including a legal description of the area, a plot plan, and an environmental document, for submission to the appropriate public agency.

5.6.6 Urban Water Conservation Program

As referenced in the KGA GSP Basin Setting (Chapter 2), urban water usage in the future is expected to comply with the conservation mandates contained in SB 606 and AB 1668, both bills signed into law in May 2018. Based on that legislation, indoor residential use is to be capped at 55 gpcd in 2019 and ramp down to 50 gpcd by 2030, and outdoor residential use is to be capped in the future based on local climate and size of landscaped areas. Standards for outdoor usage are to be defined in a SWRCB rule-making process to be completed by June 2022.

Urban water conservation compliance currently derives from SB7X-7 passed in 2009 (Water Conservation Act of 2009), and the UWMPs of both Shafter and Wasco, along with associated ordinances, reflect that Act’s mandates of a 20% reduction in urban per capita water usage by 2020. Future achievements in urban conservation will be as derived from the passage of AB 1668 and SB 606 in 2018. Future amendments to UWMPs and modified ordinances of both cities will eventually embody these recent laws.

Given the early implementation stages of AB 1668 and SB 606, its benefits in terms of reduced groundwater pumping by Shafter and Wasco can only be roughly approximated. The Pacific Institute, in its 2014 report “Urban Water Conservation and Efficiency Potential in Calif.” estimated that indoor usage could be reduced by 33-40 gpcd, and that outdoor/landscape usage could be reduced by 20-50 gpcd. These values are on a statewide basis and likely unrealistic in some regions; however, the report postulates that total urban water usage could be reduced by as much as 30-60%. Savings of this magnitude would represent a significant reduction in groundwater pumping by both cities. The Measurable Objectives to be partially met with
additional urban conservation include groundwater level stabilization and, by proxy, groundwater storage stabilization.

5.6.7 In-District Allocation Structure

At the time of this draft of the management area plan, neither NKWSD nor SWID have an established allocation structure and fee schedule for groundwater extraction. As SGMA is implemented throughout the Subbasin, the districts are required to manage to the Sustainable Management Criteria (SMCs) established in Section 5 of this management area plan. One of the ways to manage for the SMCs is to allocate the sustainable yield for their respective districts to the landowners within their districts. The allocation structure would allow for the transfer of groundwater pumping credits within each district’s jurisdiction, provided that it does not lead to localized impacts at the representative monitoring sites defined in Sections 4 of this management area plan. The transfer of allocation credits to is help the landowner meet irrigation demand only, not solely to create a groundwater market.

While the specifics of such an allocation structure may vary between the districts, a baseline groundwater extraction volume would be allocated to each parcel based on its size and the sustainable yield for the district. If a landowner were to extract more water than the baseline volume for that parcel or for the aggregate of all of their parcels within the district, they would be required to pay an extraction fee which would be applied toward projects and programs implemented by the district to reach and/or maintain sustainability.

5.6.7.1 Permitting and Regulatory Process

While there is no permitting required for the implementation of an allocation structure, the Board of Directors for each District would be required to review and approve the structure and fee schedule prior to implementation.

5.6.7.2 Status of Project

This management action is in the conceptual stages, having been discussed with various stakeholder groups. However, an actual structures and fee schedules have yet to be devised for either district.

5.6.7.3 Benefits

The benefits to sustainable groundwater management have not been quantified at this time. However, the development and implementation of an allocation structure for each district would allow for the districts to utilize their sustainable yield as a management tool for reaching and maintaining their SMCs.

5.6.7.4 Source and Reliability of Water

No water source is required for this management action.
5.6.7.5 Costs and Funding

The costs of developing and implementing an in-district allocation structure would be funded by the districts for their jurisdictions.

5.6.7.6 CEQA/NEPA Considerations

A CEQA document will be required for the implementation of an in-district allocation structure to document the analysis of potential impacts to groundwater resources.

5.6.8 Voluntary Land Fallowing

In the event of an extended or severe drought, the districts may not be able to entirely meet in-district demand with the available water. In the absence of decreased demand and the combination of decreased availability in surface water supply and decreased recharge from other sources in the subbasin has the potential to lead to violations of the SMCs at the representative monitoring sites. To facilitate the districts’ ability to maintain sustainability at their respective monitoring sites, the districts will develop and implement their own voluntary land fallowing programs for their jurisdictions.

5.6.9 Pumping Restrictions

In the event that the District’s or the entire Subbasin are nearing a condition where they are at risk of triggering an undesirable result, even with the implementation of the projects and management actions described in this management area plan, it may be necessary for the districts to limit groundwater pumping. The volume of groundwater extraction permitted under this management action would be determined by the districts based on the sustainable yield for the district and the SMCs at the representative monitoring sites.

5.7 Summary

A summary list of the projects and management actions considered by NKWSD and SWID are provided in Table 5-1 and Table 5-2 below respectively.
This Page Left Blank Intentionally
<table>
<thead>
<tr>
<th>FMA Number</th>
<th>FMA Name</th>
<th>Summary Description</th>
<th>Relevant Sustainable Indicators Monitorable</th>
<th>Relevance to Existing Infrastructure/Summary of Proposed Changes</th>
<th>Circumstance for Implementation</th>
<th>Public Notice Process</th>
<th>Pending and Regulatory Process Requirements</th>
<th>Status</th>
<th>Proposed / Estimated Costs</th>
<th>Timeline for Implementation</th>
<th>Project</th>
<th>Expected Benefits</th>
<th>Priority</th>
<th>Secondary</th>
<th>Source(s) of Water, if applicable</th>
<th>Water Quality Improvement</th>
<th>Water Quantity Improvement</th>
<th>Water Resilience Improvement</th>
<th>Financial Costs</th>
<th>Existing Infrastructure</th>
<th>Estimated Costs</th>
<th>Potential Funding Sources</th>
<th>One-time Costs</th>
<th>Ongoing Costs (per year)</th>
<th>vulnerable Counties/Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earmarked Cost Improvements, Long Snow Rd.</td>
<td>Longing to increase surface water reliability and prevent losses from seepage.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>Geo-Info</td>
<td>Ongoing</td>
<td>2019-2021</td>
<td>4,600 AYF</td>
<td>TBD</td>
<td>Kern River, CVP, and SWP supplies</td>
<td>District</td>
<td>$14,090,000</td>
<td>TBD</td>
<td>Grant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Expanding Water Banking Program</td>
<td>Expanding use of existing facilities and development of additional recharge and recovery systems.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>CEGA</td>
<td>Ongoing</td>
<td>2020</td>
<td>7,000 AYF</td>
<td>TBD</td>
<td>Other Urban Sources of supply</td>
<td>District</td>
<td>TBD</td>
<td>Grant District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Groundwater Banking Consequence Improvements to NMDWD Recharge and Recovery</td>
<td>Improvements to existing well network for return capacity of recharged water for District’s neighbors.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>CEGA</td>
<td>Initiated</td>
<td>2019-2021</td>
<td>4,000 AYF</td>
<td>TBD</td>
<td>Kern River, CVP, and SWP supplies</td>
<td>District</td>
<td>TBD</td>
<td>Grant District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Beneficial Use of Offsite Produced Water</td>
<td>Offsite produced water of sufficient quality for beneficial reuse used as recharged water for groundwater recharge.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020</td>
<td>11,000 AYF</td>
<td>TBD</td>
<td>Other Urban Sources of supply</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SCADA Automation and Emergency Management Improvements</td>
<td>Develop automation and remote sensing for ET monitoring and improved management of surface water conveyance.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>None</td>
<td>Initiated</td>
<td>2021</td>
<td>3,900 AYF</td>
<td>TBD</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>Grant District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Picacho Well</td>
<td>Installation of a surface well on Picacho Creek to replace the existing structure.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>CEGA</td>
<td>Conceptual</td>
<td>2020</td>
<td>7,000 AYF</td>
<td>TBD</td>
<td>Kern River, CVP, and SWP supplies</td>
<td>District</td>
<td>TBD</td>
<td>Grant District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Expanding Recharge (RRID)</td>
<td>Expansion of recharge program to include on-farm spreading to maximize recharge capability.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>CEGA</td>
<td>Conceptual</td>
<td>2020</td>
<td>6,000 AYF</td>
<td>TBD</td>
<td>CVP Water</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Groundwater Recharge (Groundwater Recovery)</td>
<td>Improvements to allocated ground water for efficiency and groundwater protection through incentive programs.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>On-Farm Recharge Activities Incentive Program</td>
<td>Development of an incentive program to encourage landowners to use available surface water to facilitate further groundwater recharge.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Subsurface Recharge Feasibility Study</td>
<td>Implementation of a program which would supply water to landowners for use in recharge recharge projects.</td>
<td>• •</td>
<td>Open completion of feasibility studies</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Consequent Agricultural Land to Urban Use</td>
<td>Conversion of agricultural land to urban use within the lands of each city to urbanization and to the benefit of the community.</td>
<td>• •</td>
<td>Ongoing</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>Board Approval</td>
<td>Conceptual</td>
<td>2020</td>
<td>TBD</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>General Water Conservation Program</td>
<td>Implementation of urban water and water usage language as required in AB 696 and AB 1886.</td>
<td>• •</td>
<td>Open implementation of the law</td>
<td>Long-term Board Meetings &amp; Workshops</td>
<td>Board Approval</td>
<td>Conceptual</td>
<td>2020</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>In District Allocation Structure</td>
<td></td>
<td>• •</td>
<td>Open implementation of the law</td>
<td>Board Approval</td>
<td>Conceptual</td>
<td>2020</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>On-Farm Water Savings Program</td>
<td>Development and implementation of a voluntary soil following program to facilitate water savings.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020-2021</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Irrigation Water Recycling Program</td>
<td></td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020-2021</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Irrigation Water Recycling Program</td>
<td></td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020-2021</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Irrigation Water Recycling Program</td>
<td></td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020-2021</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>On-Farm Water Savings Program</td>
<td>Development and implementation of a voluntary soil following program to facilitate water savings.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020-2021</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>On-Farm Water Savings Program</td>
<td>Development and implementation of a voluntary soil following program to facilitate water savings.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>None</td>
<td>Ongoing</td>
<td>2020-2021</td>
<td>None</td>
<td>TBD</td>
<td>None</td>
<td>None</td>
<td>District</td>
<td>TBD</td>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMA Number</td>
<td>PMA Name</td>
<td>Summary Description</td>
<td>Relevance/ Sustainability Indicators Affected</td>
<td>Implementation Timeline</td>
<td>Cost Breakdown</td>
<td>Estimated Benefits</td>
<td>Required Authorities</td>
<td>Source(s) of Water, if Applicable</td>
<td>Legal Authority Required</td>
<td>Ongoing Costs per Year</td>
<td>Potential Funding Sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>---------------------</td>
<td>---------------------------------------------</td>
<td>------------------------</td>
<td>----------------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>-----------------------------</td>
<td>-------------------------</td>
<td>--------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3.5 Minate Lateral Piping and WWK</td>
<td>Construction of the 3.5 mile lateral main to serve 355 acres of irrigated land with surface water.</td>
<td>• •</td>
<td>Ongoing</td>
<td>SWD Board Meetings &amp; Website</td>
<td>NPDES, Dual Control Plan, ESGA, and NEPA</td>
<td>Initiated</td>
<td>2020</td>
<td>Through 2040</td>
<td>1,927 AFY</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Recharge Project</td>
<td>Conveyance improvements to SWID’s existing distribution system that will allow CVP water to be delivered from the FKC for recharge.</td>
<td>• •</td>
<td>Already being implemented</td>
<td>SWD Board Meetings &amp; Website</td>
<td>NPDES and Dual Control Plan</td>
<td>Initiated</td>
<td>2020</td>
<td>Through 2040</td>
<td>1,726 AFY</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Estehrko Recharge Project</td>
<td>Construction of a 265 acre recharge site for CVP surface water.</td>
<td>• •</td>
<td>Already being implemented</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Ongoing</td>
<td>2020</td>
<td>Through 2040</td>
<td>16,838 AFY</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Leonard Avenue Conveyance Improperment Project</td>
<td>Construction of pipeline to connect SWID’s existing system to Semitropic to reduce operational flexibility to deliver delivered surface water.</td>
<td>• •</td>
<td>Already being implemented</td>
<td>SWD Board Meetings &amp; Website</td>
<td>NPDES, Stormwater ESGA, and NEPA</td>
<td>Initiated</td>
<td>2020</td>
<td>Through 2040</td>
<td>1,445 AFY</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Improved Water Level Measurement of District Recharge Facility.</td>
<td>Construction of and connection to two monitoring wells to better manage and collect information on groundwater levels for district recharge facilities.</td>
<td>• •</td>
<td>Open completion of scope of work</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>Through 2040</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Surface Water First Incentive Program</td>
<td>Implementation of fees for water users when surface water is available.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>Through 2040</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>On-Farm Efficiency/Deficit Irrigation Practices Incentive Program</td>
<td>Agreements to individual farming operations that address water use efficiency and groundwater protection through incentive programs.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>Through 2040</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>On-Farm Recharge Activities Incentive Program</td>
<td>Development of an incentive program to encourage the delivery of available water to facilitate further groundwater recharge.</td>
<td>• •</td>
<td>Open adoption of the plan</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>Through 2040</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Subsurface Recharge Feasibility Study</td>
<td>Implementation of a program which would supply water to landowners for use in subsurface recharge practices.</td>
<td>• •</td>
<td>Open completion of feasibility studies</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>Through 2040</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Conversion of Agricultural Land to Urban Use</td>
<td>Conversion of agricultural land to urban use within the limits of each city to reduce groundwater use and to the increased demand.</td>
<td>• •</td>
<td>Ongoing</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>TBD</td>
<td>Through 2020</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Urban Water Conservation Program</td>
<td>Implementation of urban indoor and outdoor usage (e.g. reduced or deferred use of water)</td>
<td>• •</td>
<td>Open implementation of the plan</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>2020</td>
<td>Through 2030</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>In District Allocation Structure</td>
<td>Implementation of an allocation structure that would address for the rostering of groundwater pumping credits within the district’s jurisdiction.</td>
<td>• •</td>
<td>Open implementation of the law</td>
<td>SWD Board Meetings &amp; Website</td>
<td>Bond Approval</td>
<td>Conceptual</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Voluntary Land Fallowing</td>
<td>Development and implementation of a voluntary land fallowing program to reduce demand.</td>
<td>• •</td>
<td>Ongoing</td>
<td>SWD Board Meetings &amp; Website</td>
<td>Bond Approval</td>
<td>Conceptual</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Pumping Restrictions</td>
<td>Land use of groundwater through pumping restrictions</td>
<td>• •</td>
<td>Ongoing</td>
<td>SWD Board Meetings &amp; Website</td>
<td>None</td>
<td>Conceptual</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>District / SGMA</td>
<td>Landowners, Cities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. References and Technical Studies


KCWA, 2018. Digital Data Delivery to GEI for historical groundwater records used in water supply contour maps.


O’Geen, A.T.; Matthew B.B. Saal; Helen Dahlke; David Doll; Rachel Elkins; Allan Fulton; Graham Fogg; Thomas Harter; Jan W. Hopmans; Chuck Ingels; Franz Niederholzer; Samuel
Sandoval Solis; Paul Verdegaal and Mike Walkinshaw. 2015. Soil suitability index identifies potential areas for groundwater banking on agricultural lands. California Agriculture, V. 69, No. 2


USFWS. 2015. Data Collection Requirements and Procedures for Mapping Wetland, Deepwater, and Related Habitats of the United States (version 2). Falls Church, VA.


APPENDIX A
KERN GROUNDWATER AUTHORITY
FOR THE TULARE LAKE BASIN PORTIONS OF KERN COUNTY
AMENDED AND RESTATED JOINT POWERS AGREEMENT

THIS AMENDED AND RESTATED AGREEMENT ("Agreement") is made and
effective as of March 22, 2017, pursuant to the Joint Exercise of Powers Act (Government
Code Sections 6500, et seq.) by and between the public agencies listed on the attached Exhibit A.

This Agreement is made with reference to the following facts and understandings.

A. Each of the parties to this Agreement (the "Members") provides water service to
landowners and/or residents and/or provides water to retail water entities within its respective
service area and the County of Kern has various oversight and active roles relative to water
resources within the County, including, but not limited to, flood control, police powers, and
water service.

B. Pursuant to a Joint Powers Agreement dated as of May 27, 2014 (the "Original
Agreement"), the Kern Groundwater Authority (the "Authority") was created to carry out the
purposes of Part 2.75 of Division 6 (commencing at Section 10750 of the California Water Code)
and develop, adopt and implement a groundwater management plan that would be available to
those lands within the boundaries of the Authority’s members and within the Tulare Lake
Groundwater Basin.

C. On August 29, 2014, the California Legislature passed comprehensive
groundwater legislation contained in SB 1168, SB 1319 and AB 1739. Collectively, those bills,
as subsequently amended, enacted the “Sustainable Groundwater Management Act” ("SGMA").
Governor Brown signed the legislation on September 16, 2014 and it became effective on
January 1, 2015. In adopting SGMA, the Legislature intended “[t]o provide local groundwater
agencies with the authority and technical and financial assistance necessary to sustainably
manage groundwater.” (California Water Code Section 10720(d).)

D. SGMA anticipates that each affected groundwater basin or subbasin will be
regulated separately by one or more Groundwater Sustainable Agencies (each, a “GSA”). A
local agency or combination of local agencies may elect to be the GSA for a basin or sub-basin.
SGMA generally provides that a combination of local agencies may form a GSA through a joint
powers agreement, memorandum of understanding or other legal agreement. (California Water
Code Section 10723.6)

E. Groundwater sustainability under SGMA is to be achieved through Groundwater
Sustainability Plans ("GSPs"). Under SGMA, a GSP can be a single plan developed by one or
more GSAs, or multiple coordinated plans within a basin or subbasin by multiple GSAs
(California Water Code Section 10727).

F. The Members, individually and collectively, have the goal of cost-effective,
sustainable groundwater management in the Kern County Subbasin that considers the interests
and concerns of the Members and other stakeholders.
G. As used in this Agreement “Kern County Subbasin” means such basin as defined in Department of Water Resources Bulletin 118, as its boundaries may be modified from time to time through the procedures described in California Water Code Section 10722.2.

H. The intent of the Members under this Agreement is to provide each Member with the sole right and responsibility to implement SGMA within its respective boundaries and/or Management Areas, as defined herein, in a manner determined by the Member, whether through the Authority or as a GSA. To facilitate coordination within the Kern County Subbasin, the Members desire for the Authority to have the authority to serve as a GSA for some or all of the Members within the Kern County Subbasin in a manner that allows the Members (individually or collectively) to directly implement SGMA and a GSP within their respective Management Areas as defined herein, while the Authority serves primarily a coordinating and administrative role in order to provide for sustainable groundwater management through the subbasin. The Members expressly intend that the Authority will not have the authority to limit or interfere with the respective Members’ rights and authorities over their own internal matters, including, but not limited to, a Member’s surface water supplies, groundwater supplies, facilities, operations, water management, and Water Supply Matters, as defined herein. Nothing in this Agreement is intended to modify or limit Members’ police powers.

I. The Members expressly intend that neither SGMA, nor this Agreement, nor any GSP adopted by the Authority shall be construed as authorizing the Authority, or any dispute resolution process contained herein, to:

(i) determine or alter surface water rights or groundwater rights (California Water Code Section 10720.5 (b));

(ii) make binding determinations of the water rights of any person or entity (California Water Code Section 10726.8 (b)); or

(iii) supersede the existing land use authority of cities or counties, including the city or county general plan, within the overlying basin (California Water Code Section 10726.8 (f)).

J. In light of the enactment of SGMA together with the goals and intent described above, the Members wish to amend and restate the Original Agreement in its entirety as provided herein.

THEREFORE, in consideration of the mutual promises, covenants and conditions herein set forth, it is agreed by and among the Members that the Original Agreement is hereby amended and restated to read in its entirety as follows:

**Article I: Definitions**

As used in this Agreement, unless the context requires otherwise, the meaning of the terms hereinafter set forth shall be as follows:

(a) “Associate Members” shall mean those Members of the Authority admitted in accordance with the terms and provisions of this Agreement that are not General Members. The Board of Directors may from time to time admit Associate Members on terms and conditions
consistent with SGMA and as determined by the Board. Representatives of Associate Members may not serve on the Board and/or Board Committees. Likewise, while the Board of Directors welcomes their input, the representatives of Associate Members shall be non-voting, their presence shall not be counted in determining whether a quorum is present, and they shall not be permitted in closed sessions of the Board of Directors.

(b) "Authority" shall mean the Kern Groundwater Authority, being the separate entity created pursuant to the provisions of Government Code sections 6500 et seq. by this Agreement.

(c) "Board of Directors" or "Board" shall mean the governing body of the Authority as established by Section 3.01 of this Agreement.

(d) "Committee" shall mean any committee established pursuant to Section 3.03 of this Agreement.

(e) "Fiscal Year" shall mean that period of 12 months established as the Fiscal Year of the Authority pursuant to Section 4.01 of this Agreement.

(f) "General Members" shall mean those Members of the Authority more particularly identified as General Members on Exhibit A, and any parties which shall hereafter become General Members in accordance with the terms and provisions of this Agreement. A local agency as defined by SGMA may participate as a General Member on its own behalf or join with one or more agencies as a single General Member. Multiple agencies which elect to coordinate their representation as one General Member shall, for purposes of this Agreement, be treated as one General Member.

(g) "GSA" shall mean Groundwater Sustainability Agency as defined in SGMA.

(h) "GSA Notice Date" shall mean March 1, 2017.

(i) "Kern County Subbasin" means the groundwater subbasin described in Recital G of this Agreement.

(j) "GSP" shall mean Groundwater Sustainability Plan as defined in SGMA.

(k) "Management Area" shall mean the area within the boundaries of a Member or group of Members to be managed by that Member or group of Members under any GSP adopted by the Authority.

(l) "Members" shall mean the General Members and Associate Members.

(m) "SGMA" shall mean the Sustainable Groundwater Management Act.

(n) "Special Activities" shall mean activities that are consistent with the purpose of this Agreement, but which are undertaken by fewer than all the Members in the name of the Authority pursuant to Section 3.07.
(o) "Water Supply Matters" shall mean a Member’s surface water supplies, groundwater supplies, facilities, operations, water management, water supply projects and financial affairs.

**Article II: Creation of Authority**

**Section 2.01 – Creation.**

The Members hereby reaffirm that, pursuant to their joint exercise of powers under the provisions of Government Code sections 6500 et seq., they have created a public entity to be known as the "Kern Groundwater Authority."

**Section 2.02 – Term.**

This Agreement is an amendment of the Original Agreement and shall therefore become effective, including without limitation on General Members not executing it, upon its execution by at least 75% of the General Members and will remain in effect until terminated by agreement of a majority of then participating General Members. Notwithstanding the above, once the Authority has adopted and approved a GSP for some or all of the Kern County Subbasin, this Agreement shall not be terminated except by agreement of 75% of the General Members (as described in Section 3.05 below). Unless it is terminated, this Agreement shall remain in effect and be binding upon the Members and upon all future Members for such a period as the Authority engages in any activities under this Agreement, except as to any party which withdraws or is terminated from its participation in the Authority in accordance with this Agreement. This Agreement shall supersede the Original Agreement and the Interim Funding Agreement effective 2013. Any monies collected pursuant to the Interim Funding Agreement which have not been expended as of the date of this Agreement shall be credited towards each Member’s financial commitment as identified herein.

**Section 2.03 – Purpose.**

(a) The purposes of this Agreement are to:

(i) provide for the joint exercise of powers common to each of the Members and powers granted pursuant to SGMA (subject to the restrictions contained in this Agreement), through the Authority, to cooperatively carry out the purposes of SGMA and develop, adopt and implement a legally sufficient GSP covering those portions of the Kern County Subbasin that are within the jurisdictional boundaries of the Members, subject to the limitations set forth herein; and
(ii) provide a mechanism for the coordination of groundwater management activities by and among the Members, in accordance with SGMA.

(b) Each of the General Members (or group of General Members) shall have the sole and absolute right, in its sole discretion, to:

(i) become a GSA individually or collectively within the General Member’s boundaries or the Management Area managed in whole or in part by such General Member;

(ii) approve the portion, section or chapter of the GSP adopted by the Authority as applicable within the General Member’s boundaries or the Management Area managed in whole or in part by such General Member, as provided for in Section 7.01 of this Agreement; and

(iii) implement SGMA and the GSP adopted by the Authority within the General Member’s boundaries or the Management Area managed in whole or in part by such General Member.

(c) Except to the extent requested by a General Member with respect to the lands within its boundaries, the Authority shall serve primarily a coordinating and administrative role in order to provide for sustainable groundwater management of the Kern County Subbasin in a manner that does not limit any Member’s rights or authority over its own water supply matters, including, but not limited to, a Member’s Water Supply Matters. Subject to the provisions, limitations and restrictions contained in this Agreement, activities unrelated to coordinating and administrative tasks necessary for groundwater management and sustainability shall not be undertaken by the Authority.

(d) Notwithstanding any other provision of this Agreement, the Authority shall not seek status as a GSA or approve a GSP prior to the GSA Notice Date.

(e) Not later than the GSA Notice Date, or such later date as determined by the Board of Directors, each Member shall provide the Authority with written notice that such Member will:

(i) continue as a Member and request the Authority to act as the GSA within such Member’s boundaries or for the Management Area managed in whole or in part by such Member pursuant to a separate agreement between the Authority and the Member setting forth the terms and conditions of the Authority’s role as the GSA within such Member’s boundaries or for the Management Area managed in whole or in part by such Member;

(ii) continue as a Member and confirm that it will implement the GSP adopted by the Authority within such Member’s boundaries or for the Management Area managed in whole or in part by such Member continue as a Member;

(iii) continue as a Member but seek GSA status within its boundaries or within the Management Area managed in whole or in part by such Member in order to implement SGMA and the GSP adopted by the Authority therein; or
(iv) seek GSA status within its boundaries or within the Management Area managed in whole or in part by such Member and adopt its own GSP, in which case such Member shall be deemed to have withdrawn from the Authority pursuant to Article VI but will endeavor in good faith to develop and execute a coordination agreement with the Authority in accordance with SGMA. Such Member may still be eligible to become an Associate Member pursuant to Section 6.02 (a).

The County of Kern may form a separate GSA or be part of a GSA for areas not within the boundaries of other Members and also be a GSA or participate in a GSA formed pursuant to this Agreement.

**Section 2.04 – Powers.**

(a) Subject to the limitations and restrictions contained within this Agreement, the Authority shall have the power to take any action, for the benefit of its Members, to carry out the purposes of this Agreement, including, but not limited to, applying for loans and grants, becoming a GSA for any or all of the Kern County Subbasin except the portions thereof for which Members become the GSA, and developing, adopting and implementing a GSP, subject to the paramount right of Members to become GSAs as specified in Section 2.03. The Authority shall have the power to sue and be sued. Notwithstanding the foregoing, the Authority shall not have the power to control, limit or empower a Member’s rights and authorities over its own Water Supply Matters. Likewise, unless a Member requests it, the Authority shall have no power to interfere with (i) the Member’s rights, use or management of the Member’s water or water supply or (ii) the rights of individual landowners within the Member’s boundaries to utilize, apply, store, or otherwise use surface or groundwater. Subject to the limitations and restrictions contained in this Agreement, the Authority is authorized, in its own name, to do all acts necessary for the exercise of said powers provided that said acts are duly adopted by the then seated Board of Directors and are consistent with this Agreement. Except as provided in Section 4.05, the Authority may not levy assessments on its Members. In accordance with California Government Code Section 6509, the foregoing powers shall be subject to the restrictions upon the manner of exercising such powers pertaining to the Cawelo Water District.

(b) Notwithstanding anything to the contrary in this Agreement, the Authority shall not (i) undertake any activities within any Member’s boundaries, or within a Management Area managed in whole or in part by such Member, unless the Member formally and expressly requests, consents to and agrees, in writing, to the activity proposed in accordance with Section 7.4 or (ii) acquire or seek to acquire by eminent domain any property of a Member. Nothing in this Agreement shall modify or limit the police powers of Members, if any.

**Article III: Internal Organization**

**Section 3.01 – Governing Body.**

(a) The Authority shall be governed by a Board of Directors which is hereby established and which shall be initially composed of representatives of the General Members, as shown on Exhibit A. Without amending this Agreement, the Board of Directors composition shall be altered from time to time to reflect the termination and/or admission of any new General Members.
(b) Each General Member’s governing board shall select a representative from its governing body or the governing body of one of the agencies within the General Member to serve as their Board member. A General Member may designate from its governing body or the governing body of one of the agencies within the General Member to serve as its alternative Director. The role of each alternate Director shall be to assume the duties of the Director appointed by his/her Member entity in case of the absence or unavailability of such Director, including without limitation such Director’s duties as a member of any Committee established pursuant to Section 3.03. The Directors and alternates so named shall continue to serve until their respective successors are appointed.

(c) Nothing in this Agreement shall preclude a future amendment of this Agreement to reconfigure the Board of Directors into a smaller body comprised of representatives of General Members or other individuals, all as defined in such amendment.

Section 3.02 – Officers.

The Board shall select a Chair from among the Board of Directors who shall be the presiding officer of the Board meetings. The Board shall select a Vice Chair from among the Board of Directors who shall serve as the presiding officer in the absence of the Chair. The Board shall also select a Secretary, who need not be a member of the Board of Directors. The terms of such Officers shall be established by the Board of Directors from time to time and as necessary.

Section 3.03 – Committees.

There shall be established such Committees as the Board of Directors shall determine from time to time. Each such Committee shall be comprised of representatives of General Members, shall exist for the term specified in the action establishing the Committee, shall meet as directed by the Board of Directors, and shall make recommendations to the Board of Directors on the various activities of the Authority. The Board of Directors may delegate authority to the Committee to administer and implement the various activities of the Authority, subject at all times to the limitations on the Authority set forth in this Agreement; provided, that no power to enforce any aspect of SGMA or the GSP adopted by the Authority shall be delegated to a Committee.

Members shall be give reasonable advance notice of all Committee meetings, including without limitation ad hoc Committee meetings, all of which meetings shall be open to Members and their representatives.

Section 3.04 – Seal; Bylaws.

The Board may (but need not) adopt an official seal for the Authority and adopt such bylaws as it may deem necessary to regulate the affairs of the Authority in accordance with this Agreement. The bylaws may be amended from time to time by a majority vote of the Board of Directors as it may deem necessary.
Section 3.05 – Voting: Quorum.

(a) Subject to Section 3.05(c), each member of the Board of Directors shall be entitled to a vote determined as follows:

(i) Each member of the Board shall have one (1) vote on matters with respect to which such member is entitled to vote.

(ii) Voting on actions related to Special Activities shall be weighted as determined by each Special Activity agreement.

(b) Directors holding two-thirds of the voting power on the entire Board of Directors on a matter shall constitute a quorum for the transaction of Authority business. Any Board member abstaining from a vote shall be counted for purposes of determining the existence of a quorum, but shall not be deemed to be voting.

(c) A Director (including a Director serving as a member of a Committee) shall be entitled to vote on any matter or action (i) that would affect the General Member represented by such Director, (ii) relating to the general business or administration of the Authority, or (iii) that would impact any land or landowners within the boundaries of the General Member represented by such Director or the Management Area managed in whole or in part by such General Member.

(d) Examples of matters and actions on which a Director shall be entitled to vote include without limitation matters or actions relating to the implementation of SGMA within the boundaries of the General Member represented by such Director, amounts to be paid by the General Member represented by such Director to the Authority, the imposition of fees or charges within the boundaries of the General Member represented by such Director, the adoption or amendment of the Authority’s GSP.

(e) In the event of a disagreement as to whether a Director is entitled to vote on a matter or action coming before the Board or a Committee, such Director shall be entitled to vote on the matter or action unless 75% of the Directors present at the meeting determine that such Director is not so entitled.

(f) Except as otherwise provided in this Agreement, any action by the Board of Directors shall require a two-thirds vote of the Directors entitled to vote thereon that are present at the meeting. Any amendment of this Agreement shall be governed by Section 8.01.

(g) Two-thirds of the members of a Committee entitled to vote thereon shall constitute a quorum for a matter or action before the Committee. All questions and matters of any nature whatsoever coming before any Committee shall be determined, provided a quorum is present, by the concurrence of 75% of the members of such Committee entitled to vote thereon present and voting on such matter. Any Committee member entitled to vote thereon abstaining from a vote shall be counted for purposes of determining the existence of a quorum, but shall not be deemed to be voting.

(h) This Section 3.05 shall not apply to matters affecting implementation of SGMA within a particular Management Area. Such matters shall be governed by the Member or
Members implementing SGMA within that Management Area, except to the extent otherwise agreed upon by such Member(s) pursuant to 2.04(b) or in a Special Activity agreement.

Section 3.06 – Meetings.

Meetings of the Board of Directors and any Committee (to the extent applicable) shall be conducted in accordance with the Ralph M. Brown Act, California Government Code Sections 54950, et seq.

Section 3.07 - Special Activities.

With the prior approval of the entire Board of Directors, Members may undertake Special Activities in the name of the Authority. All Members shall be given the opportunity to participate in each Special Activity of the Authority unless the Special Activity is an action described in Section 7.04. Prior to undertaking a Special Activity, the Members electing to participate in the Special Activity shall enter into an activity agreement. Such activity agreement shall provide that (i) no Special Activity undertaken pursuant to such agreement shall conflict with the terms of this Agreement and (ii) the Members to the activity agreement shall indemnify, defend and hold the Authority, and the Authority’s other Members, harmless from and against any liabilities, costs or expenses of any kind arising as a result of the Special Activity described in the activity agreement. All assets, rights, benefits, debts, liabilities and obligations attributable to a Special Activity shall be assets, rights, benefits debts, liabilities and obligations solely of the Members that have entered into the activity agreement for that Special Activity, in accordance with the terms of the activity agreement, and shall not be the assets, rights, benefits, debts, liabilities and obligations of those Members that have not executed the activity agreement. Members not electing to participate in the Special Activity shall have no rights, benefits, debts, liabilities or obligations attributable to such Special Activity.


Section 4.01 – Fiscal Year.

The Fiscal Year of the Authority shall be from January 1 through December 31 of each year.

Section 4.02 – Funds: Accounts.

(a) The North Kern Water Storage District shall serve as the Fiscal Agent and Treasurer for the Authority unless otherwise determined by the entire Board. The Fiscal Agent shall be responsible for all money of the Authority from whatever source. The Board may compensate the fiscal agent for services rendered.

(b) All funds of the Authority shall be strictly and separately accounted for and regular reports shall be rendered of all receipts and disbursements at least quarterly during the Fiscal Year. The books and records of the Authority shall be open to inspection by the Members.

(c) The Authority shall contract with a certified public accountant to make an audit or review of the accounts and records of the Authority which shall be conducted in compliance with Section 6505 of the California Government Code. The Fiscal Agent shall have the right to reject
any proposed certified public accountant. All costs associated with this Audit will be the full responsibility of the Authority.

Section 4.03 – Property: Bonds.

The Board of Directors shall from time to time designate the officers and persons, in addition to those specified in Section 4.02 above, who shall have charge of, handle, or have access to any property of the Authority. Each such officer and person shall file a bond in an amount designated by the Board of Directors.

Section 4.04 – Budget.

By a date set by the Board of Directors each Fiscal Year, the Board of Directors shall adopt a budget for the Authority for the ensuing Fiscal Year; provided, that except as provided in Section 4.05, the Authority shall not impose assessments or other charges on Members. Notwithstanding the foregoing, by its execution of this Agreement, each Member confirms that it has authorized its Director and Alternate Director to approve actions and expenditures by the Authority over and above the approved annual budget of the Authority for a Fiscal Year that do not create a fiscal obligation greater than $5,000 on such Member without further action of such Member.

Section 4.05 – Payments To The Authority.

(a) Except as otherwise provided, all fees, costs and expenses incurred by the Authority for general administrative services, such as legal, preparation of audits, and other general administrative functions shall be funded (i) from permissible contributions from third parties and (ii) assessments on the General Members, levied from time to time by the Board of Directors to carry out the activities of the Authority generally applicable to all General Members, which shall be equal per General Member, as initially shown on Exhibit A.

(b) No Member shall be bound, financially or otherwise, by any obligation, contract or activity undertaken by the Authority unless and except to the extent agreed upon by the Member, except that each Member shall be obligated to fund its then current annual share of the general basic budget of the Authority, provided such budgets are otherwise approved as provided herein. Funding of other matters shall be through Special Activity agreements or as otherwise agreed to by the Members in writing.

Section 4.06 – GSP Fees.

The Authority may impose reasonable fees, charges, assessments and other levies to implement its GSP and/or SGMA; provided, that the Authority shall have no authority to impose any such fees, charges, assessments or other levies on any of its Members or within a Management Area without the express consent and approval of the affected Member(s), or the Member or Member implementing the Authority’s GSP and SGMA within such Management Area.
Article V: Management

Section 5.01 - Management.

In addition to, or in lieu of, hiring employees, the Authority may engage one or more General Member(s) or third party(ies) to manage any or all of the business of the Authority on terms and conditions acceptable to the Board of Directors. Any General Member or third party so engaged shall have such responsibilities as are set forth in the contract for such General Member’s or third party’s services.

Article VI: Relationship of Authority And Its Members

Section 6.01 - Separate Entity: Property.

In accordance with California Government Code Sections 6506 and 6507, the Authority shall be a public entity separate and apart from the parties to this Agreement. Unless, and to the extent otherwise agreed herein, the debts, liabilities and obligations of the Authority shall not be debts, liabilities or obligations of the Member entities. The Authority shall own and hold title to all funds, property and works acquired by it during the term of this Agreement.

Section 6.02 - Admission, Withdrawal and Termination of Members.

(a) Additional qualified parties may join in this Agreement and become General Members upon the approval of the entire Board of Directors, subject to terms and conditions as may be established by the Board of Directors. Associate Members may be admitted on terms and conditions established by the entire Board of Directors. Prior to being admitted as a new Member, an entity shall execute an agreement to be bound by the terms of this Agreement and any other terms and conditions established by the Board of Directors.

(b) Notwithstanding anything herein to the contrary, any Member may withdraw from this Agreement by giving 30 days written notice of its election to do so, which notice shall be given to the Board of Directors and to each of the other parties.

(c) Upon withdrawal, the Member shall not be relieved of all obligations for assessments to pay costs or liabilities of the Authority which were incurred prior to the date of the withdrawing Member’s notice of withdrawal, but shall remain responsible for all obligations for assessments to pay costs or liabilities of the Authority which were incurred prior to the date of the withdrawing Member’s notice of withdrawal.

(d) Subject to any contrary provisions of SGMA, a Member may be terminated by a three-fourths vote of the Directors representing Members not subject to the termination vote if such Member is then in breach of this Agreement and the breach is identified in the vote of the Board of Directors. Upon termination, the breaching Member shall no longer be a Member of the Authority; provided, that such termination shall become effective no earlier than 90 days after such vote of the Board of Directors and shall only be effective if the breach identified in the vote of the Board of Directors has not be cured by the effective date for the termination.

(e) Upon termination, the Member shall be entitled to a reimbursement for all assessments collected within 12 months prior to the termination vote and they shall be relieved
of all ongoing obligations for assessments to pay costs or liabilities of the Authority which were incurred prior to the date of the termination.

(f) Upon withdrawal or termination as a Member, the provisions of Section 2.04(b) shall remain applicable to any such withdrawing or terminated Member. The withdrawing or terminated Member will also be entitled to copies of all documents, information, and material developed by the Authority and paid for in whole or in part by the Member prior to the Member’s withdrawal or termination.

(g) Upon withdrawal or termination as a Member, whether occurring before or after the GSA Notice Date and/or the date the Authority becomes a GSA as provided for in SGMA, or whether occurring before or after June 30, 2017, it is contemplated the withdrawing or terminated Member would concurrently become (or designate) a GSA for the lands within its boundaries (or a Management Area managed in whole or in part by such Member), so that such lands of the withdrawing or terminated Member would continue to be subject to a GSA and if applicable a GSP and the powers of such withdrawing Member within its boundaries would not be limited by this Agreement. In such event the Authority and its remaining Members shall (i) not object to or interfere with the lands in the withdrawing or terminated Member’s boundaries (or a Management Area managed in whole or in part by such Member) being in a GSA, as designated by such withdrawing or terminated Member, (ii) facilitate such transition to the extent reasonably necessary, and (iii) in cooperation with the withdrawing or terminated Member, withdraw from managing the Kern County Subbasin as a GSA (if it has already elected to be a GSA) for that portion of the Basin within the boundaries of the withdrawing or terminated Member and so notify the Department of Water Resources.

Section 6.03 – Disposition Of Property Upon Termination Or Determination By Board Of Directors Of Surplus.

(a) Upon termination of this Agreement or upon determination by the Board of Directors that any surplus money is on hand, such surplus money shall be returned to the Members of the Authority. The distribution of said surplus shall be proportionate to the current year percentages as shown in Exhibit A, or as modified after the inclusion of new Members.

(b) The Board of Directors shall first offer any surplus properties, works, rights and interests of the Authority for sale to the Members and the sale shall be at the Authority’s actual cost unless otherwise required by law. If no such sale is consummated, then the Board of Directors shall offer the surplus properties, works, rights and interests of the Authority for sale in accordance with applicable law to any governmental agency, private entity or persons for good and adequate consideration.

Section 6.04 – Liability For Debts.

The Members do not intend hereby to be obligated either jointly or severally for the debts, liabilities or obligations of the Authority, except as may be specifically provided for in California Government Code Section 895.2 as amended or supplemented. Provided, however, if any General Member(s) of the Authority are, under such applicable law, held liable for the acts or omissions of the Authority caused by negligent or wrongful act or omission occurring in the performance of this Agreement, such parties shall be entitled to contribution from the other Members so that after said contributions each General Member shall bear an equal share of such liability, as shown on the then-current Exhibit A. This Section 6.04 does not apply to acts or omissions of a Member in implementing the GSP adopted by the Authority within such
Member's boundaries or a Management Area managed in whole or in part by such Member.

**Section 6.05 – SGMA-Related Expenses Incurred by Members.**

Expenses incurred by a Member, or group of Members, for the implementation of the SGMA within a Management Area shall be borne solely by that Member or group of Members. Neither the Authority nor its other Members shall be liable for such expenses.

**Article VII – Implementation of SGMA**

**Section 7.01 – Development of GSP.**

Any Member or group of Members may create its or their own chapter or provisions governing SGMA implementation within their respective boundaries or a Management Area managed in whole or in part by such Member(s) for inclusion by the Authority into the Authority’s GSP. The Authority shall promptly review the proposed chapter or provisions for consistency with the Authority’s GSP and to determine that it meets the requirements of SGMA. If the Authority determines by a vote of 75% of the Directors that a Member’s proposed chapter or provisions is/are consistent with SGMA and the Authority’s GSP, it shall incorporate such chapter or provisions into the Authority’s GSP. Such chapter or provisions may include operating conditions and criteria for groundwater banking projects that have previously been negotiated with other Members or agencies within the Basin and/or are contained within approved environmental documents, and in reviewing a Member’s chapter the Authority shall not reject or fail to approve a Member’s chapter based solely upon such operating conditions and criteria. The Authority shall not adopt a GSP that will be implemented within any Member’s boundaries or Management Area without the prior approval of the Member.

**Section 7.02 – Authorization to Carry Out the Terms of the GSP.**

The Authority is authorized to carry out any of the following powers for the benefit of its Members that are included in the GSP adopted by the Authority without any further approval of the Board of Directors, subject at all times to the limitations and restrictions contained within this Agreement:

(a) Collection and maintenance of water extraction information and other technical data.

(b) Coordination of actions within, and reporting by, a Management Area.

(c) Carrying out studies and other technical investigations.

(d) Establishment and administration of conjunctive use and land fallowing programs.

(e) Requiring permitting of water extraction facilities.

(f) Requiring installation of meters.

(g) Buy, sell, exchange, recharge, and/or store water if the benefits thereof are made available to all General Members.
(h) Fix and collect rates for replenishment and other activities as a regulatory or service fee provided for at Water Code Sections 10730 through 10731.

Section 7.03 – Actions Requiring Additional Approval.

Subject to the limitations of this Agreement, the Authority shall not do any of the following without the approval of 75% of the voting power of the Board of Directors:

(a) Restrict or otherwise limit extraction of native groundwater other than through economic incentives and disincentives.

(b) Fund capital construction projects.

Notwithstanding any other provision of this Agreement, the Authority shall not restrict or otherwise limit the extraction of water stored (whether through direct recharge or in lieu deliveries) in the Kern County Subbasin as a part of any banking or recharge project or program, or otherwise seek to regulate the operation any such project or program.

Section 7.04 – Management Areas.

Any General Member (or group of General Members) may request that the Authority directly assume the responsibility of implementing SGMA and the Authority’s GSP within its Management Area by giving written notice to the Authority, which notice may be given at any time. Where the service areas of multiple Members overlap a Management Area, the Members within the Management Area shall unanimously join the request. The Board of Directors shall take action to accept or reject such request. If the Authority accepts such request, the Authority and the requesting General Member(s) shall develop a mutually acceptable agreement describing the respective roles and responsibilities of the Authority and the requesting General Member(s) with respect to such implementation.

Except as otherwise expressly provided, the Authority’s role within a Management Area, unless otherwise unanimously requested by the Member(s) managing such Management Area, shall be primarily coordinating and administrative. In particular, the roles and responsibilities for implementing SGMA and the GSP within a Management Area shall be the subject of a Special Activity agreement between the Member(s) and the Authority.

Article VIII: Miscellaneous Provisions

Section 8.01 – Amendment.

This Agreement may be amended from time to time by the concurrence of 75% of the General Members. To provide non-concurring parties an opportunity to withdraw from the Authority as provided herein, an amendment shall be binding on all parties 60 days after the required concurrence has been obtained.

Section 8.02 – Severability And Validity Of Agreement.

Should the participation of any party to this Agreement, or any part, term or provision of this Agreement be decided by a courts or the Legislature to be illegal, in excess of that party’s authority, in conflict with any law of the State of California, or otherwise rendered unenforceable or ineffectual, the validity of the remaining portions, terms or provisions of this Agreement shall
not be affected thereby and each party hereby agrees it would have entered into this Agreement upon the remaining terms and provisions.

Section 8.03 – Assignment.

Except as otherwise provided in this Agreement, the rights and duties of the parties to this Agreement may not be assigned or delegated without the advance written consent of the Authority (as evidenced by a majority vote of the Board of Directors), and any attempt to assign or delegate such rights or duties in contravention of this section shall be null and void. Any assignment or delegation permitted under the terms of this Agreement shall be consistent with the terms of any contracts, resolutions or indentures of the Authority then in effect, including without any Special Activity agreement to which the assigning or delegating Member is a party. This Agreement shall inure to the benefit of and be binding upon the successors and assigns of the parties hereto. This section does not prohibit a party from entering into an independent agreement with another agency regarding the financing of that party’s contributions to the Authority or the disposition of proceeds which that party receives under this Agreement so long as such independent agreement does not affect, or purport to affect, the rights and duties of the Authority or the parties under this Agreement.

Section 8.04 – Execution In Parts Or Counterparts.

This Agreement may be executed in parts or counterparts, each part or counterpart being an exact duplicate of all other parts or counterparts, and all parts or counterparts shall be considered as constituting one complete original and may be attached together when executed by the parties hereto. Facsimile or electronic signatures shall be binding.

Section 8.05 – Notices.

Notices authorized or required to be given pursuant to this Agreement shall be in writing and shall be deemed to have been given when mailed, postage prepaid, or delivered during working hours to the addresses set forth for each of the parties hereto on Exhibit “A” of this Agreement, or to such other changed addresses communicated to the Authority and the Member entities in writing, and to such other entities that become Members.

Section 8.06 – Dispute Resolution.

(a) A dispute resolution group shall be established by the Board of Directors to resolve disputes and/or controversies through mediation relating to the interpretation, construction, performance, termination, breach of, or withdrawal from this Agreement (the “Dispute Resolution Group”). The Dispute Resolution Group shall meet with the parties involved no later than 30 days following notification of the dispute or controversy. Thereafter, the Dispute Resolution Group will have 90 days to endeavor to resolve the dispute.

(b) Following conclusion of the dispute resolution process as herein provided, any Member may pursue any judicial or administrative remedies otherwise available. Notwithstanding this Section 8.06, a Member may seek a preliminary injunction or other interlocutory judicial relief if necessary to avoid irreparable damages or to preserve the status quo.
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

Arvin Community Services District

Name of Member

By: Raul Barraza, Jr.

Print Name: Raul Barraza, Jr.

Title: General Manager
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

[Signature]
Name of Member

By: [Signature]
Print Name: [Print Name]
Title: [Title]
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

\[Signature\]

Name of Member

By: 

Print Name: David Fenn

Title: Board Member
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

City of Shafter
Name of Member

By: [Signature]

Print Name: Michael James
Title: Public Works Director
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

Kern County
Name of Member

By: ZACK SCRIVNER
Print Name: Chairman, Board of Supervisors, County of Kern
Title: Chairman, Board of Supervisors, County of Kern

APPROVED AS TO FORM
Office of County Counsel

Kern County
By: [Signature]
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

Kern County Water Agency
Name of Member
By: C. Creel

Print Name: Curtis Creel
Title: General Manager
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and
regularly adopted by their respective Board of Directors or governing board, have caused their
names to be affixed by their proper and respective officers as of the day and year first above-
written.

Kern-Tulare Water District
Name of Member

By: [Signature]

Print Name: Steven C. Dalke

Title: General Manager
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and
regularly adopted by their respective Board of Directors or governing board, have caused their
names to be affixed by their proper and respective officers as of the day and year first above-
written.

North Kern
Name of Member

By:  

Print Name: Kevin Andrew

Title: President
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

OLCESE WATER DISTRICT
Name of Member

By: ____________________________

Print Name: JEFF SIEMENS

Title: ____________________________
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above written.

Rosedale-Rio Grand Water Storage District

Name of Member

By: Gary Van

Print Name: Gary Van

Title: Director
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and
regularly adopted by their respective Board of Directors or governing board, have caused their
names to be affixed by their proper and respective officers as of the day and year first above-
written.

[Signature]
Name of Member

By: [Signature]

Print Name: Rick Wegis

Title: Board member
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

[Signature]
Name of Member

[Signature]
Print Name: Mark Franz

Title: Director
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

Name of Member

By: James R. Regan
Print Name: James R. Regan
Title: member
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

[Signature]
Name of Member

By: [Signature]

Print Name: Dennis Atkinson

Title: President
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

WEST KERN WATER DISTRICT
Name of Member

By: [Signature]

Print Name: GARY MORRIS
Title: BOARD MEMBER
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

WESTSIDE WATER DISTRICT AUTH.
Name of Member

By: [Signature]

Print Name: Joseph MacIver

Title: President
IN WITNESS WHEREOF, the parties hereto, pursuant to resolutions duly and regularly adopted by their respective Board of Directors or governing board, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

Wheeler Ridge-Maricopa Water Storage District

Name of Member

By:  

Print Name: George R. Cappello

Title: Board President

By:  

Print Name: Jose Marin

Title: Board Secretary
EXHIBIT A

GENERAL MEMBERS

Arvin Community Services District
Arvin-Edison Water Storage District
Cawelo Water District
City of Shafter
Kern County Water Agency
Kern County
Kern-Tulare Water District
North Kern Water Storage District
Olcese Water District
Rosedale-Rio Bravo Water Storage District
Semitropic Water Storage District
Shafter-Wasco Irrigation District
Southern San Joaquin Municipal Utility District
Tejon-Castaic Water District
West Kern Water District
Westside District Water Authority
Wheeler Ridge-Maricopa Water Storage District
APPENDIX B
AGRICULTURAL WATER MANAGEMENT PLAN

FOR THE

North Kern Water Storage District

August 2014

Completed In Accordance With the

WATER CONSERVATION BILL OF 2009
(SBx7-7)
Plan Checklist

The following is a checklist of plan contents drawn from the *DWR Guidebook to Assist Agricultural Water Suppliers to Prepare a 2012 Agricultural Water Management Plan*. This checklist shows where required plan elements are presented in the North Kern Agricultural Water Management Plan.

### AWMP Requirement Checklist

<table>
<thead>
<tr>
<th>AWMP Location</th>
<th>Guidebook Location</th>
<th>Description</th>
<th>Water Code Section (or other, as identified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec.I – yes</td>
<td>1.4</td>
<td>AWMP Required?</td>
<td>10820, 10608.12</td>
</tr>
<tr>
<td>Sec.I – yes</td>
<td>1.4</td>
<td>At least 25,000 irrigated acres or</td>
<td>10853</td>
</tr>
<tr>
<td>Sec.I – NA</td>
<td>1.4</td>
<td>Less than 25,000 irrigated acres and funding provided.</td>
<td>10853</td>
</tr>
<tr>
<td>Sec.I.C.1 – no</td>
<td>1.4</td>
<td>Initial AWMP prepared and adopted by December 31, 2012?</td>
<td>10820(a)</td>
</tr>
<tr>
<td>Sec.I.C.1 – yes</td>
<td>1.4</td>
<td>December 31, 2015 update.</td>
<td>10820(a)</td>
</tr>
<tr>
<td>Sec.I.C.1 – yes</td>
<td>1.4</td>
<td>5-year cycle update.</td>
<td>10820(a)</td>
</tr>
<tr>
<td>Sec.I – NA</td>
<td>1.4</td>
<td>New agricultural water supplier after December 31, 2012 – AWMP prepared and adopted within 1 year.</td>
<td>10820(b)</td>
</tr>
<tr>
<td>Sec.I.C.1 - no</td>
<td>1.5, 4.2</td>
<td>1999 AWMC MOU: Report on EWMP implemented or scheduled for implementation included.</td>
<td>10827</td>
</tr>
<tr>
<td>Sec.I.C.1 – NA</td>
<td>1.5, 5</td>
<td>USBR water management/conservation plan:</td>
<td>10828(a)</td>
</tr>
<tr>
<td>Sec.I.C.1 – NA</td>
<td>1.5, 5.1</td>
<td>Adopted and submitted to USBR within the previous four years, AND</td>
<td>10828(a)(1)</td>
</tr>
<tr>
<td>Sec.I.C.1 – NA</td>
<td>1.5, 5.1</td>
<td>The USBR has accepted the water management/conservation plan as adequate.</td>
<td>10828(a)(2)</td>
</tr>
<tr>
<td>Sec.I.A – yes</td>
<td>1.4</td>
<td>UWMP or participation in area wide, regional, watershed, or basin wide water management planning; does the plan meet requirements of SBx7-7 2.8 <em>(use checklist)</em></td>
<td>10829</td>
</tr>
<tr>
<td>Sec.I.A</td>
<td>3.1 A</td>
<td>Description of previous water management activities.</td>
<td>10826(d)</td>
</tr>
<tr>
<td>Sec.I.B.1 – yes</td>
<td>3.1 B.1</td>
<td>Was each city or county within which supplier provides water supplies notified that the agricultural water supplier will be preparing or amending a plan?</td>
<td>10821(a)</td>
</tr>
<tr>
<td>Sec.1.B.1</td>
<td>3.2 B.2</td>
<td>Was the proposed plan available for public inspection prior to plan adoption?</td>
<td>10841</td>
</tr>
<tr>
<td>AWMP Location</td>
<td>Guidebook Location</td>
<td>Description</td>
<td>Water Code Section (or other, as identified)</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
<td>-------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>App A</td>
<td>3.1 B.2</td>
<td>Publically-owned supplier: Prior to the hearing, was the notice of the time and place of hearing published within the jurisdiction of the publicly owned agricultural water supplier in accordance with Government Code 6066?</td>
<td>10841</td>
</tr>
<tr>
<td>App A</td>
<td>3.1 B.2</td>
<td>14 days notification for public hearing?</td>
<td>GC 6066</td>
</tr>
<tr>
<td>App A</td>
<td>3.1 B.2</td>
<td>Two publications in newspaper within those 14 days?</td>
<td>GC 6066</td>
</tr>
<tr>
<td>App A</td>
<td>3.1 B.2</td>
<td>At least 5 days between publications? (not including publication date)</td>
<td>GC 6066</td>
</tr>
<tr>
<td>Sec.I.C.1 – NA</td>
<td>3.1 B.2</td>
<td>Privately-owned supplier: was equivalent notice within its service area and reasonably equivalent opportunity that would otherwise be afforded through a public hearing process provided?</td>
<td>10841</td>
</tr>
<tr>
<td>Sec.I.C.1 – yes</td>
<td>3.1 C.1</td>
<td>After hearing/equivalent notice, was the plan adopted as prepared or as modified during or after the hearing?</td>
<td>10841</td>
</tr>
<tr>
<td>Sec.I.C.2</td>
<td>3.1 C.2</td>
<td>Was a copy of the AWMP, amendments, or changes, submitted to the entities below, no later than 30 days after the adoption?</td>
<td>10843(a)</td>
</tr>
<tr>
<td>Sec.I.C.3 – yes</td>
<td>3.1 C.2</td>
<td>The department.</td>
<td>10843(b)(1)</td>
</tr>
<tr>
<td>Sec.I.C.3 – yes</td>
<td>3.1 C.2</td>
<td>Any city, county, or city and county within which the agricultural water supplier provides water supplies.</td>
<td>10843(b)(2)</td>
</tr>
<tr>
<td>Sec.I.C.3- no</td>
<td>3.1 C.2</td>
<td>Any groundwater management entity within which jurisdiction the agricultural water supplier extracts or provides water supplies.</td>
<td>10843(b)(3)</td>
</tr>
<tr>
<td>Sec.I.C.3 – no</td>
<td>3.1 C.2</td>
<td>Any urban water supplier within which jurisdiction the agricultural water supplier provides water supplies.</td>
<td>10843(b)(4)</td>
</tr>
<tr>
<td>Sec.I.C.3 – yes</td>
<td>3.1 C.2</td>
<td>Any city or county library within which jurisdiction the agricultural water supplier provides water supplies.</td>
<td>10843(b)(5)</td>
</tr>
<tr>
<td>Sec.I.C.3 – yes</td>
<td>3.1 C.2</td>
<td>The California State Library.</td>
<td>10843(b)(6)</td>
</tr>
<tr>
<td>Sec.I.C.3 – no</td>
<td>3.1 C.2</td>
<td>Any local agency formation commission serving a county within which the agricultural water supplier provides water supplies.</td>
<td>10843(b)(7)</td>
</tr>
<tr>
<td>Sec.I.C.3</td>
<td>3.1 C.3</td>
<td>Adopted AWMP availability.</td>
<td>10844</td>
</tr>
<tr>
<td>AWMP Location</td>
<td>Guidebook Location</td>
<td>Description</td>
<td>Water Code Section (or other, as identified)</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
<td>-------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>S.I.C.3 – no</td>
<td>3.1 C.3</td>
<td>Was the AWMP available for public review on the agricultural water supplier’s Internet Web site within 30 days of adoption?</td>
<td>10844(a)</td>
</tr>
<tr>
<td>Sec.I.C.3 – yes</td>
<td>3.1 C.3</td>
<td>If no Internet Web site, was an electronic copy of the AWMP submitted to DWR within 30 days of adoption?</td>
<td>10844(b)</td>
</tr>
<tr>
<td>Sec.I.D – yes</td>
<td>3.1 D.1</td>
<td>Implement the AWMP in accordance with the schedule set forth in its plan, as determined by the governing body of the agricultural water supplier.</td>
<td>10842</td>
</tr>
<tr>
<td>Sec.II</td>
<td>3.2</td>
<td>Description of the agricultural water supplier and service area including:</td>
<td>10826(a)</td>
</tr>
<tr>
<td>Sec.II.A.1</td>
<td>3.2 A.1</td>
<td>Size of the service area.</td>
<td>10826(a)(1)</td>
</tr>
<tr>
<td>Sec.II.A.2</td>
<td>3.2 A.2</td>
<td>Location of the service area and its water management facilities.</td>
<td>10826(a)(2)</td>
</tr>
<tr>
<td>Sec.II.A.3</td>
<td>3.2 A.3</td>
<td>Terrain and soils.</td>
<td>10826(a)(3)</td>
</tr>
<tr>
<td>Sec.II.A.4</td>
<td>3.2 A.4</td>
<td>Climate.</td>
<td>10826(a)(4)</td>
</tr>
<tr>
<td>Sec.II.B.1</td>
<td>3.2 B.1</td>
<td>Operating rules and regulations.</td>
<td>10826(a)(5)</td>
</tr>
<tr>
<td>Sec.II.B.2</td>
<td>3.2 B.2</td>
<td>Water delivery measurements or calculations.</td>
<td>10826(a)(6)</td>
</tr>
<tr>
<td>Sec.II.B.3</td>
<td>3.2 B.3</td>
<td>Water rate schedules and billing.</td>
<td>10826(a)(7)</td>
</tr>
<tr>
<td>Sec.II.B.4</td>
<td>3.2 B.4</td>
<td>Water shortage allocation policies.</td>
<td>10826(a)(8)</td>
</tr>
<tr>
<td>Sec.III</td>
<td>3.3</td>
<td>Water uses within the service area, including all of the following:</td>
<td>10826(b)(5)</td>
</tr>
<tr>
<td>Sec.III.A</td>
<td>3.3 A</td>
<td>Agricultural.</td>
<td>10826(b)(5)(A)</td>
</tr>
<tr>
<td>Sec.III.B</td>
<td>3.3 B</td>
<td>Environmental.</td>
<td>10826(b)(5)(B)</td>
</tr>
<tr>
<td>Sec.III.C</td>
<td>3.3 C</td>
<td>Recreational.</td>
<td>10826(b)(5)(C)</td>
</tr>
<tr>
<td>Sec.III.D</td>
<td>3.3 D</td>
<td>Municipal and industrial.</td>
<td>10826(b)(5)(D)</td>
</tr>
<tr>
<td>Sec.III.E</td>
<td>3.3 E</td>
<td>Groundwater recharge.</td>
<td>10826(b)(5)(E)</td>
</tr>
<tr>
<td>Sec.III.F</td>
<td>3.3 F</td>
<td>Transfers and exchanges.</td>
<td>10826(b)(5)(F)</td>
</tr>
<tr>
<td>Sec.III.G</td>
<td>3.3 G</td>
<td>Other water uses.</td>
<td>10826(b)(5)(G)</td>
</tr>
<tr>
<td>Sec.IV</td>
<td>3.4 A</td>
<td>Description of the quantity of agricultural water supplier’s supplies as:</td>
<td>10826(b)</td>
</tr>
</tbody>
</table>
## AWMP Requirement Checklist (cont.)

<table>
<thead>
<tr>
<th>AWMP Location</th>
<th>Guidebook Location</th>
<th>Description</th>
<th>Water Code Section (or other, as identified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec.IV.A.1</td>
<td>3.4 A.1</td>
<td>Surface water supply.</td>
<td>10826(b)(1)</td>
</tr>
<tr>
<td>Sec.IV.A.2</td>
<td>3.4 A.2</td>
<td>Groundwater supply.</td>
<td>10826(b)(2)</td>
</tr>
<tr>
<td>Sec.IV.A.3</td>
<td>3.4 A.3</td>
<td>Other water supplies.</td>
<td>10826(b)(3)</td>
</tr>
<tr>
<td>Sec.IV.A.4</td>
<td>3.4 A.4</td>
<td>Drainage from the water supplier’s service area.</td>
<td>10826(b)(6)</td>
</tr>
<tr>
<td>Sec.IV.B</td>
<td>3.4 B</td>
<td>Description of the quality of agricultural waters suppliers supplies as:</td>
<td>10826(b)</td>
</tr>
<tr>
<td>Sec.IV.B.1</td>
<td>3.4 B.1</td>
<td>Surface water supply.</td>
<td>10826(b)(1)</td>
</tr>
<tr>
<td>Sec.IV.B.2</td>
<td>3.4 B.2</td>
<td>Groundwater supply.</td>
<td>10826(b)(2)</td>
</tr>
<tr>
<td>Sec.IV.B.3</td>
<td>3.4 B.3</td>
<td>Other water supplies.</td>
<td>10826(b)(3)</td>
</tr>
<tr>
<td>Sec.IV.C</td>
<td>3.4 C</td>
<td>Source water quality monitoring practices.</td>
<td>10826(b)(4)</td>
</tr>
<tr>
<td>Sec.IV.B.4, Sec.IV.C.2</td>
<td>3.4 B.4</td>
<td>Drainage from the water supplier’s service area.</td>
<td>10826(b)(6)</td>
</tr>
<tr>
<td>Sec.V</td>
<td>3.5</td>
<td>Description of water accounting, including all of the following:</td>
<td>10826(b)(7)</td>
</tr>
<tr>
<td>Sec.V.A</td>
<td>3.5 A</td>
<td>Quantifying the water supplier’s water supplies.</td>
<td>10826(b)(7)(A)</td>
</tr>
<tr>
<td>Sec.V.B</td>
<td>3.5 B</td>
<td>Tabulating water uses.</td>
<td>10826(b)(7)(B)</td>
</tr>
<tr>
<td>Sec.V.C</td>
<td>3.5 C</td>
<td>Overall water budget.</td>
<td>10826(b)(7)(C)</td>
</tr>
<tr>
<td>Sec.V.D</td>
<td>3.5 D</td>
<td>Description of water supply reliability.</td>
<td>10826(b)(8)</td>
</tr>
<tr>
<td>Sec.VI</td>
<td>3.6</td>
<td>Analysis of climate change effect on future water supplies analysis.</td>
<td>10826(c)</td>
</tr>
<tr>
<td>Sec.VII</td>
<td>3.7</td>
<td>Water use efficiency information required pursuant to Section 10608.48.</td>
<td>10826(e)</td>
</tr>
<tr>
<td>Sec.VII.A</td>
<td>3.7A</td>
<td>Implement efficient water management practices (EWMPs).</td>
<td>10608.48(a)</td>
</tr>
<tr>
<td>Sec.VIII</td>
<td>3.7 A.1</td>
<td>Implement Critical EWMP: Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement paragraph (2).</td>
<td>10608.48(b)</td>
</tr>
<tr>
<td>Sec.VII.A</td>
<td>3.7 A.1</td>
<td>Implement Critical EWMP: Adopt a pricing structure for water customers based at least in part on quantity delivered.</td>
<td>10608.48(c)</td>
</tr>
<tr>
<td>Sec.VII.A</td>
<td>3.7 A.2</td>
<td>Implement additional locally cost-effective and technically feasible EWMPs.</td>
<td>10608.48(c)</td>
</tr>
</tbody>
</table>
### AWMP Requirement Checklist (cont.)

<table>
<thead>
<tr>
<th>AWMP Location</th>
<th>Guidebook Location</th>
<th>Description</th>
<th>Water Code Section (or other, as identified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec.VII.B</td>
<td>3.7 B</td>
<td>If applicable, document (in the report) the determination that EWMPs are not locally cost-effective or technically feasible.</td>
<td>10608.48(d)</td>
</tr>
<tr>
<td>Sec.VII.A</td>
<td>3.7 A</td>
<td>Include a report on which EWMPs have been implemented and planned to be implemented.</td>
<td>10608.48(d)</td>
</tr>
<tr>
<td>Sec.VII.A</td>
<td>3.7 A</td>
<td>Include (in the report) an estimate of the water use efficiency improvements that have occurred since the last report, and an estimate of the water use efficiency improvements estimated to occur five and 10 years in the future.</td>
<td>10608.48(d)</td>
</tr>
<tr>
<td>NA</td>
<td>5</td>
<td>USBR water management/conservation plan may meet requirements for EWMPs.</td>
<td>10608.48(f)</td>
</tr>
<tr>
<td>Sec.VIII.D</td>
<td>6 A</td>
<td>Lack of legal access certification (if water measuring not at farm gate or delivery point).</td>
<td>CCR §597.3(b)(2)(A)</td>
</tr>
<tr>
<td>Sec.VIII.A</td>
<td>6 B</td>
<td>Lack of technical feasibility (if water measuring not at farm gate or delivery point).</td>
<td>CCR §597.3(b)(1)(B), §597.3(b)(2)(B)</td>
</tr>
<tr>
<td>Sec.VIII.B</td>
<td>6 A, 6 B</td>
<td>Delivery apportioning methodology (if water measuring not at farm gate or delivery point).</td>
<td>CCR §597.3.b(2)(C)</td>
</tr>
<tr>
<td>Sec.VIII.A</td>
<td>6 C</td>
<td>Description of water measurement BPP.</td>
<td>CCR §597.4(e)(2)</td>
</tr>
<tr>
<td>Sec.VIII.C</td>
<td>6 D</td>
<td>Conversion of measurement to volume.</td>
<td>CCR §597.4(e)(3)</td>
</tr>
<tr>
<td>Sec.VIII.F.4</td>
<td>6 E</td>
<td>Existing water measurement device corrective action plan? (if applicable, including schedule, budget and finance plan)</td>
<td>CCR §597.4(e)(4)</td>
</tr>
</tbody>
</table>
# Table of Contents

Section I. Plan Preparation and Adoption ............................................................................. 1  
  A. Description of Previous Water Management Activities ................................................. 4  
  B. Coordination Activities .................................................................................................. 5  
  C. Plan Adoption and Submittal ......................................................................................... 5  
  D. Plan Implementation ....................................................................................................... 6  

Section II. Description of the North Kern Water Storage District and Service Area .............. 7  
  A. Physical Characteristics ................................................................................................. 7  
  B. Operational Characteristics .......................................................................................... 17  

Section III. Description of Quantity of the Water Uses of the Agricultural Water Supplier .... 23  
  A. Agricultural Water Use ............................................................................................... 23  
  B. Environmental Water Use ........................................................................................... 25  
  C. Recreational Water Use .............................................................................................. 25  
  D. Municipal and Industrial Water Use .......................................................................... 26  
  E. Groundwater Recharge Use ....................................................................................... 26  
  F. Transfer and Exchange Use ....................................................................................... 27  
  G. Other Water Use ......................................................................................................... 28  
  H. Projected Water Use ...................................................................................................... 28  

Section IV. Description of Quantity and Quality of the Water Resources of the Agriculture Water Supplier ....................................................................................................................... 30  
  A. Water Supply Quantity ............................................................................................... 30  
  B. Water Supply Quality ............................................................................................... 34  
  C. Water Quality Monitoring Practices .......................................................................... 36  

Section V. Water Accounting and Water Supply Reliability ................................................... 38  
  A. Quantifying the Water Supplier’s Water Supplies ....................................................... 38  
  B. Quantification of Water Uses .................................................................................... 39  
  C. Overall Water Budget ............................................................................................... 41  
  D. Water Supply Reliability ............................................................................................ 42  
  E. Future Water Supply ............................................................................................... 43  

Section VI. Analysis of Effect of Climate Change ................................................................. 47  
  A. Effects of Climate Change on Water Supply ............................................................. 47  
  B. Effects of Climate Change on Agriculture’s Water Demand ..................................... 48  
  C. Response to Effects of Climate Change .................................................................... 48  

Section VII. Water Use Efficiency Information ..................................................................... 49  
  A. EWMP Implementation and Reporting ................................................................. 49  
  B. Documentation for Non-Implemented EWMPs ....................................................... 54  

Section VIII. Supporting Documentation Agricultural Water Measurement Regulation  
  Documentation .................................................................................................................. 56  
  A. Description of Water Measurement Best Professional Practices ............................. 56  
  B. Engineer Certification and Apportionment .............................................................. 57  
  C. Water Measurement Conversion to Volume ............................................................ 57  
  D. Legal Certification and Apportionment – Legal Access to the Farm-gate ............... 58  
  E. Device Corrective Action Plan .................................................................................. 58  
  F. Farm Gate Measurement and Device Accuracy Compliance .................................. 58  

References ......................................................................................................................... 62
List of Figures

Figure 1. Management Area and Neighboring Water Agencies ..............................................3
Figure 2. Facilities and Water Service Areas ........................................................................9
Figure 3. Generalized Soil Texture Map .............................................................................15
Figure 4. Annual Kern River Supply Under North Kern’s Diversion Rights ..............................22
Figure 5. Map of District in Relation to Groundwater Basin(s) ...............................................32
Figure 6. Groundwater Pumping from District-Owned Deep Wells ......................................33
Figure 7. Typical North Kern Irrigation Turnout ...................................................................56
Figure 8. Histogram of Percent Measurement Error at Individual Turnouts .........................60

List of Tables

Table 1. Summary of Coordination, Adoption and Submittal Activities ...............................6
Table 2. Water Supplier History and Size .............................................................................8
Table 3. Expected Changes to Service Area .........................................................................10
Table 4. Water Conveyance and Delivery System .................................................................11
Table 5. Water Supplier Reservoirs .......................................................................................13
Table 6. Tailwater/Operational Outflow Recovery System ....................................................13
Table 7. Landscape Characteristics .....................................................................................16
Table 8. Summary Climate Characteristics .........................................................................16
Table 9. Detailed Climate Characteristics ..........................................................................17
Table 10. Supplier Delivery System ......................................................................................18
Table 11. Water Allocation Policy .........................................................................................18
Table 12. Actual Lead Times .................................................................................................19
Table 13. Water Delivery Measurements .............................................................................19
Table 14. Water Rate Basis ..................................................................................................20
Table 15. Rate Structure .......................................................................................................20
Table 16. Frequency of Billing ..............................................................................................20
Table 17. Decreased Water Supplies Allocation ...................................................................21
Table 18. Enforcement Methods of Allocation Policies ..........................................................21
Table 19. Representative Year ..............................................................................................22
Table 20. Agricultural Water Use for 2008 (AF) ..................................................................23
Table 21. Agricultural Crop Data for 2008 .........................................................................24
Table 22. Irrigated Acres for 2008 (acres) ...........................................................................25
Table 23. Multiple Crop Information for 2008 (acres) ............................................................25
Table 24. Environmental Water Uses for 2008 ..................................................................25
Table 25. Recreational Water Uses for 2008 .......................................................................26
Table 26. Municipal/Industrial Water Uses for 2008 (AF) ....................................................26
Table 27. Groundwater Recharge Water Uses for 2008 (AF) ...............................................27
Table 28. Transfers and Exchanges Water Uses for 2008 .....................................................27
Table 29. Other Water Uses for 2008 (AF) .........................................................................28
Table 30. Surface Water Supplies (AF) ...............................................................................30
Table 31. Restrictions on Water Sources .............................................................................30
Table 32. Groundwater Basins .............................................................................................31
Table 33. Groundwater Management Plan ..........................................................................31
Table 34. Groundwater Supplies for 2008.................................................................34
Table 35. Drainage Discharge for 2008..................................................................34
Table 36. Surface Water Supply Quality - 2012.....................................................35
Table 37. Drainage Reuse Effects.........................................................................36
Table 38. Water Quality Monitoring Practices.......................................................37
Table 39. Water Quality Monitoring Programs for Surface/Sub-Surface Drainage...37
Table 40. Surface and other Water Supplies for 2008 (AF).................................38
Table 41. Groundwater Supplies Summary for 2008 ..........................................39
Table 42. Effective Precipitation Summary for 2008 (AF)....................................39
Table 43. Applied Water for 2008........................................................................39
Table 44. Quantify Water Use for 2008 (AF).........................................................40
Table 45. Quantify Water Leaving the District for 2008 (AF)...............................40
Table 46. Irrecoverable Water Losses for 2008 (AF)............................................41
Table 47. Quantify Water Supplies for 2008 (AF)...............................................41
Table 48. Budget Summary for 2008 (AF)..............................................................41
Table 49. Report of EWMPs...............................................................................50/52
Table 50. Schedule to Implement EWMPs............................................................53
Table 51. Report of EWMPs Efficiency Improvements.........................................54
Table 52. Non-Implemented EWMP Documentation............................................55
North Kern Water Storage District – Agricultural Water Management Plan

List of Appendices (included as attachments)

Appendix A. Public Hearing Notice
Appendix B. Public Hearing Notification Letters
Appendix C. Resolution of Plan Adoption
Appendix D. North Kern WSD: Rules and Regulations for Distribution and Use of Water
Appendix E. Water Meter Accuracy Verification Form

List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF</td>
<td>acre-feet</td>
</tr>
<tr>
<td>AWMP</td>
<td>Agricultural Water Management Plan</td>
</tr>
<tr>
<td>cfs</td>
<td>cubic feet per second</td>
</tr>
<tr>
<td>CIMIS</td>
<td>California Irrigation Management Information System</td>
</tr>
<tr>
<td>CVC</td>
<td>Cross Valley Canal</td>
</tr>
<tr>
<td>CVP</td>
<td>Central Valley Project</td>
</tr>
<tr>
<td>CVRWQCB</td>
<td>Central Valley Regional Water Quality Control Board</td>
</tr>
<tr>
<td>DWR</td>
<td>Department of Water Resources</td>
</tr>
<tr>
<td>EC</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>ET</td>
<td>Evapotranspiration</td>
</tr>
<tr>
<td>ETc</td>
<td>Crop evapotranspiration</td>
</tr>
<tr>
<td>ETo</td>
<td>Reference evapotranspiration</td>
</tr>
<tr>
<td>EWMP</td>
<td>Efficient Water Management Practice</td>
</tr>
<tr>
<td>ID</td>
<td>Irrigation District</td>
</tr>
<tr>
<td>IRWMP</td>
<td>Integrated Regional Water Management Plan</td>
</tr>
<tr>
<td>GWMP</td>
<td>Groundwater Management Plan</td>
</tr>
<tr>
<td>KCWA</td>
<td>Kern County Water Agency</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Groundwater Assistance</td>
</tr>
<tr>
<td>M&amp;I</td>
<td>Municipal and Industrial</td>
</tr>
<tr>
<td>MUD</td>
<td>Municipal Utility District</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>RRID</td>
<td>Rosedale Ranch Improvement District</td>
</tr>
<tr>
<td>RWWMG</td>
<td>Regional Water Management Group</td>
</tr>
<tr>
<td>USACE</td>
<td>U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>UWMP</td>
<td>Urban Water Management Plan</td>
</tr>
<tr>
<td>SBx7-7</td>
<td>Water Conservation Act of 2009</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SWP</td>
<td>State Water Project</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>WSD</td>
<td>Water Storage District</td>
</tr>
</tbody>
</table>
AGRICULTURAL WATER MANAGEMENT PLAN

Section I. Plan Preparation and Adoption

The North Kern Water Storage District (North Kern, North Kern WSD, or District) Agricultural Water Management Plan (AWMP) has been prepared in accordance with the requirements of the Water Conservation Bill of 2009 (SBx7-7, Water Code §10820). Figure 1 is a map showing the location of the District. Because the District serves an area greater than 25,000 acres and was formed before December 31, 2012, North Kern is among the water suppliers required to prepare a plan. Development of the plan has been supported by a grant for $50,000 from the Department of Water Resources (DWR).

This document conforms to the framework presented in A Guidebook to Assist Agricultural Water Suppliers to Prepare a 2012 Agricultural Water Management Plan (Guidebook) that was issued by the DWR on October 12, 2012 to aid water suppliers in preparing Agricultural Water Management Plans in accordance with the requirements of SBx7-7. Although this plan was prepared in conformance with the Guidebook, some of the requirements presented in the Guidebook, such as consideration of facilitating alternative uses for lands with exceptionally high water duties or whose irrigation contributes to significant problems, are not applicable to the District’s facilities or operations.

The requirements introduced by SBx7-7 are intended to encourage agricultural water suppliers to assess current efficient water management practices, to evaluate additional practices that may conserve water, and to provide for the accurate measurement of water. As such, the AWMP process presents an opportunity for water suppliers to demonstrate existing and planned activities and programs designed to improve water use efficiency.

Included in Section VII of this plan is an analysis of each of the Efficient Water Management Practices (EWMPs) presented in the Guidebook. The EWMPs are grouped into the following categories:

- Critical Efficient Water Management Practices
  1. Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of California Water Code Section 531.10 and to implement paragraph (2) of the legislation.
  2. Adopt a pricing structure for water customers based at least in part on quantity delivered.

- Conditional Efficient Water Management Practices
  1. Facilitation of alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including problem drainage.
  2. Facilitation of use of available recycled water that otherwise would not be used beneficially, meets health and safety criteria, and does not harm crops or soils. The use of recycled urban wastewater can be an important element in overall water management.
3. Facilitate the financing of capital improvements for on-farm irrigation systems.

4. Implement an incentive pricing structure that promotes one or more of the following goals:
   A. More efficient water use at the farm level such that it reduces waste;
   B. Conjunctive use of groundwater;
   C. Appropriate increase of groundwater recharge;
   D. Reduction in problem drainage;
   E. Improved management of environmental resources, and
   F. Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.

5. Expand lined or piped distribution systems, construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance, and reduce seepage.

6. Increase flexibility in water ordering by, and delivered to, water customers within operational limits.

7. Construct and operate supplier operational outflow and tailwater systems.

8. Increase planned conjunctive use of surface water and groundwater within the supplier service area.


10. Facilitate or promote customer pump testing and evaluation.

11. Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports.

12. Provide for the availability of water management services to water users. These services may include, but are not limited to, all of the following:
   A. On-farm irrigation and drainage system evaluations;
   B. Normal year and real-time irrigation scheduling and crop evapotranspiration information;
   C. Surface water, groundwater, and drainage water quantity and quality data, and
   D. Agricultural water management educational programs and materials for irrigators.

13. Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional change to allow more flexible water deliveries and storage.

14. Evaluate and improve the efficiencies of the suppliers’ pumps.
North Kern Water Storage District – Agricultural Water Management Plan


MILEAGE SCALE

North Kern Water Storage District
Kern County, California

Agricultural Water Management Plan

GEI Consultants

AUGUST 2014

FIGURE 1
A. Description of Previous Water Management Activities

Water management activities previously implemented or now being implemented by the District include:

- Encourage and facilitate the construction of irrigation distribution system facilities to lands which rely exclusively on pumped groundwater for the purpose of expanding the District’s capability to deliver surface water in lieu of groundwater pumping.
- Deliver surface water in lieu of groundwater pumping when practicable; use water pricing, as appropriate, to encourage such deliveries.
- Maximize use of available surface water supplies for irrigation and spreading; use water pricing, water exchanges, and water banking as appropriate.
- Enter into temporary contracts for CVP water which is available from time to time on the Friant-Kern Canal.
- Develop water exchanges and/or water banking arrangements that result in a net increase in District water supplies, when practicable.
- Encourage USACE to expedite the “fix” for Isabella Dam deficiencies and remove the storage restriction that has been in place since 2006.
- Maintain existing recharge capability in areas of the District that urbanize.
- Encourage and support neighboring water agencies with the importation of available surface water supplies.
- Recharge the aquifer with high quality surface water.
- Promote water use efficiency through financial support of the North West Kern RCD-DWR Mobile Laboratory and by encouraging landowners to take advantage of this resource by requesting field irrigation evaluations.
- Actively participates in regional water management planning through the Poso Creek Regional Water Management Group. The District also participates in local water resource management forums, including the Semitropic Water Storage District’s Groundwater Monitoring Committee, the Kern River Watershed Water Quality Coalition, the Kern Fan Monitoring Committee, and the Kern Groundwater Management Committee.
- Expand the District’s website to include data on groundwater levels and quality.
- Encourage the installation of flow meters on private wells.
- Identify wells monitored by DWR or the Kern County Water Agency (KCWA) and consolidate water level readings from these wells with readings from wells measured by North Kern.
- Identify wells which are sampled for water quality by DWR or KCWA.
As noted above, the District participates in area-wide, regional, watershed or basin-wide water management planning though the Poso Creek Regional Water Management Group.

**B. Coordination Activities**

1. **Notification of AWMP Preparation**

SBx7-7 does not specify how much advance time is required for notification of cities and counties of plan preparation, does not require notification to any other agency(s) and does not require that comments from any city, county or other agency must be solicited and considered. In complying with these provisions, North Kern notified the entities shown in Table 1. Appendix A presents the public notice of plan preparation, and Appendix B includes Public Hearing Notification Letters.

2. **Public Participation**

Public participation activities associated with preparation of the AWMP are presented in Table 1.

**C. Plan Adoption and Submittal**

The purposes of this AWMP are to assess North Kern’s current and planned water management operations and to respond to the provisions of SBx7-7, the associated Agricultural Water Management Planning Act (Section 1, Part 2.8, Division 6 of the Water Code), and the subsequent Agricultural Water Measurement Regulation requirements (described in Title 23 California Code of Regulations). The plan describes the District’s status in implementation of two new mandatory EWMPs and includes a discussion of the potential impacts of climate change on District operations. The two new mandatory EWMPs required by SBx7-7 are:

- Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement paragraph (2) of the legislation.
- Adopt a pricing structure for water customers based at least in part on quantity delivered.

The plan includes an analysis confirming that the District is in compliance with the legislation’s requirements, noted above, regarding 1) delivery measurement, and 2) volumetric pricing.

1. **Plan Adoption**

In preparing this plan, North Kern solicited public input by holding a public hearing and inviting oral and written comments prior to adoption of the plan at a Board of Director’s meeting on _____, 2014. Table 1 shows the state and local interested parties who were notified of and/or provided input to this AWMP. Appendix C of this document includes a Resolution of Plan Adoption. The first update of the plan will be submitted to DWR by December 31, 2015 and will be based on a revised Guidebook expected to be issued by DWR in early 2015. Subsequent to this first update, the plan will be updated on a 5-year cycle. North Kern is a public entity but was not a signatory to the 1999 MOU with the Agricultural Water Management Council and is not a CVP contractor. Therefore, the District has not
prepared either an AWMP or a USBR management/conservation plan in the past.

2. Plan Submittal
The steps to be followed in submittal of AWMPs are described in the Guidebook and are outlined in Table 1. A copy of the adopted plan was submitted to DWR and the other entities shown on Table 1 on ___, 2014.

3. Plan Availability
The requirements for availability of the District’s AWMP are presented in A Guidebook to Assist Agricultural Water Suppliers to Prepare a 2012 Agricultural Water Management Plan. The District’s compliance with these requirements is shown in Table 1.

The AWMP, as adopted by the District, will be available from the District by request.

<table>
<thead>
<tr>
<th>Potential Interested Parties</th>
<th>Notified of Plan Preparation</th>
<th>Assisted in Preparation</th>
<th>Received Draft Plan</th>
<th>Notified of Public Meetings</th>
<th>Notified of Intention to Adopt</th>
<th>Sent Copy of Adopted Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>County of Kern</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>City of Shafter</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>City of Wasco</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DWR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bakersfield Public Library</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>California State Library</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

D. Plan Implementation
North Kern is implementing EWMPs based upon the program described in Section VII of this AWMP. These EWMPs include improvements to district operations that enhance water management and promote water conservation as well as the EWMPs mandated by SBx7-7 that promote water measurement and volumetric pricing.
Section II. Description of the North Kern Water Storage District and Service Area

A. Physical Characteristics

The North Kern WSD, established in 1935, is a public agency which supplies surface water from the Kern River and groundwater to primarily agricultural customers. About 52,000 acres of the 60,000 gross acres (87 percent) in the North Kern service area have been essentially fully developed to irrigated agriculture for over forty years; however, cropping patterns have varied over the years.

Most of the water in the Kern River comes from snowmelt, with peak runoff occurring from April through July, during which time about two-thirds of the annual flow volume occurs. Historically, the supply available to North Kern from this source has ranged from less than 10,000 acre-feet in a “dry” year to nearly 400,000 acre-feet in a “wet” year. Owing to the highly variable Kern River supply, North Kern supplements available surface water supplies with pumped groundwater in “dry” years, and recharges the underlying groundwater using spreading ponds (about 1,500 acres) in “wet” years.

1. Size of the Service Area

The District was organized in 1935 and adopted its “Project Report” in 1950, with implementation of improvements laid out in the report beginning shortly thereafter. Fundamentally, the Project provided for the District to purchase the right in perpetuity to all water accruing under various Kern River “pre-1914” water rights. Because the river rights purchased by North Kern were largely “junior” rights and subject to large swings in yield depending on river hydrology, the Project Report also described a series of projects focused on “re-regulating” these highly variable supplies for the purpose of “maintaining economic pumping lifts” for landowners within the District. Re-regulation was primarily to be accomplished through construction and operation of “recharge/spreading ponds” to maximize the capture of wetter year river supplies accruing to the rights and groundwater wells to “recover” previously recharged water in drier years when surface supplies accruing to the rights were limited.

To supplement its “base” Kern River supplies described above, the District entered into an additional Kern River water supply contract with the City of Bakersfield in 1976. Although the “basic term” of this contract expired at the end of 2011, the contract continues pursuant to “extension term” provisions and is expected to continue to provide water supplies to the District in the future, particularly during wetter years. In addition to its Kern River supplies, the District uses occasional flows available from Poso Creek and takes advantage of other supplies available from the State Water Project (SWP) and the Federal Central Valley Project (CVP) from time to time. These water supplies have allowed the District to maintain a positive long-term supply balance, primarily for agricultural purposes.

The District is comprised of two service areas; a surface water service area (Class 1) and a groundwater service area (Class 2), each comprising about one-half of the District’s area. These service areas are identified on Figure 2. North Kern delivers surface water and/or pumped groundwater to satisfy all of the irrigation water requirements of the surface water service area. The remaining one-half of the
District principally relies on groundwater pumped through the use of on-farm wells; however, to the extent that the District has water available for spreading (i.e., over and above the needs of the surface water service area) and there is an irrigation demand that can be physically reached, surface water is delivered to the Class 2 service area as well.

In addition to the 60,000-acre “old District”, since 1980, North Kern has also serviced approximately 9,200 acres of additional land referred to as the Rosedale Ranch Improvement District (RRID). This area is located immediately to the south of the “old District” (near the City of Bakersfield) and has a distribution system with the capacity to meet the irrigation water requirements of all irrigated lands. The Improvement District does not benefit from the same water rights that are available to the “old District”; accordingly, groundwater remains the principal source of water within RRID, with surface water being purchased and delivered by North Kern on an “as-available” basis, which is relatively infrequent. Because RRID does not hold the same water rights as North Kern and does not have access to the same sources of water, RRID is not included in the plan’s water balance or in the discussion of water management practices. The RRID service area is identified on Figure 2.

| Table 2. Water Supplier History and Size |
|-------------------------------|--------|
| Date of Formation              | 1935   |
| Source of water                |        |
| Local surface water            | X      |
| Local groundwater              | X      |
| Gross acreage at time of formation | 61,854 acres |
| Gross acreage - current service area (2012) – Old District | 60,000 acres |
| Gross acreage – current service area (2012) – RRID         | 9,200 acres |
| Current irrigated acreage (2012) – Old District             | 52,936 acres |
| Current irrigated acreage (2012 ) - RRID                     | 7,400 acres |

North Kern is governed by a five-member Board of Directors. Each member represents a geographical area within the District known as a division. Each board member must be a landowner (or a representative of a landowner) within the District and be elected by the landowners within their division.
Land use within North Kern is primarily agricultural. In the 1950s, at the time of North Kern’s original project, the District’s lands were developed almost exclusively to annual crops. Currently, permanent crops, principally nuts and grapes, account for about 85 percent of the irrigated area. In the past, the principal annual crops have included cotton, tomatoes, and wheat. While the cropping pattern has changed over time, the total farmed acreage has varied with the economics of farming. Going forward, it is reasonable to anticipate that the farmed acreage will continue to evidence modest annual fluctuations without any increasing trend (since the District is essentially fully developed) or decreasing trend.

Where farm lands in North Kern are proximate to urban areas, there has been pressure to convert these lands to urban uses. Urbanization is occurring throughout the Kern County Subbasin and other water districts are also facing this issue. To date, the Rosedale Ranch area has been the primary target for urbanization as the City of Bakersfield expands to the north. Approximately 1,000 acres have been annexed to the City of Bakersfield since formation of the Improvement District in 1980. Rosedale Ranch continues to carry on discussions with appropriate agencies to help ensure the management of the groundwater resource. In 2006, the City of Shafter annexed about 5,200 acres located within North Kern, generally in the area bounded on the south by Seventh Standard Road and extending north about five miles. Most of the annexed land remains in irrigated agriculture. The anticipated magnitude of the urbanization trend to both North Kern and RRID, in terms of land use, is shown in Table 3.

### Table 3. Expected Changes to Service Area

<table>
<thead>
<tr>
<th>Change to Service Area</th>
<th>Estimate of Magnitude</th>
<th>Cause of Change</th>
<th>Effect on Water Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Service Area</td>
<td>Negligible</td>
<td>Urbanization</td>
<td>No substantive impact</td>
</tr>
<tr>
<td>Increased Service Area</td>
<td>Negligible</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Reduction in Irrigated Area</td>
<td>Negligible</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

2. Location of the Service Area and Water Management Facilities

North Kern is located in Kern County, west of U.S. Highway 99, southwest of the City of McFarland, northwest of the City of Bakersfield, and east of the cities of Shafter and Wasco. As noted previously, while most of North Kern lies north of Seventh Standard Road, those lands lying south of Seventh Standard Road fall into Rosedale Ranch Improvement District. Figure 1 illustrates the District’s location within Kern County. Neighboring irrigation districts are Cawelo WD to the east, Shafter-Wasco ID and Semitropic WSD to the west, and Southern San Joaquin MUD to the north. Similar to North Kern, these other water districts rely on surface water supplies for irrigation from the SWP, the CVP and the Kern River to supplement groundwater supplies.

North Kern and neighboring districts overlie a common groundwater basin. Due to concerns regarding the future reliability of historically available surface water supplies, in 2007 North Kern and other districts and entities in the Poso Creek region prepared the Poso Creek Integrated Regional Water Management Plan (Poso Creek IRWMP) that identified potential new facilities and “non-structural”
measures to improve intra- and inter-district management of water supplies. The overarching goal of the Poso Creek IRWMP is to maximize the capture and use of surface water supplies available to the region and thereby reduce the impacts of existing and potential regional loss of water supply reliability.

Delivery of surface water and groundwater in North Kern is accomplished through a network of largely unlined canals; however, the system also includes some pipelines and lined canals. The District’s principal supply artery, and the most upstream of its two points of diversion from the Kern River, is the Beardsley-Lerdo system. This system is entirely gravity and consists of the diversion structure, or headworks, on the Kern River and a canal which delivers water along the eastern or “high” side of the District. The lined portion of this canal extends from the headworks to the District’s boundary and is referred to as the Beardsley Canal, while the portion within North Kern is unlined and is referred to as the Lerdo Canal. Up to 850 cfs has been conveyed through the Beardsley Canal for delivery into the District. The second point of diversion, located about 4.5 miles downstream of the first, is the Calloway Headworks which serves the relatively large, unlined section of the Calloway Canal. This facility is also entirely gravity and extends for 10.4 miles before entering the District at Seventh Standard Road. This “wet-year” facility has a capacity of 1,000 cfs at the headworks. Distribution laterals are generally unlined ditches and deliver water to farm turnouts by gravity from the previously-described main conveyance facilities. The main conveyance canals and distribution laterals within North Kern are shown on Figure 2.

Typically, District-owned wells are only used during “dry” years when surface water supplies are inadequate. Groundwater is delivered to customers during dry years via a network of small, lined canals running parallel to the larger, unlined canals used for conveyance of surface water. The District owns and operates about 100 wells at locations shown in Figure 2. Approximately 200 privately-owned wells in the Class 2 service area are used to meet irrigation demands in this part of the District.

Poso Creek traverses the north part of the District, however, significant flows from this creek are infrequent, and it is dry much of the time. The District holds a water rights permit for the diversion and use of Poso Creek water. An agreement with Cawelo WD and Semitropic WSD provides for allocation of Poso Creek water among the three districts. In addition, the channel of Poso Creek is periodically used for groundwater recharge with other surface water supplies available to North Kern. Water is only recharged in Poso Creek when the stream bed is dry so water introduced for recharge does not contribute to the creek’s natural flow. Table 4 provides a summary of existing irrigation facilities in North Kern.

### Table 4. Water Conveyance and Delivery System

<table>
<thead>
<tr>
<th>System Used</th>
<th>Number of Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined Canals</td>
<td>130</td>
</tr>
<tr>
<td>Lined Canals</td>
<td>20</td>
</tr>
<tr>
<td>Pipelines</td>
<td>20</td>
</tr>
<tr>
<td>Drains</td>
<td>0</td>
</tr>
</tbody>
</table>

1 The Poso Creek IRWMP was initially adopted in 2007; however, a 2014 Plan Update was recently prepared and adopted, which brings the Plan into compliance with “Proposition 84” standards.
North Kern relies heavily on storage and recovery of groundwater for the year-to-year regulation which is required to manage North Kern’s highly variable Kern River supplies. Seasonal regulation and some year-to-year regulation are provided by the District’s use of conservation storage space in Isabella Reservoir.

The U.S. Army Corps of Engineers (USACE) constructed Isabella Dam in the 1950s and is responsible for day-to-day operations. Isabella Reservoir, with a total storage capacity of 568,500 acre-feet, is located well to the east of the District in the southern Sierra Nevada Mountains. Later, in the 1960s, the District contracted with the United States to acquire conservation storage capacity in Lake Isabella as a means to further regulate its Kern River supplies. Surface water supplies regulated in Isabella Reservoir are used conjunctively with the groundwater storage underlying the District.

Isabella Reservoir is a multiple purpose water storage facility with the primary mission being flood control. Flood control operating criteria developed by the USACE require that total reservoir storage be no more than 170,000 acre-feet by November 1 of each year, unless otherwise approved by USACE. Historically, the maximum total reservoir storage approved by USACE has been 245,000 acre-feet. With a minimum pool of 30,000 acre-feet, North Kern’s carryover storage ranges from about 34,000 to 48,000 acre-feet.

In addition to flood control, the reservoir is used to storing water for irrigated agriculture, release water to generate electricity, and as a recreation and water sports facility. North Kern is not responsible for maintenance of the reservoir but does pay its allocated share of maintenance costs based on a contract with the USACE.

North Kern’s share of the available conservation space in the reservoir ranges from 24 to 34 percent. Based on the reservoir’s capacity at the spillway crest, this implies a range of about 129,000 to 183,000 acre-feet. However, current storage restrictions have reduced this range to about 79,000 to 112,000 acre-feet.

The District has small volumes of operational storage available in mid-system reservoirs within its service area. However, since this storage is used exclusively for canal regulation, this reservoir capacity is not included in Table 5.
Table 5. Water Supplier Reservoirs

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Capacity (AF)</th>
<th>North Kern’s Storage Rights (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isabella Reservoir (at Spillway Crest)</td>
<td>568,500</td>
<td>129,000 - 183,000</td>
</tr>
<tr>
<td>Isabella Reservoir (with USACE storage restriction)</td>
<td>360,000</td>
<td>79,000 – 112,000</td>
</tr>
<tr>
<td>Isabella Reservoir (carryover storage)</td>
<td>170,000</td>
<td>34,000 – 48,000</td>
</tr>
<tr>
<td>North Kern Reservoirs*</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Small operational storage facilities within North Kern WSD, not included in AWMP budget.

The majority of land within the District’s service area is well drained, and the need for on-farm surface drainage is minimal since the majority of irrigated farmland is irrigated with low-volume application methods. Table 6 summarizes the existence of tailwater/operational outflow recovery systems. Currently, North Kern has no District-operated recovery system, while the number of on-farm operated tailwater/operational outflow recovery systems is minimal.

Table 6. Tailwater/Operational Outflow Recovery System

<table>
<thead>
<tr>
<th>System</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>District Operated Tailwater Recovery</td>
<td>No</td>
</tr>
<tr>
<td>Landowner Operated Tailwater Recovery</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Following is a list of recent key improvements made to North Kern maintained canals and conveyance channels; refer to Figure 2 for specific canal names. This list supplements the description of previous water management activities presented in Section 1 and the description of specific EWMP implementation and reporting included in Section VII (Table 49).

- Installed new pump station and one mile of 96-inch diameter concrete pipe to convey water from the Calloway Canal to the Lerdo Canal, a 40-foot lift. This improvement increases the District’s ability to take advantage of CVP supplies that become available from time to time from the Friant-Kern Canal (typically during “wet” years) by allowing such water to reach all of the District’s irrigation demand and spreading ponds. In addition, it eliminated a portion of the 8-1 Canal and the associated canal seepage. [Calloway-to-Lerdo Intertie]

- Installed a lined canal between the Calloway Canal and the Cross Valley Canal (CVC), including a new turnout on the CVC, all of which increases the District’s ability to divert and utilize water supplies that are available in the California Aqueduct from time to time and to facilitate water management exchanges. [Calloway-to-CVC Intertie]

- Converted the 8-9 and 9-6 canals into pipeline conveyances, which eliminated potential seepage and evaporation losses.
• Implemented Supervisory Control and Data Acquisition (SCADA) monitoring to check water levels at strategic locations in the District’s distribution system and prevent overflow of regulating reservoir storage.

• Lined portions of the Calloway Canal with bentonite to reduce seepage potential, specifically in areas that were known to exhibit relatively high rates of seepage.

• Replaced old, worn-out propeller meters (McCrometer and Seametrics models) at turnouts with new meters.

• Implemented iPhone scanning and real-time water meter reading network so water consumer usage can be uploaded to the District’s server and accounting program. This has reduced human error in reporting water usage and has assisted in verifying compliance with SBx7-7 delivery volume measurements.

3. Terrain and Soils

The North Kern Water Storage District is located on the valley floor of the southern portion of the San Joaquin Valley, a physiographic trough. The northwest-southeast trending valley is bounded by the Sierra Nevada Range to the east, the Tehachapi Mountains to the south and the Temblor Range and Coast Range to the west. The valley floor is characterized by low alluvial plains and fans and by overflow lands and old lakebeds.

Alluvial deposits in the Kern County sub-basin generally consist of sand, silt, and clay laid down in a complex sequence principally by the Kern River, Poso Creek, Deer Creek, the White River, small drainages along the Sierra Nevada Mountains to the east, and to a lesser extent, by streams along the Coast Range to the west. The terminus for these flows in the geologic past was Tulare Lake, located to the north of Kern County on the west side of the San Joaquin Valley. The axis of the San Joaquin Valley Basin along the west side of the valley has been subsiding over time and, as a generalization, the sediments tend to dip and thicken towards the axis of the basin and pinch out on the east and west edges. The District’s service area is flat with land surface elevations ranging from over 320 feet above sea level on the east to less than 300 feet above sea level on the west.

The predominant irrigation systems in North Kern are above-ground drip systems for permanent orchard and vineyard crops. Annual crops are irrigated largely with hand-move sprinkler systems. Over the last five years, the percentage of acreage irrigated by each of the systems noted above has remained constant.

The soil types in Kern County vary in structure, texture, and chemistry with geographical location. Valley floor soils within North Kern are derived mostly from mixed granitic and sedimentary rocks and are characterized as saline-alkaline. The generalized soils map units or soil associations underlying the area are described in the published soil survey for northwestern Kern County and are presented in Figure 3. A general soil map unit consists of one or more major soil types and some minor soils that occur together in a recognizable pattern.
Soils are described in this report in terms of associations because of the size of the District and because of their similarities to each other. Soils within the District do not have any identifiable impacts upon water operations and management in the service area.

Table 7 summarizes the topographic characteristics of the irrigated lands.

**Table 7. Landscape Characteristics**

<table>
<thead>
<tr>
<th>Topography Characteristic</th>
<th>Percent of the District</th>
<th>Effect on Water Operations and Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Land</td>
<td>100%</td>
<td>Land is adaptable to sprinkler and micro irrigation systems</td>
</tr>
</tbody>
</table>

4. **Climate**

North Kern lies at the southern end of the San Joaquin Valley, a portion of the valley that is partially surrounded by a horseshoe-shaped ring of mountains. The Sierra Nevada Mountains to the east shut out most of the cold air that flows southward over the continent in winter. It also catches and accumulates snow, which provides irrigation water for use during the dry summer months.

Summers are typically hot and dry. The average length of the growing season is 265 days, typically lasting from March to November. December and January are characterized by frequent fog or low clouds which occur mostly at night. These conditions prevail when cold, moist air is trapped in the valley by a high pressure system. In extreme cases, fogginess or cloudiness may occur continuously for two to three weeks. The depth of the fog or clouds is usually less than 3,000 feet. Under these conditions, there usually are clear skies and mild temperatures in the surrounding foothill and mountain areas. Most of the precipitation occurs in the winter with little to none occurring during the summer months of June through August. By contrast, rates for evaporation and transpiration are low in the cooler, wetter months and peak during the hot, dry summer growing season.

Table 8 summarizes climate data from the CIMIS station at the City of Shafter. Temperatures in the summer are typically in the upper 90s and nights are fairly warm. Throughout the year, the mean temperatures vary from 38°F in December to 98°F in July. Annual precipitation typically ranges between five to seven inches. More detailed climatic data from the Shafter station are presented in Table 9.

**Table 8. Summary Climate Characteristics**

<table>
<thead>
<tr>
<th>Climate Characteristic</th>
<th>Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Precipitation</td>
<td>5.80 inches</td>
</tr>
<tr>
<td>Minimum Monthly Precipitation</td>
<td>0 inches</td>
</tr>
<tr>
<td>Maximum Monthly Precipitation</td>
<td>5.97 inches</td>
</tr>
<tr>
<td>Minimum Temperature (Avg. December Minimum)</td>
<td>38.3 °F</td>
</tr>
<tr>
<td>Maximum Temperature (Avg. July Maximum)</td>
<td>98.5 °F</td>
</tr>
</tbody>
</table>

*Obtained from DWR CIMIS data for Shafter/USDA Station #5.
Table 9. Detailed Climate Characteristics

<table>
<thead>
<tr>
<th>Month/Time</th>
<th>Average Precipitation (inches)</th>
<th>Average Reference ET₀ (inches)*</th>
<th>Average Minimum Temperature, °F</th>
<th>Average Maximum Temperature, °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>0.9</td>
<td>1.60</td>
<td>38.6</td>
<td>56.9</td>
</tr>
<tr>
<td>February</td>
<td>1.1</td>
<td>2.41</td>
<td>42.6</td>
<td>63.9</td>
</tr>
<tr>
<td>March</td>
<td>1.0</td>
<td>4.36</td>
<td>45.8</td>
<td>68.9</td>
</tr>
<tr>
<td>April</td>
<td>0.6</td>
<td>5.67</td>
<td>50.1</td>
<td>75.9</td>
</tr>
<tr>
<td>May</td>
<td>0.2</td>
<td>6.96</td>
<td>57.3</td>
<td>84.6</td>
</tr>
<tr>
<td>June</td>
<td>0.1</td>
<td>8.12</td>
<td>64.0</td>
<td>92.4</td>
</tr>
<tr>
<td>July</td>
<td>0.0</td>
<td>8.10</td>
<td>69.6</td>
<td>98.5</td>
</tr>
<tr>
<td>August</td>
<td>0.1</td>
<td>7.75</td>
<td>68.5</td>
<td>96.6</td>
</tr>
<tr>
<td>September</td>
<td>0.2</td>
<td>5.74</td>
<td>63.5</td>
<td>90.1</td>
</tr>
<tr>
<td>October</td>
<td>0.3</td>
<td>3.97</td>
<td>54.8</td>
<td>80.7</td>
</tr>
<tr>
<td>November</td>
<td>0.7</td>
<td>1.82</td>
<td>44.7</td>
<td>66.8</td>
</tr>
<tr>
<td>December</td>
<td>0.6</td>
<td>0.99</td>
<td>38.3</td>
<td>56.5</td>
</tr>
<tr>
<td>Wet Season</td>
<td>4.3**</td>
<td>11.18**</td>
<td>42.0***</td>
<td>62.6***</td>
</tr>
<tr>
<td>Dry Season</td>
<td>1.5**</td>
<td>46.31**</td>
<td>61.1***</td>
<td>89.4***</td>
</tr>
<tr>
<td>Annual</td>
<td>5.80**</td>
<td>57.49**</td>
<td>53.2***</td>
<td>77.7***</td>
</tr>
</tbody>
</table>

*Obtained from DWR CIMIS data for Shafter/USDA Station #5. “Wet Season” constitutes average of November through March; “Dry Season” covers remaining months (April through October).
**Total seasonal and annual values
***Average of seasonal and annual monthly values

B. Operational Characteristics

1. Operating Rules and Regulations

North Kern’s adopted Rules and Regulations for Distribution and Use of Water (Rules and Regulations) is the guideline for District operations and delivery of water (included as Appendix D). The Rules and Regulations cover the procedures which are followed to distribute irrigation water in an orderly, efficient, and equitable manner.

As presented in the Rules and Regulations, water orders are to be placed a minimum of 48 hours prior to the time that service is requested, and water deliveries run continuously until the scheduled amount of water has been delivered. No “turn on” orders are accepted for less than a 24-hour period unless special arrangements have been made with the District or the District has in effect a less-than-24 hour-program where water users can place orders for periods of fewer than 24 hours. For the purpose of properly scheduling District activities and facilities, “turn off” orders are given at the same time as “turn on” orders.

Although the Rules and Regulations describe North Kern’s obligations for water delivery, in practice, the District strives to accommodate growers’ water orders, regardless of notice, so long as the orders can
be delivered without disrupting other scheduled orders. Therefore, North Kern routinely operates as a scheduled on-demand system. On the day a water order is put into effect, one of the district’s canal tenders turns the delivery gate on or off, in accordance with the scheduled delivery, at the time a canal tender passes the gate on his regular run. Generally, turn ons, turn offs and adjustments are made in the mornings. Whenever possible, service is provided as requested; however, at times, the District may require the rescheduling of service due to capacity limitations within the District’s distribution system or necessary shutdowns for emergencies beyond the District’s control.

Table 10. Supplier Delivery System

<table>
<thead>
<tr>
<th>Type</th>
<th>Check if Used</th>
<th>Percentage of System Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Demand</td>
<td></td>
<td>0 %</td>
</tr>
<tr>
<td>Arranged Demand</td>
<td>X (48 hr notice)</td>
<td>100 %</td>
</tr>
<tr>
<td>Rotation</td>
<td></td>
<td>0 %</td>
</tr>
</tbody>
</table>

North Kern delivers nearly all of the irrigation water required in the Class 1 Service Area, and deliveries to the Class 2 Service Area are made to the extent supplies are available. Table 11 illustrates factors used to allocate water in North Kern. These factors are considered in setting the annual water allocation that is applied uniformly across the District.

Table 11. Water Allocation Policy

<table>
<thead>
<tr>
<th>Basis of Water Allocation</th>
<th>(Check if applicable)</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flow</td>
<td>Volume</td>
</tr>
<tr>
<td>Land within the service area</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Reservoir storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian rights</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water year type</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Amount of land owned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted runoff</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although the District makes every reasonable effort to comply with water orders, the conveyance and delivery capabilities of the District’s facilities, as well as the achievement of overall economy of operational costs, make it necessary that at times, and particularly during periods of peak irrigation use, essentially 24-hour operation of facilities be maintained to assure that all water users receive adequate supplies of irrigation water.

In the event of emergencies, water users may turn off the supply of water to their turnout. In these events, water users must immediately notify the district office by telephone or in person. Water users
who do not notify the District and receive authorization prior to the change may be charged a special service fee for each occurrence.

Table 12 illustrates the lead times for requested service, as part of the arranged-demand service, as mentioned earlier.

<table>
<thead>
<tr>
<th>Table 12. Actual Lead Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
</tr>
<tr>
<td>Water orders</td>
</tr>
<tr>
<td>Water shut-off</td>
</tr>
</tbody>
</table>

2. Water Delivery Measurements or Calculations

All deliveries of surface water and groundwater by the District are measured. Meter readings at each turnout are taken every day a turnout is running and also at the end of every month by District staff, using permanently stationed on-farm propeller meters (McCrometer and Seametrics models). Bar code readings are used to ensure the time and location of each measurement and to reduce transcription errors by electronically downloading data into the District’s dispatch office. Most deliveries to irrigators are measured using the on-farm meters, which are periodically checked as part of the District’s maintenance program. The meters provide a very accurate method of water measurement at District turnouts. Table 13 shows levels of accuracy for typical types of measurement devices.

All propeller meters used by the District are equipped with totalizers, which accumulate the volume of flow at each turnout. According to the manual SBx7 Flow Rate Measurement Compliance for Agricultural Irrigation Districts by the Irrigation Training & Research Center of the California Polytechnic Institute, San Luis Obispo, devices with totalizers provide measurements that are sufficiently precise to assume that the flow rate accuracy is equivalent to the calibrated volumetric accuracy. As a result, the devices used by the District to measure delivery rates provide data that enables reliable computation of volumes of water delivered from North Kern canals. Section VIII of this report discusses steps the District is taking to comply with the water measurement requirements of SBx7-7 by verifying the accuracies of metering devices.

<table>
<thead>
<tr>
<th>Table 13. Water Delivery Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Measurement</td>
</tr>
<tr>
<td>Propeller meters</td>
</tr>
<tr>
<td>Weirs</td>
</tr>
<tr>
<td>Pump, runtime</td>
</tr>
</tbody>
</table>

3. Water Rate Schedules and Billing

The North Kern WSD Board of Directors annually establishes a base service charge which is applied on a per-acre basis to all lands and is based on budget requirements and Board policy. Water tolls are based
on available water supply, estimated deliveries, and the revenue required to balance the District’s budget.

Effective February 1, 2013, the water toll rate is $115.00 per acre-foot for Class 1 water and $185.00 per acre-foot for Class 2 water for water users not participating in the “standby” program. Another option for Class 2 water includes a “standby” (i.e. guaranteed allocation) for water delivery including a flat-rate fee of $35.00 charged in May and $150.00 per acre-foot upon delivery.

<table>
<thead>
<tr>
<th>Table 14. Water Rate Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Billing</td>
</tr>
<tr>
<td>Volume of Water Delivered</td>
</tr>
<tr>
<td>Area (acres)</td>
</tr>
<tr>
<td>Crop</td>
</tr>
<tr>
<td>Land Assessment</td>
</tr>
</tbody>
</table>

A different but uniform rate is set for each of the Class 1 and Class 2 service areas each year so as to balance the District’s budget for that year. Table 15 provides this information in tabular form.

<table>
<thead>
<tr>
<th>Table 15. Rate Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Billing</td>
</tr>
<tr>
<td>Uniform</td>
</tr>
</tbody>
</table>

Currently North Kern bills its irrigation water users either at the end of each month, or the first day of the following month, depending on the volume and timing of water deliveries to users. The frequency of billing is shown in Table 16.

<table>
<thead>
<tr>
<th>Table 16. Frequency of Billing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Monthly</td>
</tr>
</tbody>
</table>

4. Water Shortage Allocation Policies

Water supplies on the Kern River vary depending on watershed precipitation, snow melt runoff, and North Kern’s share of the prior year’s carryover storage in Isabella Reservoir. As such, water supply planning must take into consideration the amount of water that will be available during the irrigation season, the current year’s water requirements, and the target carryover storage for the following season.

During years of short surface water supply, North Kern conjunctively uses groundwater, through the operation of District-owned wells, and water users in the Class 2 service area increase their use of groundwater through the operation of private wells. North Kern currently has the well capacity to avoid
prorating deliveries to Class 1 lands, except in extremely dry years such as 2013, which is one of the driest years in the over 100 years of flow records on the Kern River.

Table 17 lists the measures that the North Kern Board may exercise to respond to water shortages.

**Table 17. Decreased Water Supplies Allocation**

<table>
<thead>
<tr>
<th>Allocation Method</th>
<th>Check if Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease Allocated Water</td>
<td>X</td>
</tr>
<tr>
<td>Shorten Irrigation Season</td>
<td>N/A</td>
</tr>
<tr>
<td>Restrict Water to Certain Crops</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The District may refuse to deliver water to irrigators as a consequence for wasting water, either willfully, carelessly, or on account of defective ditches or pipelines. The District may also refuse to deliver water to inadequately prepared land or users who flood certain portions of the land to an unreasonable depth or amount in order to properly irrigate other portions. Water service may be resumed when these conditions have been remedied. Table 18 summarizes enforcement methods available to curtail wasteful water use.

**Table 18. Enforcement Methods of Allocation Policies**

<table>
<thead>
<tr>
<th>Enforcement Method</th>
<th>Check if Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shut-off of Water</td>
<td></td>
</tr>
<tr>
<td>Refuse service</td>
<td>X</td>
</tr>
<tr>
<td>Fines/Penalties</td>
<td></td>
</tr>
</tbody>
</table>

5. **Basis for Reporting Water Quantities**

The nature of North Kern’s water rights is such that there is significant year-to-year variability in the available surface water supplies. In a “dry” year, surface water supplies are very limited and pumping from District-owned-and-operated wells is significant. In a “wet” year, surface water supplies are sufficient not only to satisfy irrigation water requirements (and thereby avoid the use of District-owned deep wells), but to make significant deliveries to spreading ponds for direct groundwater recharge.

Given the high degree of variability in the District’s surface water supplies and operations, a “median” runoff year on the Kern River was considered to be the most appropriate choice for a “representative year”. For example, owing to the high degree of variability, an “average” or greater water supply year occurs in about one out of three years. Additional considerations in the selection of a representative year included that it be a relatively recent year which reflects the “current” level of development. Further, in 2007, a court decision was rendered which affected North Kern’s water rights going forward.

2008 was selected as the year during the period beginning in 2007 when flow in the Kern River most closely approximated the long-term median annual runoff. During 2008, annual natural flow of the Kern River at the First Point of Measurement was only 4 percent below the average annual runoff index computed over the period of record extending from 1894 through 2011. Figure 4 illustrates the variation in Kern River supply under North Kern’s water rights during the period from 1992 through 2012.
The selection of calendar year 2008 as the representative year is presented in Table 19.

<table>
<thead>
<tr>
<th>Description</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representative year based upon</td>
<td>2008</td>
</tr>
<tr>
<td>First month of representative year</td>
<td>January</td>
</tr>
<tr>
<td>Last month of representative year</td>
<td>December</td>
</tr>
</tbody>
</table>
Section III. Description of Quantity of the Water Uses of the Agricultural Water Supplier

North Kern’s principal surface water supply is the Kern River, which is diverted and delivered northward into the District through a largely open canal, gravity system. The District serves approximately 210 accounts with an average of 280 acres per account.

Owing to the highly variable Kern River supply, North Kern supplements available surface water supplies with underlying groundwater resources. During “wet” years, when irrigation water requirements are easily met, significant deliveries of surface water are made to irrigation and spreading (i.e. for groundwater recharge). The District maintains approximately 100 water wells that are used to supplement surface water supplies, primarily during “dry” years.

North Kern is well positioned to participate in exchanges to supplement local water supplies, which involve SWP and CVP supplies owing to its proximity to major SWP and CVP conveyances and service areas.

A. Agricultural Water Use

The primary crops grown within North Kern are deciduous trees (mostly almonds and pistachios), grape vines, grains, row crops, and nursery crops. Improvements in irrigation water delivery systems and changing economic conditions have brought many changes to the crop mix within the District. Nut trees and grapes have been among the crops with the most rapidly expanding acreages, now accounting for around 85 percent of the total irrigated area. During the last several decades, thousands of acres of annual crop land have been converted to these high value permanent crops.

The change from annual to permanent crops has led to a “hardening” of the District’s total water requirements over time, especially in recent years. Table 20 summarizes agricultural water use within the District for 2008.

Table 20. Agricultural Water Use for 2008 (AF)

<table>
<thead>
<tr>
<th>Source</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Water Supplier Delivered</td>
<td></td>
</tr>
<tr>
<td>Surface and groundwater</td>
<td>149,988</td>
</tr>
<tr>
<td>Other (M&amp;I Use)</td>
<td>N/A</td>
</tr>
<tr>
<td>Other Water Supplies</td>
<td></td>
</tr>
<tr>
<td>Surface Water</td>
<td>N/A</td>
</tr>
<tr>
<td>Groundwater (Private Pumping*)</td>
<td>N/A</td>
</tr>
<tr>
<td>Other</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Private pumping exists, but is not reported to the District.

Table 21 presents water needs for specific crops grown within the North Kern service area. The efficiency of on-farm applications and crop water demands vary by crop, soil type, irrigation method and other factors; however, for the purposes of this water balance, a uniform adjustment for crop water
demands in excess of ET was applied to all crops. This adjustment was approximated by comparing the estimated average unit crop ET derived from Table 21 (164,919 ac-ft divided by 52,396 acres or 3.15 ac-ft/ac) with the per-acre volume of Class 1 water deliveries measured by the District in 2008, 92,976 ac-ft. Dividing the volume of delivered water by the area served by Class 1 water, estimated to be 50 percent of the total cropped area served in 2008 or 26,198 acres, yields a Total Crop Water Demand of 3.55 ac-ft/acre, a benchmark assumed to satisfy all water requirements of Class 1 lands.

This benchmark can be met by applying a uniform adjustment of approximately 13 percent to the Crop ET Requirement values presented in Table 21. The 13 percent adjustment for evaporative losses and deep percolation includes a value of 5 percent that major growers in the District commonly apply as a leaching requirement. As noted in Table 45, surface water runoff from irrigated lands in North Kern is negligible. Also, as shown in Table 42, effective precipitation in 2008 was only 3,362 acre-feet (1.8 percent of the Total Crop Water Requirement computed in Table 21).

Table 21. Agricultural Crop Data for 2008

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total Acres</th>
<th>Estimated ETc (ft)</th>
<th>Crop ET Requirement (AF)</th>
<th>Crop Water Demand in Excess of ET (AF)</th>
<th>Total Crop Water Demand (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Hay</td>
<td>3,678</td>
<td>4.10</td>
<td>15,080</td>
<td>1,960</td>
<td>17,040</td>
</tr>
<tr>
<td>Almonds</td>
<td>30,289</td>
<td>3.28</td>
<td>99,348</td>
<td>12,915</td>
<td>112,263</td>
</tr>
<tr>
<td>Peppers</td>
<td>152</td>
<td>1.62</td>
<td>246</td>
<td>32</td>
<td>278</td>
</tr>
<tr>
<td>Grain – Corn</td>
<td>182</td>
<td>2.95</td>
<td>537</td>
<td>70</td>
<td>607</td>
</tr>
<tr>
<td>Grain – Wheat</td>
<td>626</td>
<td>2.07</td>
<td>1,296</td>
<td>168</td>
<td>1,464</td>
</tr>
<tr>
<td>Grapes – Table</td>
<td>5,818</td>
<td>2.81</td>
<td>16,349</td>
<td>2,125</td>
<td>18,474</td>
</tr>
<tr>
<td>Pecans</td>
<td>188</td>
<td>3.34</td>
<td>628</td>
<td>82</td>
<td>710</td>
</tr>
<tr>
<td>Pomegranates</td>
<td>334</td>
<td>3.38</td>
<td>1,129</td>
<td>147</td>
<td>1,276</td>
</tr>
<tr>
<td>Cotton</td>
<td>754</td>
<td>2.71</td>
<td>2,043</td>
<td>266</td>
<td>2,309</td>
</tr>
<tr>
<td>Open Land</td>
<td>1,568</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roses</td>
<td>2,961</td>
<td>3.28</td>
<td>9,712</td>
<td>1,263</td>
<td>10,975</td>
</tr>
<tr>
<td>Pistachios</td>
<td>2,601</td>
<td>4.11</td>
<td>10,690</td>
<td>1,390</td>
<td>12,080</td>
</tr>
<tr>
<td>Apples</td>
<td>1,256</td>
<td>3.45</td>
<td>4,333</td>
<td>563</td>
<td>4,896</td>
</tr>
<tr>
<td>Cherries</td>
<td>27</td>
<td>4.17</td>
<td>113</td>
<td>15</td>
<td>128</td>
</tr>
<tr>
<td>Olives</td>
<td>83</td>
<td>3.59</td>
<td>298</td>
<td>39</td>
<td>337</td>
</tr>
<tr>
<td>Vegetables – Misc</td>
<td>1,723</td>
<td>1.62</td>
<td>2,791</td>
<td>363</td>
<td>3,154</td>
</tr>
<tr>
<td>Others</td>
<td>156</td>
<td>2.09</td>
<td>326</td>
<td>42</td>
<td>368</td>
</tr>
<tr>
<td>TOTAL</td>
<td>52,396</td>
<td>3.15</td>
<td>164,919</td>
<td>21,439</td>
<td>186,358*</td>
</tr>
</tbody>
</table>

* As referenced in the text above, the approximation of total “applied” irrigation volume for the service area from the District’s internal water budget (North Kern WSD 2008) is approximately 185,956 ac-ft, less than one percent different from the computed Total Crop Water Demand presented in this table.

The District’s gross service area now encompasses approximately 60,000 acres. As shown in Table 22, approximately 52,400 acres were irrigated from surface water and groundwater sources in 2008, and the total crop water demand was estimated at about 186,400 acre-feet.
Table 22. Irrigated Acres for 2008 (acres)

<table>
<thead>
<tr>
<th>Service Area</th>
<th>60,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water and Groundwater Irrigated Area</td>
<td>52,396</td>
</tr>
</tbody>
</table>

For the purposes of this report, cropped acres are the same as irrigated acres with the amount of irrigated land not cropped at any time during the year shown in Table 21 as “Open Land”. Over 85 percent of the cropped acres are planted with permanent crops with almonds being the predominant permanent crop with 30,289 acres. Inter-cropping is not a common practice within the North Kern service area.

Table 23. Multiple Crop Information for 2008 (acres)

<table>
<thead>
<tr>
<th>Cropped</th>
<th>52,396*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-cropping</td>
<td>Negligible</td>
</tr>
<tr>
<td>Double cropping</td>
<td>7,306</td>
</tr>
</tbody>
</table>

*Includes crops irrigated with surface water and groundwater.

B. Environmental Water Use

North Kern does not make deliveries of water specifically for environmental purposes. Any environmental water uses realized from District-maintained water supplies are incidental to the District’s operations. In particular, to the extent that there is water in the District’s canals or the 1,500 acres of spreading ponds that are periodically flooded, it is available to local wildlife and provides incidental habitat benefits. The USACE is responsible for Isabella Reservoir operations and any environmental use of water stored in Isabella Reservoir is incidental to that operation.

These potential sources do not qualify as consumptive environmental water uses applicable to the AWMP water balance and Table 24 has been completed accordingly.

Table 24. Environmental Water Uses for 2008

<table>
<thead>
<tr>
<th>Environmental Resources</th>
<th>Volume (AF)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-stream flow releases</td>
<td>0</td>
</tr>
<tr>
<td>Streams</td>
<td>0</td>
</tr>
<tr>
<td>Lakes or reservoirs</td>
<td>0</td>
</tr>
<tr>
<td>Riparian vegetation</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
</tr>
</tbody>
</table>

*There is no water consumption assigned to environmental water uses.

C. Recreational Water Use

Recreational activities at Isabella Reservoir, also known as Lake Isabella, include camping, fishing, and boating. The USACE is responsible for day-to-day reservoir operations, while the Kern County Parks and Recreation Department administers the recreational activities at the lake. North Kern is not responsible for any recreational activities at Lake Isabella. Recreational use of District water supplies is incidental to the District’s storage of water in the reservoir, which is for the purpose of regulating the
supplies. Accordingly, no consumptive use of water has been assigned North Kern’s water in Isabella storage for the purpose of the water accounting in this plan.

Table 25. Recreational Water Uses for 2008

<table>
<thead>
<tr>
<th>Recreational Facility</th>
<th>Volume (AF)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>

* There is no water consumption assigned to recreational water uses.

D. Municipal and Industrial Water Use

North Kern delivers only raw (non-potable) water throughout its service area; accordingly, there are no direct deliveries for M&I purposes. All M&I water use in the North Kern service area is supplied by groundwater pumping. To date, the City of Shafter, other local communities, rural residences and businesses have relied exclusively on groundwater pumped from the Kern County Subbasin for domestic and commercial uses. When available surface water supplies permit, the District replenishes the underlying groundwater through significant recharge operations which are conducted at multiple spreading pond locations. The spreading operations are carried out in support of the pumping required to satisfy the irrigation water requirements within the District; however, as a practical matter, the same groundwater system supplies both agricultural uses and M&I uses.

In 1952, North Kern entered into an agreement for the use of water rights which limited uses of the water to irrigation, livestock watering, and groundwater replenishment. In 2008, North Kern entered into an amendment to the 1952 agreement which provides for M&I water uses. To date, these uses have been relatively small. In particular, the City of Shafter has pumped less than 1,000 acre-feet for such purposes.

Table 26 summarizes the District’s municipal and industrial water uses.

Table 26. Municipal/Industrial Water Uses for 2008 (AF)

<table>
<thead>
<tr>
<th>Municipal/Industrial Entity</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal Entity</td>
<td>357 (By City of Shafter)</td>
</tr>
<tr>
<td>Industrial Entity</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

E. Groundwater Recharge Use

Indirect recharge occurs to the extent that the District delivers surface water in lieu of pumped groundwater to satisfy irrigation water requirements. Kern River water which is surplus to immediate irrigation requirements and cannot be regulated in the District’s share of conservation storage space available in Isabella Reservoir is available for direct recharge. In this regard, North Kern makes use of over 1,500 acres of spreading ponds, the dry channel of Poso Creek, and unlined canals. The spreading ponds have been in use for over 60 years and consist of relatively small ponds or cells within a given spreading site, separated by contour dikes. There are five sites, which range from about 60 acres up to
about 600 acres, with the locations shown on Figure 2. Since the spreading ponds were constructed in the 1950s, North Kern has spread over 3.25 million acre-feet of water. It is noteworthy that, prior to the development of its extensive spreading grounds, North Kern initiated field experimentation and research in 1936 regarding the use of artificial recharge methods in the southern San Joaquin Valley.

During particularly “wet” years, direct recharge through the use of spreading ponds is significant in the basin. Table 27 lists the acre-feet of water allocated towards groundwater recharge in 2008.

### Table 27. Groundwater Recharge Water Uses for 2008 (AF)

<table>
<thead>
<tr>
<th>Location/Groundwater Basin</th>
<th>Method of Recharge</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>District Spreading Ponds</td>
<td>Spreading of Surface Water</td>
<td>2,384</td>
</tr>
<tr>
<td>District Canal Seepage*</td>
<td></td>
<td>25,377</td>
</tr>
<tr>
<td>Poso Creek*</td>
<td></td>
<td>103</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>27,864</td>
</tr>
</tbody>
</table>

*Values have not been reduced by potential evaporation, represent gross estimates.

**F. Transfer and Exchange Use**

North Kern is well-positioned to participate in exchanges which involve SWP and CVP supplies owing to its proximity to major SWP and CVP conveyances and service areas. Regarding CVP water, it is noted that the Friant-Kern Canal slices through the middle of North Kern from north to south. In addition, two of North Kern’s immediate neighbors are CVP-Friant contractors; namely, the Southern San Joaquin Municipal Utility District and the Shafter-Wasco Irrigation District. Regarding SWP water, the Cross Valley Canal conveys SWP water from the California Aqueduct into the metropolitan Bakersfield area, where water is pumped into North Kern’s Beardsley Canal for delivery to the Cawelo Water District. Though not a long-term CVP contractor, North Kern has purchased CVP water that has been available from time to time, typically during the peak runoff period of wet years, generally through “Section 215” contracts. In this regard it is noteworthy that the District has constructed two turnouts from the Friant-Kern Canal to facilitate such purchases, as well as having instituted water banking and exchange arrangements with neighboring districts. Table 28 summarizes North Kern activity in water exchanges in 2008.

### Table 28. Transfers and Exchanges Water Uses for 2008

<table>
<thead>
<tr>
<th>From What Agency</th>
<th>To What Agency</th>
<th>Type of Transfer or Exchange (Ag to M&amp;I, M&amp;I to Ag, or Ag to Ag)</th>
<th>Volume (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Kern WSD</td>
<td>Semitropic WSD</td>
<td>Agricultural to Agricultural</td>
<td>5,412</td>
</tr>
<tr>
<td>North Kern WSD</td>
<td>Shafter-Wasco ID</td>
<td>Agricultural to Agricultural</td>
<td>2,829</td>
</tr>
<tr>
<td>North Kern WSD</td>
<td>Kern-Tulare WD</td>
<td>Agricultural to Agricultural</td>
<td>361</td>
</tr>
<tr>
<td>North Kern WSD</td>
<td>Kern-Tulare WD</td>
<td>Agricultural to Agricultural*</td>
<td>5,014</td>
</tr>
</tbody>
</table>

*Noted in 2011 AHR as “Friant-Kern Canal Pump-in Deliveries”.

In 2012 North Kern and other members of the Poso Creek Regional Water Management Group (Poso Creek RWMG) completed State (California Environmental Quality Act – CEQA) and Federal (National Environmental Policy Act – NEPA) environmental documents for groundwater banking, transfer, and exchange programs among the members of the RWMG. These programs, which may involve SWP,
CVP and local water supplies, envision the expansion of water management programs among the RWMG in response to reductions in historically available regional surface water supplies as documented in the Poso Creek IRWMP. Expanded water banking, transfer and exchange programs designed to improve regional water management will assist in reducing the adverse impacts on regional groundwater conditions and agricultural operations associated with regional losses of surface water supplies.

As noted elsewhere in this report and in the Poso Creek IRWMP, North Kern has substantial assets to both recharge and recover water supplies for banking, transfer and exchange purposes. North Kern is also faced with potentially large reductions in its historically available Kern River water supplies due largely to the State Water Resources Control Board’s decision in 2010 to remove the Kern River from the “fully appropriated stream” list and proposed actions of the City of Bakersfield and the Kern Delta Water District. Consequently, North Kern must optimize the use of its water and facilities assets through banking, transfer, and exchange programs within the Poso Creek region, and in others areas of Kern County, which can be assisted because of the District’s excellent proximity to the Friant-Kern Canal and CVP “Friant Division” contractors. These actions are necessary for the continuation of viable agricultural operations within the District.

G. Other Water Use

All water uses of any significance have been described previously in this section. Negligible volumes of water are used within the District for livestock watering, mixing with agricultural chemicals before spraying, and dust abatement. Table 29 notes that the cumulative water use for these purposes is insignificant.

<table>
<thead>
<tr>
<th>Water Use</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>No other uses of significance</td>
<td>N/A</td>
</tr>
</tbody>
</table>

H. Projected Water Use

Projections of future water use in the District are directly related to the future availability of water supplies. Should North Kern’s surface water supplies be reduced from historical levels, both the District and the District’s landowners will increase reliance on groundwater; the same situation applies to other members of the Poso Creek RWMG. However, it is very unlikely that continuously high levels of groundwater pumping can be sustained without the availability of adequate supplemental surface water supplies. It is intended that existing and future groundwater banking, transfer and exchange programs will bring additional surface water supplies into North Kern to offset some of the losses in historically available supplies.

As previously discussed, Kern River water supplies constitute the significant majority of surface water supplies available to the District to support groundwater levels and agricultural operations. As discussed more fully in Section V.D – Water Supply Reliability and Section V.E – Future Water Supply, reductions in the historical availability of the District’s Kern River supplies are likely in the future, and significant reductions are possible. Additionally, the availability and reliability of other historical surface
water supplies to support groundwater conditions in the Poso Creek Region have been reduced as a result of environmental concerns affecting the SWP and CVP-Delta and CVP-Friant, and it is likely that supplies from these sources will continue to be reduced due to on-going environmental restrictions. Although the districts overlying the Poso Creek drainage are implementing plans and projects through the IRWM process intended to mitigate reductions in historically available surface water supplies, it is unlikely that these projects will fully offset these reductions. Should offsets be insufficient, absent a reduction in demand, it is reasonable to expect an increased reliance on pumped groundwater going forward.

Future demand patterns in the District will also certainly change as some irrigated agricultural lands are converted to urban uses; however, the total demand may or may not change depending on a number of factors, including the density of the urban development. There may be less recharge with urban development, owing to impervious surfaces and piping of wastewater to a treatment facility for reuse. If dual systems are part of the urban development, then non-potable supplies could be delivered to landscape irrigation uses.
Section IV. Description of Quantity and Quality of the Water Resources of the Agricultural Water Supplier

A. Water Supply Quantity

1. Surface Water Supply

With regard to surface features, the Calloway, Friant-Kern, and Lerdo canals run north-south through the District; Poso Creek runs northwest through the northern part of the District; and the Kern River is south of the District. North Kern’s principal surface water supply is the Kern River, diverted and delivered by gravity to water users through the aforementioned canals. Poso Creek is a relatively small, intermittent source of local surface water. Table 30 shows North Kern’s diversions from the Kern River for the years 2007-2011 in acre-feet per year (amounts are measured at Seventh Standard Road, the District’s south boundary).

Surface water is retained and regulated in the District’s conservation storage space in Isabella Reservoir, as noted in Table 5. The USACE constructed Isabella Dam in the 1950s and is responsible for day-to-day reservoir operations. Isabella “surface storage” is used by the District to supplement groundwater storage associated with the District’s recharge and recovery activities. Table 31 lists restrictions or imposed limitations on sources of North Kern’s water supply, in particular, the storage of water in Isabella Reservoir.

Table 30. Surface Water Supplies (AF)

<table>
<thead>
<tr>
<th>Source</th>
<th>Diversion Restriction</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern River</td>
<td>Water year type and priority rights</td>
<td>73,177</td>
<td>93,321</td>
<td>84,909</td>
<td>180,110</td>
<td>358,165</td>
</tr>
</tbody>
</table>

Source: North Kern WSD

Table 31. Restrictions on Water Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Restrictions or Imposed Limitations</th>
<th>Name of Agency Imposing Restrictions</th>
<th>Operational Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern River</td>
<td>Storage</td>
<td>USACE</td>
<td>Dam-safety considerations caused USACE to impose a maximum storage restriction of 360,000 AF, which is about 200,000 AF less than the reservoir’s capacity at spillway crest. This restriction will be in place until the dam-safety concerns have been addressed.</td>
</tr>
</tbody>
</table>

2. Groundwater Supply

In years of deficient surface water supply, continuity of delivery to the surface water service area is maintained by the operation of approximately 100 wells which are owned and operated by the District, while on-farm wells are used to meet irrigation demands in the remainder of North Kern.
Long-term water-level data in selected wells representing the unconfined to semi-confined aquifers are used to evaluate groundwater movement, storage conditions, and pumping costs. Historically, water levels in supply wells have been measured twice a year, in both the “spring” and “fall”, with the timing of these measurements intended to coincide with the annual water level high and low, respectively. Measurement of water levels will continue to be performed in both spring and fall to show seasonal variations in water levels throughout the District, and groundwater levels at select wells will be monitored on a monthly basis. These data have been made available to the KCWA and the DWR for the District-owned wells.

The average depth to groundwater in the District has been around 200 feet at the end of a “wet” period (1986) and around 270 feet at the end of a “dry” period (1993). Over the last 20 years, the annual (average) spring water levels have fluctuated within a band of about 50 feet. Seasonal fluctuations can be significant and are a function of the amount of groundwater pumping in a given year and the location within the District. In general, seasonal fluctuations are greatest in the northern portion of the District and are less pronounced in the south.

The San Joaquin Valley portion of Kern County is referred to as the Kern County Subbasin, the north boundary of which is coincident with the north county line. North Kern WSD is within the Kern County Subbasin, designated as DWR Groundwater Basin Number 5-22.14, and the District is shown in relation to the groundwater basin boundary in Figure 5.

The Kern County Subbasin is well-studied, with major investigations having been conducted by both state and federal agencies. Project reports and environmental documents prepared by local water districts are a source of more site-specific data. Table 32 summarizes information on the size and capacity of the Kern County Subbasin. Importantly, the “safe yield” of the basin - the amount of water that can be withdrawn based on “natural” basin replenishment (i.e., excluding conjunctive use/banking programs) - has not been determined but is clearly a relatively small fraction of groundwater production from the Subbasin in dry years. Table 33 lists the firm responsible for preparation of the District’s groundwater management plan. The executive summary of this plan is available upon request.

Table 32. Groundwater Basins

<table>
<thead>
<tr>
<th>Basin Name</th>
<th>Size (Sq. Mi.)</th>
<th>Estimated Capacity (AF)</th>
<th>Safe Yield (AFY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern County Groundwater Subbasin</td>
<td>3,040</td>
<td>40,000,000</td>
<td>Unknown</td>
</tr>
</tbody>
</table>


Table 33. Groundwater Management Plan

<table>
<thead>
<tr>
<th>Prepared By:</th>
<th>GEI Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year:</td>
<td>2012</td>
</tr>
<tr>
<td>Is Appendix Attached?</td>
<td>No, but it is available upon request</td>
</tr>
</tbody>
</table>
Irrigation Wells

Groundwater pumping by the District is used to offset deficiencies in available surface water supplies. About one-half of the District’s approximately 100 wells were constructed in the 1950s and are about 800 feet in depth, while wells constructed since that time are typically drilled to a depth of about 1,000 feet, with the top of the screened interval located from 400 to 500 feet below ground surface and extending 500 to 600 feet.

Pumping lifts vary with hydrology and with location; however, they are estimated to have ranged from 350 to 400 feet over recent years. The at-well pumping drawdowns during the irrigation season can exceed 100 feet, but are typically about 50 to 75 feet. Based on a 2008 field survey, privately-owned on-farm wells totaled over 200, about 70 percent of which were in a ready-to-operate condition.

During the drier years, the District’s well field is principally operated during the nine-month period extending from February through October and is operated at or near capacity from May into August. Annual pumpage from District wells has ranged up to 100,000 acre-feet. Conversely, there are years where available surface water supplies are adequate and the well field is not used at all. In fact, there have been instances where District wells have not been operated for several consecutive years, as illustrated in Figure 6.

![Figure 6. Groundwater Pumping from District-Owned Deep Wells.](image)

District water is priced lower in wet years when Kern River supplies are “plentiful”, thereby incentivizing the use of District (surface) water over groundwater pumping. In dry years, the District pumps large volumes of groundwater and District water prices are higher, encouraging water users to conserve.
The volume of measured groundwater pumped within the boundaries of North Kern in 2008 for discharge into the North Kern distribution system is shown in Table 34. Although additional non-district (or privately-owned) wells are pumped within the District for direct application onto farmland without conveyance through North Kern facilities, the volume is not reported to the District.

Table 34. Groundwater Supplies for 2008*

<table>
<thead>
<tr>
<th>Groundwater Basin</th>
<th>2008 Total (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>District Deep Wells</td>
<td>88,611</td>
</tr>
<tr>
<td>Non-District Deep Wells</td>
<td>4,522</td>
</tr>
<tr>
<td>Total</td>
<td>93,133</td>
</tr>
</tbody>
</table>

* Measured volume discharged into district facilities for conveyance and use within the District

3. Other Water Supplies

In general, North Kern does not have uncontrolled inflows to the District. The exception to this is Poso Creek which is frequently dry but which, at times, is a source of unregulated inflow. Flows from Poso Creek are measured at weirs which enable the District to estimate inflows except during storms when accurate measurement by the weirs is not possible.

4. Drainage from the Water Supplier’s Surface Area

Drainage Wells

Drainage wells and surface drainage systems are not employed by the District. As Table 35 summarizes, there are no flows to saline sinks or to a perched water table.

Table 35. Drainage Discharge for 2008

<table>
<thead>
<tr>
<th>Surface/Subsurface Drainage Path</th>
<th>AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows to saline sink</td>
<td>None</td>
</tr>
<tr>
<td>Flows to perched water table</td>
<td>None</td>
</tr>
</tbody>
</table>

B. Water Supply Quality

North Kern’s groundwater and surface water quality is generally good to excellent. Surface water diverted from the Kern River originates from snowpack in the Sierra Nevada Mountains, in particular the Kings-Kern Divide. The Kern River watershed covers approximately 2,300 square miles of the western slopes of the Sierras towards the southern end of the Central Valley. Kern River water contains low amounts of total dissolved solids (TDS) and minimal or negligible amounts of other water quality constituents that impact agricultural and/or domestic water use. The quality of the underlying groundwater is much more variable.

The District is a member of the Kern River Watershed Coalition Authority which, among other things, implements the Central Valley Regional Water Quality Control Board (CVRWQCB) Irrigated Lands Regulatory Program (ILRP). North Kern also performs water quality monitoring consistent with the ILRP including water quality analyses at the canal inlets for the main supply arteries. Water quality sensors collect data for temperature, conductivity and pH which are later analyzed by the District.
1. Surface Water Supply – Kern River (Head of the Beardsley Canal)

Water is diverted from the Kern River at two points. The principal supply artery, and most upstream diversion, is the Beardsley-Lerdo canal system. Surface water quality monitoring is generally performed at this station, indicative of the water from the Kern River that is diverted into North Kern canals. The diverted water at this location has a TDS of approximately 69 milligrams per liter (mg/l) with low concentrations of other constituents, as seen in Table 36. The quality of the river water is fairly consistent from year to year.

Note that Table 36 presents data from 2012 and not from the representative year used in previous tables and text (2008). This presents a more current depiction of the quality of water diverted from the Kern River.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>mg/l</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Ca</td>
<td>mg/l</td>
<td>13</td>
</tr>
<tr>
<td>Mg</td>
<td>mg/l</td>
<td>2.4</td>
</tr>
<tr>
<td>Na</td>
<td>mg/l</td>
<td>15</td>
</tr>
<tr>
<td>K</td>
<td>mg/l</td>
<td>0.94</td>
</tr>
<tr>
<td>Cl</td>
<td>mg/l</td>
<td>4.4</td>
</tr>
<tr>
<td>SO₄</td>
<td>mg/l</td>
<td>17</td>
</tr>
<tr>
<td>NO₃</td>
<td>mg/l</td>
<td>&lt; 2.0</td>
</tr>
<tr>
<td>TDS</td>
<td>mg/l</td>
<td>69</td>
</tr>
</tbody>
</table>

2. Groundwater Supply

Groundwater in the eastern part of the subbasin is typically sodium bicarbonate type water, while groundwater to the west is characterized by calcium sulfate type water. Criteria set by the DWR define three classes of groundwater, referred to as Class 1 (TDS < 700 ppm), Class 2 (700 ppm < TDS < 2000 ppm), and Class 3 (TDS > 2000 ppm), where Class 1 is the best quality. Most of the historical water quality sampling in the District has been done for agricultural purposes. Based on this sampling, groundwater underlying the District generally meets the Class 1 criteria; however, there are exceptions. The most notable is an area of high salinity extending south from the Shafter Airport to near Seventh Standard Road and Highway 99. Outside of this area, total dissolved solids (TDS) concentrations in the District groundwater typically range from 250 to 500 ppm which is good from an irrigation water perspective.

Of the constituents typically included in an irrigation water quality analysis, nitrate nitrogen (NO₃) is one constituent with concentrations that have, in some cases, exceeded the corresponding primary drinking water maximum contaminant level (MCL) of 10 mg/L. In particular, there are three principal areas where this has occurred:
1) Between Highway 46 and Kimberlina Road.
2) South of Kimberlina Road and east of the Friant-Kern Canal.
3) South of Dresser Avenue, primarily northeast of or near the Friant-Kern Canal.

Full drinking water quality analyses are much more limited in North Kern. With the recently lowered MCL for arsenic of 0.01 mg/L, meeting these standards may be problematic for many public supply wells in the San Joaquin Valley; however, testing to date suggests that arsenic concentrations in groundwater underlying North Kern is typically below the MCL.

3. Other Water Supplies

There are no additional water supplies other than those described in this plan, so the characteristics of the District’s water supply are captured through monitoring of surface water and groundwater.

4. Drainage from the Water Supplier’s Surface Area

The District does not provide any drainage facilities, nor does it control or monitor any on-farm subsurface drainage systems Therefore limitations to drainage reuse is not of concern to the District, as shown in Table 37. As noted above, the District does participate in and help facilitate the ILRP in cooperation with the KCWA and the Kern River Watershed Coalition Authority, including participating in a cooperative program to monitor water quality on Poso Creek.

On-farm tailwater drainage within the District’s service area is minimal due to the prevalence of low-volume and level-basin irrigation systems. In cases where on-farm tailwater is generated, the water users typically contain it within their property.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Drainage Reuse Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased Leaching</td>
</tr>
<tr>
<td>TDS</td>
<td>N/A</td>
</tr>
</tbody>
</table>

C. Water Quality Monitoring Practices

1. Source Water

North Kern regularly monitors the quality of surface water diverted from the Kern River to confirm the suitability of this water for agricultural use. The majority of monitoring locations are at main supply diversions from the Kern River. Groundwater is occasionally monitored at district deep well locations, typically in years of heavy use due to low surface water supply. Table 38 provides general information on monitoring of source water quality in the District.
Table 38. Water Quality Monitoring Practices

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Monitoring Location</th>
<th>Monitoring Practice</th>
<th>Frequency of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern River</td>
<td>Head of the Beardsley</td>
<td>Agricultural Suitability</td>
<td>Monthly</td>
</tr>
<tr>
<td>Kern River, Groundwater*</td>
<td>7th Standard, Zachary, Kimberlina, Stiff House</td>
<td>Agricultural Suitability</td>
<td>Monthly</td>
</tr>
</tbody>
</table>

* During wet years all flow at this location may be surface water. During dry years, groundwater is also conveyed past this location with the volume of groundwater inversely proportional to the availability of surface water.

2. Drainage Water

Drainage water is essentially non-existent in the district due to extent of permanent crops. As noted in Table 39, North Kern will conduct monitoring of surface drainage and groundwater as needed to confirm the suitability of this water for reuse.

Table 39. Water Quality Monitoring Programs for Surface/Sub-Surface Drainage

<table>
<thead>
<tr>
<th>Monitoring Program</th>
<th>Analyses Performed</th>
<th>Frequency of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface and Groundwater</td>
<td>EC and NO₃</td>
<td>As needed</td>
</tr>
</tbody>
</table>
Section V. Water Accounting and Water Supply Reliability

A. Quantifying the Water Supplier’s Water Supplies

1. Agricultural Water Supplier Water Quantities

Diversions of surface water from the Kern River vary from year to year depending on the weather, the amount of runoff, and operational considerations. For purposes of the AWMP, 2008 was chosen as the reference year representing a typical water delivery year. Table 40 summarizes monthly diversions from the Kern River to North Kern delivery canals in 2008. Note that these values represent the monthly amount of water arriving within District boundaries after consideration of operational losses which occur outside of the District’s service area (which include canal seepage and evaporative losses at Isabella Reservoir).

### Table 40. Surface and other Water Supplies for 2008 (AF)

<table>
<thead>
<tr>
<th>Source</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern River</td>
<td>1,512</td>
<td>7,076</td>
<td>12,724</td>
<td>10,065</td>
<td>12,269</td>
<td>12,001</td>
<td>11,985</td>
<td>6,920</td>
<td>6,058</td>
<td>3,774</td>
<td>5,492</td>
<td>3,445</td>
<td>93,321</td>
</tr>
<tr>
<td>Transfers &amp; Exchanges</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recycled Water</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1,512</td>
<td>7,076</td>
<td>12,724</td>
<td>10,065</td>
<td>12,269</td>
<td>12,001</td>
<td>11,985</td>
<td>6,920</td>
<td>6,058</td>
<td>3,774</td>
<td>5,492</td>
<td>3,445</td>
<td>93,321</td>
</tr>
</tbody>
</table>

Along with water diverted from the Kern River, North Kern and local communities and irrigators pump groundwater from the Kern County Subbasin. North Kern reporting of groundwater pumping includes district-owned wells, about 100 at different locations across the District, and estimations of pumping from privately-owned wells within the District boundaries. All groundwater pumped by North Kern, and water received through exchanges with neighboring districts, is used to supplement the available surface water supply when it is less than the demand.

Table 41 summarizes the quantity of groundwater pumped by North Kern in 2008. This includes the District-owned deep wells, as well as those private wells which are pumped into the District’s system for conveyance and delivery.
Table 41. Groundwater Supplies Summary for 2008 (AF)

<table>
<thead>
<tr>
<th>Month</th>
<th>District Deep Wells</th>
<th>Non-District Deep Wells</th>
<th>Total¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>February</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>March</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>April</td>
<td>8,197</td>
<td>0</td>
<td>8,197</td>
</tr>
<tr>
<td>May</td>
<td>14,414</td>
<td>0</td>
<td>14,414</td>
</tr>
<tr>
<td>June</td>
<td>14,855</td>
<td>835</td>
<td>15,690</td>
</tr>
<tr>
<td>July</td>
<td>15,377</td>
<td>1,224</td>
<td>16,601</td>
</tr>
<tr>
<td>August</td>
<td>13,676</td>
<td>1,061</td>
<td>14,737</td>
</tr>
<tr>
<td>September</td>
<td>10,798</td>
<td>561</td>
<td>11,359</td>
</tr>
<tr>
<td>October</td>
<td>10,361</td>
<td>581</td>
<td>10,942</td>
</tr>
<tr>
<td>November</td>
<td>933</td>
<td>260</td>
<td>1,193</td>
</tr>
<tr>
<td>December</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>88,611</td>
<td>4,522</td>
<td>93,133</td>
</tr>
</tbody>
</table>

¹Pumped into North Kern distribution system for irrigation use within the District
²Does not include private groundwater pumping not conveyed through district facilities

2. Other Water Sources Quantities

Surface water diverted from the Kern River and groundwater are the two sources of water actively managed by North Kern. Effective precipitation constitutes an uncontrolled source of supply which reduces the applied irrigation water requirement. Table 42 shows the estimated volume of effective precipitation for 2008, based on North Kern’s total irrigated area. This estimate is based on KCWA’s published estimate of the average effective precipitation per acre for 2008 (KCWA 2008), and the 52,396 total irrigated acres within the service area.

Table 42. Effective Precipitation Summary for 2008 (AF)

| Total Annual Effective Precipitation | 3,362 |

B. Quantification of Water Uses

Table 43 shows the volume of water delivered through District facilities to North Kern irrigation customers in 2008. The volume of water delivered is based on flow measurements at the farm turnouts.

Table 43. Applied Water for 2008

<table>
<thead>
<tr>
<th>District Deliveries to Farm Turnouts</th>
<th>Volume (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>149,988</td>
</tr>
</tbody>
</table>

Table 44 summarizes water uses within the North Kern service area for 2008. The calculated crop ETc was used in developing the District’s water balance (Table 44). During this year, there were estimated to be 52,396 irrigated acres within the District and total crop water demand for the irrigated areas during that year was estimated to be 186,358 acre-feet as developed in Table 21 and described in the text which accompanies the table.
The estimate of losses from the canal system is based on balancing measured system inflows and outflows and is recorded in Table 44 as “conveyance seepage and evaporation” (item 4).

Table 44. Quantify Water Use for 2008 (AF)

<table>
<thead>
<tr>
<th>Estimated Water Use</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop Water Use</strong></td>
<td></td>
</tr>
<tr>
<td>1 Crop Water Requirement (includes ETc and an allowance for leaching)</td>
<td>186,358</td>
</tr>
<tr>
<td>2 Leaching (included in item 1)</td>
<td>N/A</td>
</tr>
<tr>
<td>3 Cultural practices</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Conveyance and Storage System</strong></td>
<td></td>
</tr>
<tr>
<td>4 Conveyance seepage &amp; evaporation</td>
<td>25,377</td>
</tr>
<tr>
<td>5 Conveyance operational outflows</td>
<td>N/A</td>
</tr>
<tr>
<td>6 Reservoir evaporation</td>
<td>0</td>
</tr>
<tr>
<td>7 Reservoir seepage</td>
<td>0</td>
</tr>
<tr>
<td><strong>Environmental Use</strong></td>
<td></td>
</tr>
<tr>
<td>8 Environmental use – wetlands</td>
<td>0</td>
</tr>
<tr>
<td>9 Environmental use – other</td>
<td>0</td>
</tr>
<tr>
<td>10 Riparian vegetation</td>
<td>0</td>
</tr>
<tr>
<td>11 Recreational use</td>
<td>0</td>
</tr>
<tr>
<td><strong>Municipal and Industrial</strong></td>
<td></td>
</tr>
<tr>
<td>12 Municipal (from Table 26)</td>
<td>0</td>
</tr>
<tr>
<td>13 Industrial (from Table 26)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Outside the District</strong></td>
<td></td>
</tr>
<tr>
<td>14 Transfers or Exchanges out of the service area (from Table 28)</td>
<td>13,616</td>
</tr>
<tr>
<td><strong>Conjunctive Use</strong></td>
<td></td>
</tr>
<tr>
<td>15 Groundwater recharge</td>
<td>2,487</td>
</tr>
<tr>
<td><strong>Other (from Table 29)</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>227,838</td>
</tr>
</tbody>
</table>

(a) Included in item 1, see Table 21 and preceding text.
(b) Operational outflows are directed into the channel of Poso Creek for groundwater recharge.
(c) Included in item 4.
(d) This amount reflects direct recharge only, i.e., it does not include canal seepage (which is included in item 4) or the deep percolation of applied irrigation water.

Table 45 summarizes the amount of monitored on-farm surface and subsurface drainage water leaving the service area. As discussed earlier, drainage wells and surface drainage systems are not employed by the District.

Table 45. Quantify Water Leaving the District for 2008 (AF)

<table>
<thead>
<tr>
<th>Drain Water</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface drain water leaving district</td>
<td>0</td>
</tr>
<tr>
<td>Subsurface drain water leaving district</td>
<td>0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 46 shows that there are no irrecoverable losses from the District.

<table>
<thead>
<tr>
<th>Drain Water</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows to saline sink</td>
<td>None</td>
</tr>
<tr>
<td>Flows to perched water table</td>
<td>None</td>
</tr>
<tr>
<td>Subtotal</td>
<td>None</td>
</tr>
</tbody>
</table>

### C. Overall Water Budget

Table 47 summarizes the total water supplies available in 2008 to the North Kern service area. Surface water is the volume of water diverted from the Kern River to the North Kern water system (canals). The groundwater volume includes both North Kern pumping from deep wells and private pumping that is discharged for conveyance into district facilities, but does not include private pumping not conveyed through the North Kern distribution system. The total rainfall in the North Kern service area for the period of January through December 2008 was 3.50 inches. The unit effective precipitation for 2008 was estimated at 0.77 inches per acre for the San Joaquin Valley portion of Kern County by KCWA (KCWA 2008). Based on 52,396 acres of irrigated land, the total effective precipitation is estimated at 3,362 acre-feet.

<table>
<thead>
<tr>
<th>Water Supplies</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Surface Water (summary total from Table 40)</td>
<td>93,321</td>
</tr>
<tr>
<td>2 Groundwater (summary total from Table 41)</td>
<td>93,133</td>
</tr>
<tr>
<td>3 Annual Effective Precipitation (summary total from Table 42)</td>
<td>3,362</td>
</tr>
<tr>
<td>4 Water purchases*</td>
<td>0</td>
</tr>
<tr>
<td>5 Transfers or exchanges into District*</td>
<td>0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>189,816</td>
</tr>
</tbody>
</table>

*Included in item 1.

Table 48 summarizes the water budget for the service area. Because of the uncertainty regarding the lack of accounting for the extent of private pumping in the North Kern water budget, the closure term of the budget represents an approximation of the level of private pumping that occurred in 2008.

<table>
<thead>
<tr>
<th>Water Accounting</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Subtotal of Water Supplies (Table 47)</td>
<td>189,816</td>
</tr>
<tr>
<td>2 Subtotal of Water Uses (Table 44)</td>
<td>227,838</td>
</tr>
<tr>
<td>3 On-farm Drainage Water Leaving Service Area (Table 45)</td>
<td>0</td>
</tr>
<tr>
<td>Closure term attributed to estimated private pumping within North Kern</td>
<td>38,022</td>
</tr>
</tbody>
</table>

The District’s measured deliveries of water to Class 1 and Class 2 lands (North Kern WSD, 2008) were used to verify the estimate of private pumping contained in Table 48. As noted earlier, Class 1 irrigation
deliveries serve approximately 50 percent of the irrigated acreage in North Kern and are assumed to fully satisfy total water requirements. By contrast, Class 2 deliveries, which serve the remaining 50 percent of the irrigated acreage, must be augmented by private pumping to meet total water requirements. For this reason, the difference between the volume of water delivered in 2008 to Class 1 lands (92,978 AF) and the volume delivered to Class 2 lands (57,010 AF) may be used as a surrogate to represent the volume of private pumping. This difference of 35,968 acre-feet varies by approximately 5.5 percent from the value presented in Table 48, which suggests that the closure term is a reasonable approximation of private pumping.

D. Water Supply Reliability

The Kern River is North Kern’s principal source of surface water supply and the amount available to the District in any given year is highly variable, ranging from less than 10,000 acre-feet in a “dry” year to nearly 400,000 acre-feet in a “wet” year. Therefore, efficient water management practices and conjunctive management (i.e. the coordinated use of surface water and groundwater sources) are critical. During “dry” years with reduced availability of surface water supplies, the District relies on carryover storage in Isabella Reservoir to the extent available, but also relies heavily on pumped groundwater (derived primarily from previously recharged surface water).

The Poso Creek IRWMP identified water supply reliability as the region’s principal water resources concern going forward and identified and prioritized a number of projects to mitigate the anticipated reduction in water supply reliability. Several of these projects have been constructed, are under construction, or will be under construction in the near term. Some examples of improvements to District facilities are illustrated in Section II.

Because North Kern shares a common groundwater basin with other districts in the Poso Creek region, the future reliability of water supplies available to support agriculture in North Kern is closely tied to regional water supply reliability.

Despite the significant success of North Kern’s conjunctive use program, as well as water management programs conducted by other districts in the Poso Creek region, significant concerns regarding future regional groundwater conditions persist. These concerns result from reductions of historically available surface water supplies to the region. Specifically, over the last five to ten years supplies of SWP and CVP “Cross Valley Contractors” and “Friant Division” supplies available to the region have been reduced as a result of environmental issues affecting the California Bay-Delta and the “San Joaquin River Settlement”. Additionally, over the last several years, Kern River water supplies historically available to the region have also been reduced, and further reductions in Kern River supply could result from proceedings pending before the State Water Resources Control Board.\(^2\) Surface water supply reductions result in increased levels of groundwater pumping with adverse impacts on groundwater levels and conditions.

---

\(^2\) In April 2010, the State Board removed the Kern River from the “fully appropriated stream” list, indicating their intention to process several pending “applications for appropriation” – including an application filed by North Kern.
E. Future Water Supply

North Kern derives nearly all of its surface water from diversions from the Kern River; therefore, future changes in the North Kern water supply will be driven by changes in Kern River hydrology and particularly by the volume, nature and timing of precipitation in the watershed. The discussion presented in Section VI of this plan describes how climate change may affect the hydrology of the Kern River watershed.

In addition to variations in the District’s Kern River supplies associated with hydrology, the District is faced with serious threats to its historical Kern River supplies through projects and actions proposed by the City of Bakersfield and the Kern Delta Water District. If implemented, these projects would result in a significant reallocation of Kern River supplies away from North Kern and toward the City and/or Kern Delta. Given North Kern’s heavy dependence on Kern River supplies, such a reallocation would result in a corresponding increase in groundwater pumping which would have substantial adverse impacts on North Kern’s water supply balance.

To the extent portions of North Kern’s historical Kern River supplies are reduced as described above, less surface water would be available to offset groundwater pumping and for direct groundwater recharge. Combined with other reduction in the availability of regional surface water supplies, recharge to the underlying groundwater reservoir would be significantly reduced while pumping would increase to offset the loss of surface water supplies.

While changes in watershed hydrology may reduce the reliability of surface water from the Kern River watershed in ways the District cannot control, the District will adapt its water management practices to respond to these changes to the extent practicable. This may involve adaptive management strategies for water consumers or the expansion of water banking transfers and exchanges, which are addressed in the discussion that follows.

1. Expansion of Water Banking, Transfers, and Exchanges

In response to potential losses of historical Kern River supplies and resulting adverse impacts to groundwater, North Kern, through thePoso Creek IRWMP, has identified and constructed several major capital improvements that enhance the District’s capabilities to conjunctively use its Kern River supplies, other surface supplies available to the District, and, through water banking, transfer, and exchange agreements, surface supplies available to other agencies in the Poso Creek region, Kern County, and along the Friant-Kern Canal.

The District’s primary objective in developing additional banking, transfer and exchange programs is to maximize deliveries of surface water supplies into the District to offset potential losses in historical supplies which support groundwater conditions underlying the District and thereby sustain future agricultural operations. To accomplish this objective, it is in the District’s interest to consider diverse water banking, transfer, and exchange programs with Poso Creek RWMG agencies, other agencies in Kern County, and agencies within the Friant-Kern Canal service area.
Existing Water Banking and Exchange Programs
North Kern has implemented water banking and exchange programs to optimize management of water supplies, increase the total volume of water brought into the District, and develop facilities to improve future water management. These programs include numerous “bucket-for-bucket” exchanges, one-time “low priority/mutually agreeable” banking programs, and several longer-term higher priority programs. All of the District banking programs include provisions whereby 10 percent of the water banked is “left behind” (not recovered) to support groundwater levels in the District. Furthermore, development of the higher priority programs included construction of facilities (e.g., wells, turnouts, etc.) that benefit both the banker and the District.

Expansion of Water Banking and Exchange Programs
As discussed previously, through the Poso Creek IRWMP, North Kern identified several capital projects to improve the District’s water management capabilities in order to partially compensate for losses in water supply reliability. More specifically, the District identified projects focused on significant conveyance improvements that allow the North Kern to more fully utilize its existing water management assets, particularly its facilities to recharge water in wetter years.

Many of “North Kern’s” projects identified in the Poso Creek IRWMP have been completed or are in the process of being completed, and the District has effectively established additional water banking and exchange “capacity” particularly with regard to water supplies available from the CVP Friant Division and the SWP. For the reasons previously described, North Kern intends to develop additional banking and exchange programs to more fully utilize its recharge capabilities to support the viability of continued agricultural operations in the District. These programs will increase the District’s overall water supplies since a minimum of 10 percent (and as much as 50 percent or more) of additional water recharged in the District will not be recovered by bankers and will thereby support groundwater conditions underlying the District.

District Water Banking and Exchange Capacity
As noted previously, the District has substantial recharge and recovery assets/capabilities. The use of most of these assets is prioritized to manage the District’s highly variable surface water supplies for the direct benefit of District landowners (primarily agricultural operators). However, during certain periods, substantial portions of these assets are available to support banking and exchange programs with third parties.

- Recharge Capacity

In addition to substantial capacity to recharge water “in-lieu” of groundwater pumping by the District and District landowners, North Kern operates about 1,500 acres of recharge ponds with a capacity to recharge up to 25,000 AF of water per month and with a maximum annual recharge capacity of 300,000 AF. The District directly recharges significant quantities of water in about three of ten years, with an average of 150,000 AF recharged in its spreading ponds in these years. Although the District has an additional 150,000 AF of physical recharge capacity available in these wetter years, based on the typical timing for the availability of wet year supplies from the
Friant and SWP systems, it is not reasonable to assume additional water would be available for recharge during the entire year. However, through expanded water banking programs, additional recharge on the order of 75,000 AF is possible in wet years, with lesser quantities recharged in moderately wet years. These additional recharge volumes would increase the District’s water supplies by up to 15,000 AF per year on average based on a “2 for 1” type unbalanced banking program (i.e., 50 percent of water recharged is left behind). Finally, should the District lose a portion of its historical supplies, additional recharge capacity would become available for third-party banking and exchange programs.

- Recovery Capacity and Timing

A portion of additional water recharged through expanded banking programs (typically 50 percent to 90 percent) must be recovered for the banking entity. North Kern operates a system of 100 wells with an approximate instantaneous capacity of 350 cfs. This capacity is approximately equal to peak irrigation season demands for Class 1 lands.3 Unused District well capacity is available for use by Class 2 lands in the District and to return water to District banking and exchange partners.

If the District’s wells were operated continuously over a 10-month period, total production could be on the order of 200,000 AF. Since the maximum District Class 1 and 2 demands met from District wells is approximately 150,000 AF, about 50,000 AF per year of well capacity would be available to return previously banked water to banking partners. Approximately 15,000 AF per year of this capacity is committed to the District’s existing banking programs.

As noted above, the District’s instantaneous well recovery capacity roughly matches its peak irrigation season obligation to Class 1 lands. Consequently, under very dry conditions when the District has limited surface water storage available in Lake Isabella, little well capacity is available to return water to banking partners during the peak irrigation months (approximately May through August). To the extent North Kern’s banking partners require recovery of previously banked water during this period, additional wells would be necessary. Importantly, these additional “peaking” wells will not increase the total volume of previously banked water recovered from the District, but will simply allow the timing of water recovery to match the banking partners’ needs.

3. Effects of Expanded Water Banking and Exchange Programs

As previously discussed, in 2012 North Kern and other members of the Poso Creek RWMG completed CEQA and NEPA environmental documentation for groundwater banking, transfer, and exchange programs among the RWMG. These programs envision the expansion of water management programs among the RWMG to assist in reducing the adverse impacts of regional groundwater conditions (and agricultural operations) associated with losses of surface water supplies. Since these programs are intended to reduce the adverse impacts of regional water supply losses by bringing additional wetter

3 The District supplies nearly all of the water required to meet the irrigation water requirements of the Class 1 service area.
year supplies into the region, analyses concluded that the programs would be environmentally beneficial compared with the “no project” alternative.

To support the continued viability of agricultural operations in the District, through this AWMP North Kern is proposing to broaden water banking and exchange programs previously reviewed in the Poso Creek environmental documents to include other agencies in Kern County with State and Federal water supply contracts as well as CVP “Friant Division” contractors located outside of Kern County. Broadening these programs outside the Poso Creek RWMG would provide the District with additional opportunities to supplement water supplies available for agricultural operations in the District. Since these programs would increase District surface water supplies they would be expected to incrementally improve groundwater conditions.

The secondary source of water supply for the District is groundwater. Although not immediately affected by changes in surface water hydrology, local groundwater is derived from surface water hydrology in that groundwater recharge is driven primarily by excess surface water (i.e. beyond irrigation requirements) during wet years and percolation of applied irrigation water.
Section VI. Analysis of Effect of Climate Change

A. Effects of Climate Change on Water Supply

The future of the District’s water supply will be driven largely by changes in hydrology and particularly by the volume, nature and timing of precipitation in the Kern River watershed. This section describes analyses of how climate change may affect the hydrology of the Central Valley including this watershed.

Several investigations of the possible effects of climate change to surface and groundwater sources in the Central Valley have been conducted by the USGS California Water Science Center (CAWSC). Two of these studies (USGS, 2009; Water Resources Research, 2012), report the results of modeling used to quantify the hydrological effects of warming climate scenarios including a model of runoff and recharge from the watersheds of the Sierra Nevada Mountains and a model of agricultural water-deliveries and use in the Central Valley. These scenarios were based on a commonly accepted projection of 21st century climate from the GFDL CM2.1 (Geophysical Fluid Dynamics Lab Climate Model 2.1) global climate model, responding to assumptions of rapidly increasing greenhouse-gas emissions. The scenarios predict California’s climate as becoming warmer (+2 to +4°C) and drier (10-15 percent) during the mid- to late 21st century, relative to historical conditions. Based on projections from this model, the CAWSC reports suggest that climate change could result in the following types of water resources impacts:

- Declines in total streamflow (up to 40 percent) leading to reduced surface water deliveries for agriculture and riparian habitat.

- Increased demands for irrigation water with reduced surface water deliveries that would be met by increased groundwater pumpage. This in turn, would be likely to lead to the following impacts:
  - Increased streamflow infiltration;
  - Reduced base flow;
  - Reduced groundwater outflows;
  - Increased depths to groundwater, and
  - Increased land subsidence.

These combined effects have the potential to change the Central Valley from a surface-water dominated system, relying on groundwater to supplement years where surface supplies are inadequate to meet demand, to a groundwater dominated system (Water Resources Research, 2012).

Local communities, rural residences, and businesses rely on groundwater from the Kern County Subbasin as their main supply. North Kern only pumps groundwater when surface supplies are inadequate to satisfy demand (e.g. during dry years). Currently, North Kern recharges groundwater during wet years in spreading ponds and unlined canals across the District.
The combination of groundwater use in dry years and recharge in wet years has provided a balance in water supply. Should climate change result in a reduction in water available from the Kern River, this may prompt North Kern to increase the frequency of groundwater pumping which would lead to a decrease in groundwater storage without the necessary means of replenishing the depleted storage. According to a third CAWSC study (Proceedings of the Eighth International Symposium on Land Subsidence, 2010), Kern County can expect an extreme amount of land subsidence due to the increased demand on groundwater that will result from climate change.

B. Effects of Climate Change on Agriculture’s Water Demand

Climate change is expected to increase both daytime and nighttime temperatures in the Central Valley resulting in lengthening of the growing season. This general increase in temperatures coupled with greater variability and unpredictability in precipitation is expected to lead to increases in evapotranspiration resulting from warmer seasons; thereby creating an increase in demand for irrigation water and an increase in the year-to-year variability of demand.

Temperate fruit and nut trees such as almonds, pistachios, and apples require adequate winter chill to produce economically viable yields. Increased temperatures in the Central Valley are expected to reduce winter chill hours thereby causing adverse effects on the yield of these orchard crops which currently account for approximately 77 percent of total crops in the District. By the end of the century, the safe winter chill needed for these crops is predicted to disappear. Today, the number of hours of winter chill in the San Joaquin Valley has shrunk from about 1,500 a few decades ago, to approximately 1,000 to 1,200 hours (PLoS ONE, 2009). Some farmers are beginning to overcome this change by planting trees closer together and using new varieties.

Studies are now underway to prepare farmers for the likely impacts of climate change. Such efforts include breeding varieties of fruit trees which can withstand the decreased water chill hours, developing tools to aid the crops in coping with insufficient chill, and researching the temperature responses of particular orchard crops to better understand potential long-term effects. However, some solutions such as replanting orchards with altered crop varieties or the installation of aiding tools may not be feasible for many irrigators.

C. Response to Effects of Climate Change

North Kern is committed to monitoring key indicators of climate change that affect the hydrology of the Kern River watershed and growing conditions in the District’s service area. The goal of the District is to utilize the available surface water and groundwater resources as effectively as possible in meeting the requirements of the District’s water users. It is worth noting, however, that the District’s control over water supplies is limited; thus management practice changes will need to be adaptive in nature.
Section VII. Water Use Efficiency Information

A. EWMP Implementation and Reporting

Table 49 summarizes the status of implementation of EWMPs at North Kern. As the table indicates, each of the EWMPs listed in the DWR publication the Guidebook is now being implemented.

The District has chosen to implement some EWMPs that, when viewed in isolation, are not locally cost effective water conservation measures but that contribute to the District’s overall water management strategy.
Table 49. Report of EWMPs

<table>
<thead>
<tr>
<th>Water Code Reference</th>
<th>EWMP</th>
<th>Current Status</th>
<th>Status of EWMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>10608.48.b(1)</td>
<td>Measure the volume of water delivered to customers with sufficient</td>
<td>Proceeding with</td>
<td>North Kern currently measures, monitors, and controls flows throughout its</td>
</tr>
<tr>
<td></td>
<td>accuracy to comply with subdivision (a) of Section 531.10 and to</td>
<td>implementation</td>
<td>water delivery system. The District also measures deliveries in order to bill</td>
</tr>
<tr>
<td></td>
<td>implement paragraph (2) of the legislation.</td>
<td></td>
<td>water users accurately for the volume of water used.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The District is committed to comply with the requirements of SBx7-7 by</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>verifying the accuracy of measurement of irrigation water deliveries using the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>methodology described in Section VIII of this report.</td>
</tr>
<tr>
<td>10608.48.b(2)</td>
<td>Adopt a pricing structure for water customers based at least in</td>
<td>Currently Implemented</td>
<td>North Kern charges water users based on the volume of water delivered.</td>
</tr>
<tr>
<td></td>
<td>part on quantity delivered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(1)</td>
<td>Facilitate alternative land use for lands with exceptionally high</td>
<td>Not Applicable</td>
<td>North Kern facilitates and considers requests for alternative land uses, but</td>
</tr>
<tr>
<td></td>
<td>water duties or whose irrigation contributes to significant</td>
<td></td>
<td>does not actively search for alternate land use possibilities.</td>
</tr>
<tr>
<td></td>
<td>problems, including drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(2)</td>
<td>Facilitate use of available recycled water that otherwise would</td>
<td>Currently Implemented</td>
<td>The District considers requests for use of recycled water. One potential area of</td>
</tr>
<tr>
<td></td>
<td>not be used beneficially, meets all health and safety criteria,</td>
<td></td>
<td>interest is use of water originating from oilfields.</td>
</tr>
<tr>
<td></td>
<td>and does not harm crops or soils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(3)</td>
<td>Facilitate financing of capital improvements for on-farm irrigation</td>
<td>Currently Implemented</td>
<td>The District does not provide direct financial support for capital improvements</td>
</tr>
<tr>
<td></td>
<td>systems</td>
<td></td>
<td>to on-farm systems. However, North Kern does assist in implementation of on-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>farm improvements by agreeing to provide a fixed level of financial support to</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>irrigators and then reducing water charges according to a schedule that will</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>satisfy the commitment of support.</td>
</tr>
<tr>
<td>10608.48.c(4)</td>
<td>Implement an incentive pricing structure that promotes one or more</td>
<td>Currently Implemented</td>
<td>North Kern's Board of Directors annually establishes a water rate that is the</td>
</tr>
<tr>
<td></td>
<td>of the following goals: (A) more efficient water use at the farm</td>
<td></td>
<td>basis for volumetric pricing of delivered water. Water is priced higher in dry</td>
</tr>
<tr>
<td></td>
<td>level; (B) conjunctive use of groundwater; (C) appropriate</td>
<td></td>
<td>years when the District incurs significant pumping costs, and lower in wet</td>
</tr>
<tr>
<td></td>
<td>increase of groundwater recharge; (D) reduction in problem</td>
<td></td>
<td>years with little or no district pumping. Wet-year pricing is set at levels</td>
</tr>
<tr>
<td></td>
<td>drainage; (E) improve management of environmental resources; (F)</td>
<td></td>
<td>below the costs for landowners to pump their private wells, thereby encouraging</td>
</tr>
<tr>
<td></td>
<td>effective management of all water sources throughout the year by</td>
<td></td>
<td>the conjunctive use of available surface water in lieu of groundwater pumping.</td>
</tr>
<tr>
<td></td>
<td>adjusting seasonal pricing structures based on current</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(5)</td>
<td>Expand line or pipe distribution system, and construct regulatory</td>
<td>Currently Implemented</td>
<td>North Kern has two main conveyance canals which are capable of diverting</td>
</tr>
<tr>
<td></td>
<td>reservoirs to increase distribution system flexibility and</td>
<td></td>
<td>water from the River and delivering it within the service area. One of these</td>
</tr>
<tr>
<td></td>
<td>capacity, decrease maintenance and reduce seepage.</td>
<td></td>
<td>conveyance canals is lined between the River and North Kern, and is the principal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>conveyance facility. Within North Kern, seepage from canals and regulatory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>reservoirs is recoverable as pumped groundwater. North Kern has 20 miles of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lined canal within the District which was constructed specifically for dry-year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>operations in order to reduce canal seepage. Some of the unlined distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>canals have been replaced with buried pipelines. The preponderance of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>District's distribution system remains unlined, adding to the District's recharge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>capability during wet years.</td>
</tr>
<tr>
<td>10608.48.c(6)</td>
<td>Increase flexibility in water ordering by, and delivery to, water</td>
<td>Currently Implemented</td>
<td>North Kern Water Storage District – Agricultural Water Management Plan</td>
</tr>
<tr>
<td></td>
<td>customers within operational limits.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(7)</td>
<td>Construct and operate supplier operational outflows and tailwater</td>
<td>Not Applicable</td>
<td>Due to the nature of the on-farm irrigation practices utilized in North Kern,</td>
</tr>
<tr>
<td></td>
<td>recovery systems</td>
<td></td>
<td>spillage and tailwater recovery systems are not utilized and would have little</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>effect on water efficiency.</td>
</tr>
</tbody>
</table>
Table 49. Report of EWMPs, Continued

<table>
<thead>
<tr>
<th>Water Code Reference</th>
<th>EWMP</th>
<th>Current Status</th>
<th>Status of EWMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>10608.48.c(8)</td>
<td>Increase planned conjunctive use of surface water and groundwater within the supplier service area</td>
<td>Currently Implemented</td>
<td>The District has been operating a very significant and successful conjunctive use project for over 60 years. Kern River and other surface water available to North Kern is used in preference to groundwater to the extent available. In “wet” years, available supplies which are in excess of irrigation demand are used to recharge the underlying groundwater (primarily through 1,500 acres of dedicated spreading ponds). In “dry” years, groundwater is pumped to offset deficiencies in available surface water supplies. Through the Poso Creek IRWMP, North Kern identified and has constructed several major capital improvements that enhance the District’s capabilities to conjunctively use it Kern River supplies, other surface water supplies available to the District and through water banking, transfer, and exchange agreements, surface water supplies available to others in the Poso Creek region, Kern County, and on the Friant-Kern Canal.</td>
</tr>
<tr>
<td>10608.48.c(9)</td>
<td>Automate canal control structures</td>
<td>Currently Implemented</td>
<td>North Kern has automated approximately 21 water level and flow monitoring stations at water diversion points and has installed monitoring stations along some reaches of its canals. The District has identified another 2 locations that could be automated for greater water management flexibility. The District has added, and will continue to add, canal automation to its in-house SCADA system in order to enhance water delivery flexibility to water users. The District has also installed controls to enable automatic operation of some wells. With this automation, the wells can be turned on and off remotely when the water level in the canal drops below a preset point. As with other district initiatives, North Kern has proceeded with implementation of this EWMP as a vehicle to improve customer service.</td>
</tr>
<tr>
<td>10608.48.c(10)</td>
<td>Facilitate or promote customer pump testing and evaluation</td>
<td>Currently Implemented</td>
<td>Upon request by the customer, North Kern tests private water supply pumps that pump into district canals. The District has installed water flow meters on all District-owned pumps.</td>
</tr>
<tr>
<td>10608.48.c(11)</td>
<td>Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports</td>
<td>Proceeding with Implementation</td>
<td>The North Kern Board of Directors is in the process of appointing a Water Conservation Coordinator.</td>
</tr>
<tr>
<td>10608.48.c(12)</td>
<td>Provide for the availability of water management services to water users.</td>
<td>Currently Implemented</td>
<td>North Kern (1) measures all deliveries to water users and provides each user with the volume of water delivered during each billing cycle; (2) financially supports the mobile irrigation lab which is operated by the North West Kern RCD (which provides free irrigation system performance testing to District growers); and (3) publishes a periodic newsletter for the dissemination of co-op extension and other data.</td>
</tr>
<tr>
<td>10608.48.c(13)</td>
<td>Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.</td>
<td>Currently Implemented</td>
<td>The District’s surface water supply originates from the Kern River, which is regulated by Isabella Reservoir (a USACE-operated facility). Due to dam-safety considerations, USACE imposed a storage restriction on Isabella Reservoir in 2006, and this restriction will likely be in place for several years to come. In certain water supply years, reduced regulation in Isabella Reservoir increases the District’s reliance on regulation through use of groundwater storage. North Kern and the other River interests are working closely with USACE to expedite the necessary repairs and ultimately lift the storage restriction.</td>
</tr>
</tbody>
</table>
Table 49. Report of EWMPs, Continued

<table>
<thead>
<tr>
<th>Water Code Reference</th>
<th>EWMP</th>
<th>Current Status</th>
<th>Status of EWMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>10608.48.c(14)</td>
<td>Evaluate and improve the efficiencies of the supplier’s pumps</td>
<td>Currently Implemented</td>
<td>The District has a program for regular inspection and maintenance of pumps and motors to keep them in good working order. Pumping plant efficiencies are periodically determined and, if less than a given threshold value, the pump and motor are pulled for inspection and rehabilitation.</td>
</tr>
</tbody>
</table>
The 2014 North Kern Water Operations budget for capital improvement and work orders contains funding for operation and continued implementation of the EWMPs described in Table 49. This budget includes $120,000 for capital expenditures and $181,000 for work orders. Table 50 presents the schedule for implementing EWMPs.

### Table 50. Schedule to Implement EWMPs

<table>
<thead>
<tr>
<th>EWMP</th>
<th>Activities Scheduled for 2014</th>
<th>Staffing Requirements</th>
<th>Budget Allotment</th>
<th>AWMC MOU Demand Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - Water Measurement</td>
<td>On-going</td>
<td>District staff</td>
<td>Operations</td>
<td>C-1</td>
</tr>
<tr>
<td>2 - Volume-based Pricing</td>
<td>Currently implemented</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td><strong>Conditional</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - Alternate Land Use</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>B-1</td>
</tr>
<tr>
<td>2 - Recycled Water Use</td>
<td>Currently implemented</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>B-2</td>
</tr>
<tr>
<td>3 - On-Farm Irrigation Capital Improvements</td>
<td>Currently implemented</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>B-3</td>
</tr>
<tr>
<td>4 – Incentive Pricing Structure</td>
<td>On-going</td>
<td>Management</td>
<td>Operations</td>
<td>C-2</td>
</tr>
<tr>
<td>5 – Infrastructure Improvements</td>
<td>Various activities*</td>
<td>District staff</td>
<td>Capital expenditures</td>
<td>B-5</td>
</tr>
<tr>
<td>6 – Order/Delivery Flexibility</td>
<td>On-going</td>
<td>District staff</td>
<td>Operations</td>
<td>B-6</td>
</tr>
<tr>
<td>7 – Supplier Operational Outflow and Tailwater Systems</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>B-7</td>
</tr>
<tr>
<td>8 – Conjunctive Use</td>
<td>On-going</td>
<td>District staff</td>
<td>Operations</td>
<td>B-8</td>
</tr>
<tr>
<td>9 – Automated Canal Controls</td>
<td>Currently implemented</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>B-9</td>
</tr>
<tr>
<td>10 – Customer Pump Test/Evaluation</td>
<td>On-going</td>
<td>District staff</td>
<td>Operations</td>
<td></td>
</tr>
<tr>
<td>11 – Water Conservation Coordinator</td>
<td>Implementation planned</td>
<td>District staff</td>
<td>Operations</td>
<td>A-2</td>
</tr>
<tr>
<td>12 – Water Management Services to Customers</td>
<td>On-going</td>
<td>District staff</td>
<td>Operations</td>
<td>A-3</td>
</tr>
<tr>
<td>13- Identify Institutional Changes</td>
<td>On-going</td>
<td>Management</td>
<td>Operations</td>
<td>A-5</td>
</tr>
<tr>
<td>14 – Supplier Pump Improved Efficiency</td>
<td>On-going</td>
<td>District staff</td>
<td>Operations</td>
<td>A-6</td>
</tr>
</tbody>
</table>

* Meter, gates and turnout installations, weir and structure replacement, CT-1 Canal lining, Shafter-Wasco ID South Interconnection, Shafter-Wasco ID North Interconnection, 8-17 Calloway Central

Table 51 presents an estimate of the water savings or improvements in water management anticipated to occur over the next five and ten years as a result of programs now being implemented or being planned by the District.
Table 51. Report of EWMPs Efficiency Improvements

<table>
<thead>
<tr>
<th>EWMP No.</th>
<th>EWMP</th>
<th>Estimate of Water Use Efficiency That Occurred Since Last Report</th>
<th>Estimated Water Use Efficiency 5 and 10 years in Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Lined portions of Calloway Canal to reduce seepage.</td>
<td>NA</td>
<td>Estimated annual seepage reduction of 2,265 AF for lining of reaches A, B, C and D.</td>
</tr>
<tr>
<td>9</td>
<td>Implemented SCADA monitoring to check water levels at strategic locations in the District’s distribution system to prevent overflow of regulating reservoir storage.</td>
<td>NA</td>
<td>This project is estimated to reduce annual losses from overflow by 500 AF.</td>
</tr>
<tr>
<td>5</td>
<td>Converted the 8-9 and 9-6 canals into pipeline conveyance.</td>
<td>NA</td>
<td>Average annual seepage and evaporation reduction of 4,000 AF</td>
</tr>
<tr>
<td>5</td>
<td>Constructed a lined canal between the Calloway Canal and the Cross Valley Canal including a new turnout on the CVC.</td>
<td>NA</td>
<td>Average annual seepage reduction of 2,465 AF</td>
</tr>
<tr>
<td>5</td>
<td>Installed a new pump station and one mile of 96-inch diameter concrete pipe to convey water from the Calloway Canal to the Lerdo Canal.</td>
<td>NA</td>
<td>Average annual seepage and evaporation reduction of 1,900 AF</td>
</tr>
<tr>
<td>1</td>
<td>Replaced old propeller meters with new meters.</td>
<td>NA</td>
<td>Improved measurement accuracy but no quantifiable improvements in water use efficiency.</td>
</tr>
<tr>
<td>1</td>
<td>Implemented iPhone scanning and real-time water meter reading network so delivery information can be uploaded to the District’s server and accounting program.</td>
<td>NA</td>
<td>Improved accuracy in reporting of delivery information and in accounting and billing of water usage.</td>
</tr>
</tbody>
</table>

1EWMP numbers correspond to Water Code §10608.48(c).

B. Documentation for Non-Implemented EWMPs

North Kern has implemented, or is in the process of implementing, each of the recommended EWMPs other than those categorized in Table 49 as being Not Applicable. Although certain of these measures are not locally cost-effective as individual water conservation measures, the District views them as elements of a broad program that enables North Kern to provide a high level of service to its agricultural customers and to responsibly manage surface water and groundwater resources in the District’s service area. This position is summarized below in Table 52.
<table>
<thead>
<tr>
<th>EWMP #</th>
<th>Description</th>
<th>(check one of both)</th>
<th>Justification/Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Technically</td>
<td>Not Locally Cost-Effective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infeasible</td>
<td></td>
</tr>
<tr>
<td>10608.48.c(1)</td>
<td>Facilitate alternative land uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10608.48.c(7)</td>
<td>Tailwater recovery systems</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section VIII. Supporting Documentation Agricultural Water Measurement Regulation Documentation

A. Description of Water Measurement Best Professional Practices

Section 10608.48(b) of the California Water Code requires that agricultural water suppliers governed by this section of the code, “Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10” of the legislation. Further, Section 531.10(a) requires that, “An agricultural water supplier shall submit an annual report to the department (DWR) that summarizes aggregated farm-gate delivery data, on a monthly or bi-monthly basis, using best professional practices.”

North Kern’s ability to comply with these requirements rests on the fact that all irrigation deliveries in the District are measured to support the District’s volumetric water pricing to its customers. All deliveries are made through piped turnouts, with the diameters of the pipes ranging between 8 and 12 inches. Deliveries at most farm turnouts are measured with propeller flowmeters manufactured by McCrometer and Seametrics although a few turnouts still use Armco (Waterman) gates where flows are calculated based on the gate opening. The propeller meters are mounted within the turnout piping following accepted engineering practices and measure flow rates and also record the total volume of water delivered. Figure 7 is a photograph of a typical farm turnout from a District canal.

![Figure 7. Typical North Kern Irrigation Turnout.](image)

Data on volumes of delivered water recorded by the District are updated on a daily basis. Ditch-tenders enter water delivery readings into the District’s water management software by first scanning the code for the turnout into their cell phone and then entering the reading from the water meter. This information is emailed from the field, uploaded into the District’s water management software
and reviewed by a supervisor as a quality control procedure. Irrigated acreage is determined based upon a cropping forecast that is prepared each winter for the upcoming season. These crop reports include information obtained directly from water users that identify the crop type, irrigation method and acreage. The irrigated acreage values are verified by checking the acreage identified in the Kern County Assessor’s Parcel Number database and are further field confirmed by North Kern field staff. As all turnouts at North Kern deliver water to single fields, there is a direct correspondence between the turnout identification number and the area served by that turnout.

Water delivery data are made available to water users whenever it is requested throughout the season, which enables irrigators to monitor their water usage. The District’s billing system uses the pricing structure adopted by North Kern’s Board of Directors and the flowmeter readings at a given farm turnout to determine the water bill associated with District deliveries through that turnout.

B. Engineer Certification and Apportionment

The methodology used to determine the individual device accuracy values found in Section 597.3(a) will be verified by a Professional Engineer using industry accepted standards. These methods will take into account the differential in water levels and/or fluctuations in the flow rate or velocity during the delivery event and the type, size and characteristics of the measuring device being verified.

Flowmeters at each farm turnout measure District deliveries to each irrigator’s place of use. The flowmeter indicates the instantaneous flow rate and the cumulative total of water delivered, with the latter function referred to as a “totalizer”.

Previously, meters were only repaired or replaced when a meter was observed to be malfunctioning or when a water user questioned the accuracy. However, in 2012 the District checked the accuracy of over 15 percent of the district’s meters to provide documentation for this plan. The methodology used to determine whether the accuracy of a representative sample of the flow-measurement devices complies with the requirements of Section 597.3(a) is described later in this section. North Kern plans to adopt this methodology for field testing of existing flow metering devices and to present a report approved by a California-registered Professional Engineer as the basis for ongoing compliance with SBx7-7.

C. Water Measurement Conversion to Volume

SBx7-7 requires an annual volumetric accuracy of within ±12 percent on existing devices. Since North Kern’s flow-measurement devices include totalizers (which directly record cumulative flow volume), the devices’ accuracy in measuring flow rates is representative of their ability to measure volumes of water delivered. Therefore, the discussion presented later in this section that relates to testing the accuracy of measurement of flow rates applies equally to determination of the accuracy of measurement of volumes of delivered water.
D. Legal Certification and Apportionment – Legal Access to the Farm-gate

North Kern staff has legal access to install, measure, maintain, operate, and monitor flow-measurement devices at all farm turnouts from the District’s irrigation distribution system. In addition, with few exceptions turnouts deliver water to single fields. Therefore there are no institutional or legal impediments that restrict access to turnouts or measurement of water and, for the purposes of satisfying SBx7-7, there is no need to measure water upstream of points of delivery to individual customers.

E. Device Corrective Action Plan

As noted above, in the past North Kern has repaired or replaced flow meters only when there was some obvious deficiency in their performance or when a water user questioned the accuracy of a meter. In 2012 North Kern verified the accuracy of measurement at over 15 percent of its turnouts to document measurement accuracy for this plan.

Devices identified during the 2012 program to have measurement accuracies that departed by more than ±12 percent from flows measured by a calibrated device will be sent to the district shop for repair. If the shop is not able to correct the inaccuracy in flow measurement, the device will be replaced. After installation in the field, the accuracy of repaired meters will be verified using a calibrated device, and an affidavit will be submitted by a California-registered Professional Engineer certifying the accuracy of each repaired meter to be within ±10 percent by volume. New replacement meters will be laboratory certified by their manufacturer prior to installation to have an accuracy of measurement within ±6 percent by volume. Repair or replacement of these flow meters will be completed within three years of approval of this testing program by DWR.

F. Farm Gate Measurement and Device Accuracy Compliance

SBx7-7 requires that agricultural water suppliers measure the volume of water delivered to customers with sufficient accuracy to comply with standards described in the legislation. These standards are presented below.

1. Measurement Options at the Delivery Point or Farm-gate of a Single Customer

   An agricultural water supplier shall measure the volume of water delivered at the delivery point or farm-gate of a single customer. If a device measures a value other than volume, for example, flow rate, velocity or water elevation, the accuracy certification must incorporate the measurements or calculations required to convert the measured value to volume. An existing measurement device shall be certified to be accurate to within ±12 percent by volume.

2. Initial Certification of Device Accuracy

   For existing measurement devices, the device accuracy shall be initially certified and documented by either:
• Field-testing that is completed on a random and statistically representative sample of the existing measurement devices. Field-testing shall be performed by individuals trained in the use of field-testing equipment and documented in a report approved by an engineer.

• Field-inspections and analysis completed for every existing measurement device. Field-inspections and analysis shall be performed by trained individuals in the use of field inspection and analysis, and documented in a report approved by an engineer.

3. Protocols for Field Testing

Field-testing shall be performed for a sample of existing measurement devices according to manufacturer’s recommendations or design specifications and following best professional practices. It is recommended that the sample size be no less than 10 percent of existing devices, with a minimum of 5, and not to exceed 100 individual devices for any particular device type. Alternatively, the supplier may develop its own sampling plan using an accepted statistical methodology.

If during the field-testing of existing measurement devices, more than one quarter of the samples for any particular device type do not meet the relevant accuracy criteria, the agricultural water supplier shall provide in its Agricultural Water Management Plan a plan to test an additional 10 percent of its existing devices, with a minimum of 5, but not to exceed an additional 100 individual devices for the particular device type. This second round of field-testing and corrective actions shall be completed within three years of the initial field-testing.

Field-inspections and analysis protocols shall be performed and the results shall be approved by an engineer for every existing measurement device to demonstrate that the design and installation standards used for the installation of existing measurement devices meet the relevant accuracy standards and that operation and maintenance protocols meet best professional practices.

4. North Kern WSD Program for Compliance with Water Measurement Requirements

In 2012 North Kern followed the guidelines described above by identifying 33 randomly-selected turnouts to serve as a representative sample for verification of flow measurement. This sample population represents 16.7 percent of the District’s 198 turnouts. These turnouts deliver water to 10 percent of the District’s irrigated area. Flows measured at each of the turnouts within the sample population were compared with measurements recorded by a calibrated ultrasonic flowmeter to determine the accuracy of measurement. The sample population is shown in Appendix E.

Because the propeller meters used by the District are equipped with totalizers, errors detected in the measurement of flow rates correspond with errors in measurement of delivered water volumes, with measurement error being defined as the percentage departure between the propeller flowmeter reading and the corresponding reading taken with the calibrated ultrasonic
“Accuracy” means the measured volume relative to the actual volume, expressed as a percent. The percent shall be calculated as $100 \times \frac{\text{measured value} - \text{actual value}}{\text{actual value}}$, where the “measured value” is the value indicated by the device or determined through calculation using a measured value by the device, such as flow rate, combined with a duration of flow, and “actual value” is the value as determined through laboratory, design or field testing protocols using best professional practices.

A histogram of the error of measurement values is shown below in Figure 8. Note that all readings were taken for a period of 10 minutes at each turnout.

As illustrated in the histogram, although the sample population includes a maximum value of 79 percent, the mean sample error was 6.1 percent, with a standard deviation of 16.8 percent and with approximately 58 percent of the individual error values falling within ±6 percent of the calibrated values and 76 percent falling within ±12 percent. This analysis indicates that flow measurement at a majority of turnouts meets the ±12 percent volumetric measurement accuracy required by SBx7-7 for existing measurement devices, with the accuracy of about 24 percent of the sampled devices falling outside of the acceptable accuracy limits.

The next analysis was performed using sampling errors that had been weighted so that the error of measurement is proportional to the volume of water delivered at the turnout.
accomplished by multiplying the error of measurement computed at each turnout by the flow meter reading. This weighted data yielded a 10.6 percent error of measurement for the total sample population. However, as illustrated in Figure 8, much of the total sample error is the result of errors associated with a small number of turnouts. For example, if the turnouts with the four highest weighted measurement errors (Turnouts 8-00-60-A, 8-00-78B, 8-03-25A, and 8-17-6B) were removed from the remaining population, the error of the sample population would be reduced to 5.9 percent. This value indicates that, with few exceptions, the volume of water delivered by the turnouts included in the sample population is measured at an accuracy that conforms with the standards presented in SBx7-7.
References


Appendix A
Public Hearing Notice
NORTH KERN WATER STORAGE DISTRICT

PUBLIC HEARING NOTICE

Notice is hereby given that the North Kern Water Storage District (NKWSD) will hold a public hearing on **August 19, 2014 at 7:30 AM** regarding a proposed **Agricultural Water Management Plan**, and consider adoption of the Plan.

The Water Conservation Act of 2009 requires certain agricultural water suppliers in California to prepare Agricultural Water Management Plans (AWMP). To meet the requirements of this legislation, NKWSD is preparing an AWMP. The AWMP includes a discussion of NKWSD and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The NKWSD Board of Directors will hold a hearing to consider public comments on the proposed AWMP.

A copy of the AWMP may be reviewed at the NKWSD office (33380 Cawelo Avenue, Bakersfield, CA). Written comments submitted prior to the hearing, should be directed to:

Ram Venkatesan  
North Kern Water Storage District  
P.O. Box 81435  
Bakersfield, CA 93380

Comments may also be provided at the hearing.

If you have questions regarding the AWMP, please contact Ram Venkatesan at (661) 393-2696.
Appendix B

Public Hearing Notification Letters
NORTH KERN WATER STORAGE DISTRICT

August 12, 2014

Mr. Michael James
Public Works Director
City of Shafter
336 Pacific Ave,
Shafter, CA 93263

RE: North Kern WSD Agricultural Water Management Plan – Public Hearing Notice

The North Kern Water Storage District (North Kern, District) is scheduled to hold a hearing to receive public comment on the District’s Agricultural Water Management Plan (AWMP) at 7:30 AM on August 19, 2014 in the District’s Board Room located at 33380 Cawelo Avenue, Bakersfield, CA. At the hearing, the District’s Board will receive public comments on the draft AWMP. The North Kern Board will consider adoption of the AWMP at a meeting to be held following the Public Hearing.

The AWMP includes a discussion of North Kern and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices, being implemented now or planned in the coming years. A copy of the draft plan is available for review at the District office.

Any comments prior to the hearing should be submitted to:

    Ram Venkatesan
    North Kern Water Storage District
    P.O. Box 81435
    Bakersfield, CA 93380

Any questions regarding the draft AWMP or the adoption process should be directed to Ram Venkatesan at (661) 393-2696 or ram@northkernwsd.com.

Sincerely,

Richard A. Diamond
General Manager
NORTH KERN WATER STORAGE DISTRICT

August 12, 2014

Mr. J. Paul Paris
City Manager
City of Wasco
746 8th St,
Wasco, CA 93280

RE: North Kern WSD Agricultural Water Management Plan – Public Hearing Notice

The North Kern Water Storage District (North Kern, District) is scheduled to hold a hearing to receive public comment on the District’s Agricultural Water Management Plan (AWMP) at 7:30 AM on August 19, 2014 in the District’s Board Room located at 33380 Cawelo Avenue, Bakersfield, CA. At the hearing, the District’s Board will receive public comments on the draft AWMP. The North Kern Board will consider adoption of the AWMP at a meeting to be held following the Public Hearing.

The AWMP includes a discussion of North Kern and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices, being implemented now or planned in the coming years. A copy of the draft plan is available for review at the District office.

Any comments prior to the hearing should be submitted to:

Ram Venkatesan
North Kern Water Storage District
P.O. Box 81435
Bakersfield, CA 93380

Any questions regarding the draft AWMP or the adoption process should be directed to Ram Venkatesan at (661) 393-2696 or ram@northkernwsd.com.

Sincerely,

Richard A. Diamond
General Manager
NORTH KERN WATER STORAGE DISTRICT

August 12, 2014

County Clerk
County of Kern
1115 Truxtun Avenue,
Bakersfield, CA 93301

RE: North Kern WSD Agricultural Water Management Plan – Public Hearing Notice

The North Kern Water Storage District (North Kern, District) is scheduled to hold a hearing to receive public comment on the District’s Agricultural Water Management Plan (AWMP) at 7:30 AM on August 19, 2014 in the District’s Board Room located at 33380 Cawelo Avenue, Bakersfield, CA. At the hearing, the District’s Board will receive public comments on the draft AWMP. The North Kern Board will consider adoption of the AWMP at a meeting to be held following the Public Hearing.

The AWMP includes a discussion of North Kern and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices, being implemented now or planned in the coming years. A copy of the draft plan is available for review at the District office.

Any comments prior to the hearing should be submitted to:

Ram Venkatesan
North Kern Water Storage District
P.O. Box 81435
Bakersfield, CA 93380

Any questions regarding the draft AWMP or the adoption process should be directed to Ram Venkatesan at (661) 393-2696 or ram@northkernwsd.com.

Sincerely,

Richard A. Diamond
General Manager
Appendix C
Resolution of Plan Adoption
RESOLUTION NO. 14-89
ADOPTING NORTH KERN WATER STORAGE DISTRICT'S
AGRICULTURAL WATER MANAGEMENT PLAN

WHEREAS, with the passage of the 2009 Water Conservation Act (Water Code Sections 10800, et seq. also known as SBx7-7 (the “Act”)), certain Agricultural Water Suppliers are to prepare an Agricultural Management Plan, among other things, intended to encourage agricultural water suppliers to assess current efficient water management practices, to evaluate additional practices that may conserve water, and to require accurate measurement of water; and

WHEREAS, the District has prepared an Agricultural Water Management Plan pursuant to the guidelines that were issued by the California Department of Water Resources on October 12, 2012 to aid water suppliers in preparing Agricultural Water Management Plans in accordance with the requirements of the Act.

WHEREAS, the District published notice of the availability of the Plan and of a hearing regarding same, and subsequently held a hearing on August 19, 2014 to hear and consider comments from the public on the Plan; and

WHEREAS, at the noticed public hearing, there were [no] verbal objections to the Plan.

NOW, THEREFORE, BE IT RESOLVED, that the Board of Directors of the North Kern Water Storage District does hereby approve and adopt the District’s Agricultural Water Management Plan as presented and prepared in accordance with the Act.

Moved by Director Waterhouse, seconded by Director Glende, that the foregoing resolution be adopted.

The following vote was had:
Ayes: Waterhouse, Glende, Mendes, Fornoff, Andrew
Noes: None
Absent: None

The President declared the resolution adopted.

000

I, Patrick Mize, Secretary of the Board of Directors of the NORTH KERN WATER STORAGE DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a meeting of said Board of Directors held the 19th day of August 2014.

[Signature]
Secretary of the Board of Directors of the North Kern Water Storage District
Appendix D
North Kern WSD: Rules and Regulations for Distribution and Use of Water
When Recorded return to:

North Kern Water Storage District
33380 Cawelo Avenue
Bakersfield, CA 93308-9575

NORTH KERN WATER STORAGE DISTRICT

RULES AND REGULATIONS FOR DISTRIBUTION AND USE OF WATER

Amended and Restated July 15, 2014
# INDEX

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>I</td>
<td>DEFINITIONS</td>
</tr>
<tr>
<td>District, District Office, District Records, Board, Manager, Project and Adopted Project, Distribution System, Class I Lands, Class I Water, Class II Lands, Class II Water, Special Purpose Water, Water User, Water Toll Rate, Base Service Charge, Agricultural Use, Application for Water Service.</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>AUTHORITY OF DISTRICT MANAGER AND EMPLOYEES</td>
</tr>
<tr>
<td>Manager, District Employees, Agents and Designees</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>DELIVERY AND USE OF WATER</td>
</tr>
<tr>
<td>IV</td>
<td>APPLICATION FOR WATER SERVICE AND AUTHORIZATION FOR ADMINISTRATION THEREOF</td>
</tr>
<tr>
<td>V</td>
<td>ORDERING WATER SERVICE AND MEASUREMENT OF WATER</td>
</tr>
<tr>
<td>VI</td>
<td>EMERGENCY TURN OFF</td>
</tr>
<tr>
<td>VII</td>
<td>INTERRUPTIONS IN SERVICE</td>
</tr>
<tr>
<td>VIII</td>
<td>CONTROL, USE AND RECAPTURE OF WATER</td>
</tr>
<tr>
<td>IX</td>
<td>BILLINGS, PAYMENT AND DELINQUENCY</td>
</tr>
<tr>
<td>X</td>
<td>INTERFERENCE WITH DISTRIBUTION SYSTEM</td>
</tr>
<tr>
<td>XI</td>
<td>RIGHT OF ENTRY</td>
</tr>
<tr>
<td>XII</td>
<td>ENFORCEMENT OF RULES AND REGULATIONS</td>
</tr>
<tr>
<td>XIII</td>
<td>PROCEDURE FOR ANNUALLY FIXING THE AMOUNT OF BASE SERVICE CHARGES</td>
</tr>
<tr>
<td>XIV</td>
<td>ENCROACHMENT ON DISTRICT PROPERTY</td>
</tr>
</tbody>
</table>
SECTION
PAGES

XV  ACCESS TO DISTRICT RECORDS ........................................ 14
XIV  GENERAL PROVISIONS .................................................. 15
XVII. UNUSED ENTITLEMENT IN DISTRICT'S DISTRIBUTION SYSTEM................................................................. 15
XVIII  CHANGES IN RULES AND REGULATIONS ................. 15
XVIV  SEVERABILITY OF PROVISIONS ..................................... 15

ANNEX

1. Map of District - Class I and Class II lands ............. 16
2. Resolution No. 03-91 amending Rules and Regulations ..................................................................................... 17
NORTH KERN WATER STORAGE DISTRICT

RULES AND REGULATIONS FOR
DISTRIBUTION AND USE OF WATER

INTRODUCTION

These Rules and Regulations are established pursuant to the requirements of Division 14, particularly Section 43003, of the California Water Code to enable the North Kern Water Storage District to perform its functions economically, and to achieve an efficient distribution of water for the benefit of the District.

These Rules and Regulations are in implementation of the District’s Project as herein defined and are applicable only to lands within the District located north of Seventh Standard Road excepting the lands located within the Rosedale Ranch Improvement District of the District.

Section I. DEFINITIONS

Unless the provision or context otherwise requires, the definitions contained herein govern the construction of these Rules and Regulations.

1. “District” means the North Kern Water Storage District.

2. “District Office” is the office designated from time to time by the Board of Directors pursuant to Section 40650 of the California Water Code and is currently located at 33380 Cawelo Avenue, Bakersfield, California 93308-9575. The mailing address of the District Office is P.O. Box 81435, Bakersfield, California 93380-1435. The telephone number is 661-393-2696.

3. “District Records” means the records on file at the District Office.

4. “Board” means the Board of Directors of the North Kern Water Storage District as duly constituted pursuant to Division 14 of the California Water Code.

5. “Manager” is the person appointed by the Board pursuant to its directions to manage and control the activities of the District.

6. “Project” and “Adopted Project” is the District’s Original Project, adopted July 31, 1951, as modified in the Report on Modification of North Kern Water Storage District, Adopted 1950, which modified report was adopted March 3, 1964, and the new project for a proposed contract with the United States for use of conservation storage space in Isabella Reservoir, adopted by vote of the landowners on August 25, 1964 and includes District’s distribution system, including rights of way, land and water used in connection therewith which are collectively referred to as “Project Facilities.”
7. "Distribution System" means all fixed installations which are owned and/or operated by the District having the mission of diversion, conveyance, control, measurement, pumping, storage, spreading and delivery of water to land within the District.

8. "Class I Lands" are those lands defined and classified as Class I Lands in the 1950 Project Report on file at the District Office as modified from time to time by action of the Board. These lands are also referred to as "Canal Served Lands," and are shown on the map attached hereto.

9. "Class I Water" is project water as defined in District's adopted project that is available for delivery pursuant to these Rules and Regulations, to Class I lands or so-called "Canal Served Lands." Class I water has as its main source of supply the District's canal system, supplemented in shortage years by water obtained from groundwater from District pumps.

10. "Class II Lands" are lands defined as Class II Lands in the 1950 Project Report on file at the District Office as modified from time to time by action of the Board. These lands are also referred to as so-called "Private Pump Served Lands," and are shown on the map attached hereto. Their main source of water supply is derived from their own private pumping plants.

11. "Class II Water" is water made available by District to a portion of Class II lands. At no time is the District under any obligation to provide surface water service to Class II lands. There are three types of Class II water. "Regular Class II Water" is water made available to Class II lands in years or at times when the full water needs of Class I lands have been satisfied and/or District spreading is occurring. "Special Class II Water" is water made available to Class II lands in years or at such times when the District is able to purchase water from others for the benefit and use by Class II lands. "Emergency Class II Water" is water made available to Class II lands on a temporary, interruptible basis while the private pumping facilities serving said lands are inoperative.

12. "Special Purpose Water" is water delivered on an interruptible and nondependable basis for construction work or other special purposes not directly related to agricultural uses under conditions established by the Board.

13. "Water User" is an owner of land which is entitled to receive surface water service from the District pursuant to these Rules and Regulations.

14. "Water Toll Rate" is the charge established from time to time by the Board as the amount to be paid by Water User for surface water service furnished by the District pursuant to these Rules and Regulations.

15. "Base Service Charge" is defined at Section XIII hereof.

17. "Application for Water Service" is the form to be provided by the District to be completed and filed by Water User and acknowledged by the landowner. Two different types of forms are utilized. One form or application to be executed by the Class I Water User; the other form or application to be executed by the Class II Water User.

For purposes of clarification, the singular includes the plural and masculine includes feminine.

SECTION II. AUTHORITY OF DISTRICT MANAGER AND EMPLOYEES

1. Manager

The District’s Distribution system is under the exclusive management and control of the Manager. No other person except the Manager, or his designee, shall operate any of the facilities of the District’s system. The responsibility for carrying out said operations shall rest with the Manager of the District, who shall designate certain District employees for operation and maintenance responsibilities of District’s distribution system.

2. District Employees, Agents and Designees

The Manager shall supervise the duties and activities of all District employees, agents and designees in a manner that produces, at all times, an efficient and economical operation of all District facilities.

Any controversy arising between a Water User and a District employee, agent or designee that cannot be amicably resolved by the parties shall be directed to the Manager for consideration. If the resultant settlement decision by the Manager does not meet with the satisfaction of the Water User, an appeal in writing can be addressed to the Board of Directors, whose subsequent decision shall be final.

SECTION III. DELIVERY AND USE OF WATER

1. Water User may use project water only as provided in these Rules and Regulations. Water User acquires no property right in the District’s Distribution System or in the project water and the District retains the right to all water not consumptively used by a Water User.

2. District will deliver water to Water Users through its Distribution System only pursuant to these Rules and Regulations.
3. Water furnished by the District other than Special Purpose Waters is to be used for agricultural use only. All water furnished by the District is in a raw, untreated condition and is considered unfit for human consumption without treatment. The character and quality of the water furnished may vary from time to time, and the District does not represent, guarantee or warrant in any manner or respect the character of quality thereof. The District may, however, suspend service during any period of time it has determined that the water is unfit for agricultural purposes which determination shall be final and conclusive.

4. Emergency Class II water may be made available to a person requesting such service if the Manager determines that providing such service is in the best interest of the District and will not interfere with obligations of the District. The Manager shall keep the Board advised of any Emergency Class II Water Service. Alternatively, the Board may direct that Emergency Class II water be made available upon finding such action would be in the best interest of the District and would not interfere with obligations of the District.

5. Special purpose water service may be made available if the Board determines that it is in the best interest of the District, will be for a limited period of time and will only be made if it does not interfere with the obligations of the District.

SECTION IV. APPLICATION FOR WATER SERVICE AND AUTHORIZATION FOR ADMINISTRATION THEREOF

1. In order to be eligible for surface water service the owner of the lands eligible to be served must complete, execute and file with the District an Application for Water Service which describes the lands to be served and establishes those persons authorized to place turn on and turn off orders pursuant to Section V hereof.

No application will become effective for a water user who is delinquent in any District charge or for service to any lands for which any assessment, toll or charge is delinquent unless said water user meets the criteria pursuant to Section IX-8.

Forms of the application are available at the District Office. The original and one copy of the completed application shall be returned to the District office for filing. Should the District have actual knowledge that there are Class I lands within the District for which no application has been filed, it may mail an application to the owner in accordance with the ownership and address shown on the current records at the District office. None of the foregoing establishes a duty on the District and it remains the duty of the landowner to see that a proper application is on file with the District.

When land is sold or title otherwise transferred, or when a new tenant takes possession, the District will not deliver water to such lands until a proper and binding
Application for Water Service is completed and filed by the new owner and/or the new tenant.

2. An application shall be executed by all persons that are owners of record of the lands to be served and each signature must be acknowledged before a Notary Public.

If the application is executed in any of the following capacities it shall be accompanied by the following information:

a. A guardian, conservator, administrator, executor or trustee of a testamentary trust shall furnish a certified copy of an appropriate order of court authorizing such action.

b. A trustee of an inter vivos trust shall furnish a copy of the recorded trust powers.

c. A partnership shall furnish a copy of a statement of partnership recorded under Corporation Code Section 15010.5. An application executed by a General Partner in a limited partnership shall furnish evidence of authority to obligate the partnership.

d. An attorney-in-fact shall furnish a copy of the recorded power of attorney.

e. Any other person acting in any representative capacity shall furnish evidence of his authority to act to the satisfaction of the Board.

3. If an Application for Water Service is executed by any of the following, it shall be accompanied by an Appointment of Agent to Act For Water User form which provides authority to do any and all acts to be done by the water user pursuant to these Rules and Regulations, including but not limited to, the authority to order water service for the designated lands, to receive all notices and billings from the District and to appoint sub-agents with like authority.

Such agents are to be appointed where the ownership of the land affected is in more than one person, excepting a husband and wife living at the same address, including but not limited to the situation where the subject land is owned by:

a. A corporation.
b. A partnership.
c. A Limited Liability Corporation.
d. A Limited Liability Partnership.
e. A joint venture.
f. The State, a county or other public agency.
g. Similar entities.
Forms of the Appointment of Agent are available at the District office. They are to be executed and filed in the same form and manner as the application.

4. Water user or his duly appointed agent may designate a person or persons other than himself to place orders for and/or receive District billings pursuant to Section IX hereof. Said designation shall be on forms provided by the District and shall constitute the consent of the Water user to the collection by the District of all tolls and charges arising from the water orders so authorized in the manner authorized by Sections 47181 to 47185, inclusive, of the California Water Code.

5. Without limiting any other provision in these Rules and Regulations, the power and authority of an agent or designee appointed pursuant hereto shall continue until the owner of the lands affected shall revoke such appointment. In event of such revocation, the District Manager shall be notified in writing. In the event of multiple ownerships a revocation may be made by a majority of the landowners affected, determined on an acreage basis. It is understood that the agency or designation made pursuant hereto shall not be revoked by death or incapacity of less than all of the appointing landowners.

6. In administering these Rules and Regulations, the District will rely upon the records on file at the District office for matters regarding title to land, address of landowners, authorizations, appointments, designations, and the like, filed with the District by a water user pursuant hereto which are continuing representations upon which the District is entitled to rely unless and until the District has received at the District office actual written notice of revocation. Such representations are for the benefit of the lands affected and any charge or obligation arising in favor of the District by reason of its reliance upon such continuing representations, authorizations, applications, appointments, designations and the like filed with the District shall constitute a lien upon the lands affected thereby with the same force and effect and priority as an assessment lien and, in addition to all other remedies which may be available to the District shall be collectible, all as provided in Sections 47181 to 47185, inclusive, and Section 43003 of the California Water Code.

SECTION V. ORDERING WATER SERVICE AND MEASUREMENT OF WATER

The landowner, by filing a fully executed Application, making the necessary appointments and by paying all assessments, tolls and charges when due, satisfies these Rules for servicing of water orders.

Orders to turn on and turn off water shall be made by the landowner, or the person authorized pursuant to Section IV hereof, at the District Office, personally or by telephone Bakersfield, 661-393-3361 or Shafter-Wasco 661-746-3364.

Charges for water service made available pursuant to water orders will be
calculated on the basis of continuous flow, from the time of the scheduled turn on to the scheduled turn off, multiplied by the appropriate water toll rate, and in accordance with Section IV.5. hereof.

Water user acquires no property right in the District's water supply or District's facilities by filing such order and the District retains the right to all water not consumptively used by the water user.

1. Such orders shall be submitted a minimum of 48 hours prior to the time service is requested. Water delivered will run continuously day and night until the amount of water ordered and scheduled by District for the period has been delivered. No “turn on” order will be accepted for less than a 24-hour period, unless special arrangements can be made with the District or the District has in effect a less-than-24-hour run program where water users can place orders for specific less than 24-hour periods. For the purpose of properly scheduling District's activities, it is important that “turn off” orders be given at the same time that a “turn on” order is given.

2. In general, service will be provided as requested; however, at times, District may require the rescheduling of service due to capacity limitations within the District's distribution system or necessary shutdowns for emergencies beyond District control.

3. On the day the order is put into effect the system attendant will turn the delivery gate on or off, in accordance with the scheduled delivery, at the time he passes the gate on his regular run. Generally, turn ons, turn offs and adjustments will be made by District's system attendant in the mornings. Orders for a certain hour cannot be accepted, but the system attendant will cooperate with the water user as far as possible and still maintain efficient operation of the system.

4. In the event water delivery is reduced or turned off due to actions taken by the water user, his agents, designees or their employees (including but not limited to a request that District make a non-scheduled turn off) the full amount of the water service ordered by the water user and scheduled by the District shall be paid for in accordance with the terms of the Application for Water Service and the accepted water order. If a water user, his agent, servant, employee or designee effects such unauthorized turn off he must immediately notify the system attendant or District Office.

SECTION VI. EMERGENCY TURN OFF

Water user or the District may, in an emergency, turn off the supply of water at the delivery facility. If the District effects such an emergency turn off, the water user receiving service will be notified as soon as possible. As soon as service can be resumed the water user will be notified that the District is completing his order. If a water user, his agents, servants, employees or designees effects such emergency turn off he must immediately notify the system attendant or District Office. Water users, by executing the Application for Water Service, agree to be responsible for loss or damage
caused by effecting such a turn off, which amount may be collected in the same manner as the water service charges.

SECTION VII. INTERRUPTIONS IN SERVICE

Temporary shutdowns may be made by District to make improvements and repairs. Except in any emergency, all affected water users will be notified prior to making such temporary shutdowns.

In the event the District projects a water shortage for the balance of the seasonal year then the available supply will be proportioned as determined by the Board of Directors for all Class I landowners in a manner equitable and fair.

SECTION VIII. CONTROL, USE AND RECAPTURE OF WATER

1. The District will not be responsible for the control, carriage, handling, use, disposal or distribution of water delivered to water user hereunder outside the facilities then being operated and maintained by District. Water user shall indemnify, assume the defense of and hold harmless the District and its officers, agents and employees from any and all loss, damage, liability, claims or causes of action of every nature whatsoever, for damage to or destruction of property, including District’s property, or for injury to or death of persons, in any manner arising out of or incidental to the control, carriage, handling, use, disposal or distribution of water outside such facilities.

2. District retains the right to all Project water not consumptively used by a water user. District may recapture water delivered to water user which may return to a District facility from any source. Such recapture shall not relieve a water user from any liability under sub-section 1 above. Once recaptured, water user causing such water to be subject to recapture shall have no recourse to District except as to such right as he may have as a water user.

SECTION IX. BILLINGS, PAYMENT AND DELINQUENCY

1. The landowner is responsible to the District for the payment of all tolls, charges and assessment incurred or assessed against said lands pursuant to said Adopted Project or these Rules and Regulations.

2. The Board may from time to time establish separate tolls for Class I Water, Regular Class II Water, Emergency Class II Water, and Special Purpose Water, less-than-24-hour-run-surcharge, or other classifications of water service it may establish. Likewise the Board may from time to time establish tolls and charges for use of District facilities. Water tolls and charges shall be filed with the District’s records and shall be available for public inspection.
3. Charges for water service made available pursuant to water orders will be calculated on the basis of continuous flow from the time of the scheduled turn on to the scheduled turn off multiplied at the appropriate water toll rate.

   In the event water delivery is reduced or turned off due to actions taken by the water user, his agents, or designees or their employees, including but not limited to a request that District make a non-scheduled turn off, the full amount of the water service ordered by the water user and scheduled by the District shall be paid.

4. Billings for water service made available pursuant to water orders will be prepared in accordance with water the District scheduled for delivery pursuant to turn on and turn off orders made pursuant to Section V hereof. The billings will be calculated on the basis of continuous flow during all days and nights, including Sundays and holidays, from the time of the scheduled turn on to the scheduled turn off multiplied the appropriate water toll rate and in accordance with Section IV.5 hereof.

5. For convenience of the water users, invoices for water service will be sent to the person designated in the Application for Water Service or Authorization to Receive District Billings and to place water orders shortly after the first of the month for the water taken during the prior month. Payments are due, payable and delinquent as provided in subsection IX.7 hereof.

   No water will be delivered if the water user's account is delinquent or if the lands to be served are delinquent as to any District assessment, toll or charge.

6. Payment by check should be made to the order of the North Kern Water Storage District and payments may be mailed to P. O. Box 81435, Bakersfield, California 93380-1435 provided they are received with the time specified. Payments by check shall be deemed payment on the date received provided the check clears the bank in the ordinary course of business.

7. Payment is due and payable on the 1st day of the month following delivery and, if the payment is not received by the District by 5:00 o'clock p.m. on the 30th day following the date it is due and payable, said payment is delinquent within the meaning of the provisions of Water Storage District Law and the availability of water to said lands and delivery of water to said water user will be discontinued. Water service will no longer be made available to said delinquent lands and no deliveries of water will be made to said delinquent water user until all sums due and payable to District from said lands and water user, together with all interest and penalties, have been paid. To reinstate a delinquent account payment of all charges, principal and interest must be paid in full and advance payments or security deposits may be instituted by order of the Board as a condition of future availability of water to said water user. Under Water Storage District Law, such toll and charge, when delinquent, must be increased by a penalty of 10% and the resulting total bears interest at the rate of 12% per year from the date of delinquency until date of payment.
Should a water user be delinquent on January 1, the Board at its next regular meeting shall commence proceedings to collect the charge as provided in Sections 47181 to 47185, inclusive, of the California Water Code. This may lead to a sale of the property affected and to continued refusal of water service. The District may also initiate such at other times during the year as directed by the Board.

8. Upon being provided evidence that a water user may be able to utilize a deepwell or other alternative water supply, the District staff may allow a prepayment for water delivery to lands in which any assessment, toll or charge is delinquent. Upon utilization of the prepayment for water deliveries all deliveries shall cease.

SECTION X. INTERFERENCE WITH DISTRIBUTION SYSTEM

No person shall molest, tamper with, or interfere with structures, meters or devices used for the delivery of water. In this connection attention is directed to the following:

SECTION 592, PENAL CODE OF THE STATE OF CALIFORNIA: WATER DITCHES, ETC., PENALTY FOR TRESPASS OR INTERFERENCE WITH.

"Every person who shall, without authority of the owner or managing agent, and with intent to defraud, take water from any canal, ditch, flume or reservoir used for the purpose of holding or conveying water for manufacturing, agricultural, mining, irrigating or generation of power, or power, or domestic uses, or who shall without like authority, raise, lower or otherwise disturb any gate or other apparatus thereof, used for the control or measurement of water, or who shall employ or place, or cause to be emptied or placed, into any such canal, ditch, flume or reservoir, any rubbish, filth, or obstruction to the free flow of the water, is guilty of a misdemeanor."

SECTION XI. RIGHT OF ENTRY

By execution of an Application for Water Service, water user grants to District, its agents, servants, employees, and designees, a right of entry of water user’s lands for the purpose of properly providing requested service by the water user.

SECTION XII. ENFORCEMENT OF RULES AND REGULATIONS

The manager shall be responsible for the enforcement of these Rules and Regulations. Refusal to comply with any of the Rules and Regulations shall be sufficient cause for the termination of water service, and water service will not again be furnished until full compliance has been made with all the requirements herein set forth. In no
event shall any liability accrue against the District or any of its officers, agents or employees, for damage, direct or indirect, arising from such temporary discontinuance or reduction of water deliveries.

SECTION XIII. PROCEDURE FOR ANNUALLY FIXING THE AMOUNT OF BASE SERVICE CHARGES

1. In accordance with Section 43003 of the Water Code, the following procedures are established for fixing tolls and charges authorized by Sections 43006 and 47180.

In order to provide for payment of project costs in proportion to services rendered to all lands within the District and in proportion to the services rendered to developed Class I and Class II lands under present Project conditions it is necessary that a Base Service Charge, in addition to tolls and charges fixed for surface water service, including charges for use of the District’s distribution system, be established which charge shall be made due and payable or a day certain between November 1st and December 1st of each year.

The Base Service Charge is the amount of money necessary to be raised by the District to provide for and to recover costs incurred in the administration of the District, including salaries, services and supplies, and the costs incurred by reason of the construction and operation of its adopted Project, in excess of income from surface water service, including charges for use of the District’s distribution system, plus a reasonable percentage not to exceed 15% for delinquency, and a percentage necessary to cover costs of collection.

Since there are no undeveloped assessable lands in the District and since all assessable Class I lands use or have the potential to use District surface water service and all other assessable lands are Class II lands developed in reliance upon the use of groundwater, which includes all commercial, industrial and residential lots or parcels, benefit from the District and its operations, District costs to be recovered from the Base Service Charge shall be allocated in accordance with the benefits attributable to Class I and Class II lands; EXCEPTING, that minimum rates per parcel may be established for tracts of land less than one acre in area.

2. It is necessary that the following procedure be established for annually fixing and collecting the Base Service Charge:

   a. At or before the regular meeting in October or at such other time as may be announced at said meeting, the Board shall consider, determine and by resolution fix the total amount to be collected by reason of such charges; The percentage for delinquency and cost of
collection attributable to such charges; the amount to be collected from Class I and Class II lands and the estimated rates per acre necessary to collect the charge from the respective classes of land; the minimum rate for sub-one acre parcels; order the adoption of the preliminary roll and that the roll be extended by the Manager in accordance with the findings of the Board and filed with the Secretary; set the time and place of hearing of objections to the roll as provided in subparagraph (d) hereof and determine the newspaper or newspapers in which notice shall be published.

b. Prior to the fixing of the charge by the Board, the Manager shall prepare and file with the Board a report recommending an allocation of costs proposed to be collected as the Base Service Charge together with a proposed preliminary roll. The report shall contain an estimate of the total amount to be collected by reason of such charge and as allocated to Class I and Class II lands; the percentage for delinquency and cost of collection attributable to such charge; the estimated rates per acre for Class I and Class II lands and the minimum charge for parcels less than one acre in area.

The roll shall set forth the assessees parcels and assessees names for each parcel of assessable land in the District, determined in accordance with the provisions of Chapter 3, Part 1, Division 14 (commencing with Section 39050) of the Water Code and matters on file in District’s records; the County Assessor’s parcel numbers; the acreage assessed to each such assessees according to District’s records and the classification of each such tract of land.

The Manager shall estimate the preliminary rates per acre for said charges, which rates shall be based upon the matters set forth in said roll and the determinations of the Board and shall be separately stated as a rate per acre for Class I and Class II lands and the rate of tracts less than one acre.

Said roll may include information mentioned in Sections 47325 et seq. of the Water Code dealing with collection of assessments against which bonds have been issued.

c. Said report, resolution and preliminary roll as extended shall be filed with the Secretary and be available for public inspection at the District office. Plat maps of assessable acreage shall be prepared by the District’s staff and shall be kept on file at the District’s office.

Without designation the Secretary shall forthwith publish
notice of the filing of the preliminary roll, which notice shall set forth
the preliminary rates per acre, the minimum charge for parcels less
than one acre in area and declare the time and place set by the
Board when the Board will meet and hear any objection to the
charges established for said respective tracts of land as set forth in
the roll. Said notice may contain matters required by Section
47325 et seq. Of the Water Code dealing with collection of
assessments against which bonds have been issued. The notice
shall be published once a week for two successive weeks, as
provided in Sections 39057 and 47326 of the Water Code. Said
hearing shall not be less than three weeks after the first date of
publication.

As a convenience to the assessees the Secretary shall
deposit a copy of said notice in the mail, addressed to each
assessee shown on the preliminary roll at their address as set forth
in said roll. The mailing shall be completed at least 10 days prior to
the hearing date.

d. At the time and place for hearing of objections, the Board shall
consider such objections to the roll and make such corrections
thereo as are necessary and proper. Upon conclusion of the
hearing, the Board shall by resolution adopt said roll as finally fixed
and determined; make such changes in the preliminary rates per
acre necessitated thereby; fix the date the charges shall be due and
payable which date shall be no later than December 1; order that the
charges be collected by the District Treasurer; and order the
Treasurer of the District to certify said roll. provided, however, that
the Board may order that a portion of the charge may be paid as a
second installment due and payable no later than April 1 of the
following year. The certified roll shall be filed with the Secretary of
the District.

e. The Secretary shall forthwith publish notice of the filing of the roll as
finally fixed and adopted which notice shall contain the information
mentioned in Subparagraph ©. hereof as the same has been finally
determined. As a convenience to the assessees, the Secretary
shall deposit in the mail, addressed to each assessees as shown on
the roll, an invoice stating the amount of the Base Service Charges
due and payable to the District Treasurer for said parcel prior to
December 1st of each year. Said invoice may include information
regarding payment of calls on assessments against which bonds
have been issued as is mentioned in Sections 47352 et seq. of the
Water Code.
f. The Base Service Charge becomes delinquent if payment is not received by the District Treasurer by 5:00 o'clock p.m. on the 30th day following the date charges are due and payable. Delinquent accounts and affected landowners shall be subject to the same provision applicable to water tolls and affected water users, as more particularly described at Section IX.7 above.

g. The policy and procedure contained in this section shall continue until such time as the Board determines, pursuant to noticed public hearing, that said charges, or any of them, are to be fixed on some basis other than that herein provided or until such time as there has been a reassessment of Project costs as provided in Section 46355 of the Water Code.

SECTION XIV. ENCROACHMENT ON DISTRICT PROPERTY

Without limiting rights otherwise reserved, consent for encroachment will be required from the District before any drains, fences, pipelines or other encroachments will be permitted upon District’s property. Consent forms will be furnished by the District to the applicant and must first be approved by the Manager or his designee before any construction begins. Where District rights in any property are an easement, no encroachments will be permitted which will in any manner interfere with the rights under said easement, and the District’s consent must first be obtained before any pipelines or other encroachments are constructed in any easement area. The work shall be constructed to specifications approved by the District at the sole expense of the permittee and maintained to the satisfaction of the District. If such consent is granted, the permittee shall be solely responsible for and shall indemnify and shall assume the defense of and hold harmless the District and its officers, agents and employees from any and all loss, damage, liability, claims or cause of action of every nature whatsoever, for damage, to or destruction of property, including the District’s property, or for injury to or death of persons, in any manner, arising out of permittee’s exercise of rights and privileges given in the granting of the such consent. Issuance of consent does in no way grant a permanent right, and if the District determines at a future date that said works do in fact interfere with its operations, said works shall be removed and the District’s property restored to its original state at the sole expense of the permittee. Granting of such consent does in no way and in no extent surrender or subordinate the District’s control or supervision over the encroachment. Any person or his authorized agent who uses the property of District for the movement of equipment shall be responsible to District for any damage to District property. Any persons using a District right-of-way for any purpose assumes all risks associated therewith and assumes the responsibility for any damage to District property resulting therefrom and also for any damage to private property caused by such same to District property.

SECTION XV. ACCESS TO DISTRICT RECORDS
All District records shall be maintained at the District Office. Such records are for the exclusive use of the District and shall be made available for use for other purposes only as provided by Resolution No. 80-44, as amended from time to time, adopted pursuant to the California Public Records Act (Government Code Sections 6250 et seq.).

SECTION XVI. GENERAL PROVISIONS

1. No water necessary to meet the demands of Class I lands under these Rules and Regulations shall be diverted at any time for the irrigation of Class II lands. Water user shall use the project water only upon the lands shown in his Application for Water Service and to be irrigated pursuant to the turn on order.

2. As stated in Section III.3, the water furnished by the District is not treated to make it safe for drinking purposes and anyone making such use of District water does so contrary to these Rules and Regulations at his own risk.

SECTION XVII. UNUSED ENTITLEMENT IN DISTRICT’S DISTRIBUTION SYSTEM

The Board may authorize the use of such unused capacity in its Distribution System as the Board may in its absolute discretion determine that it is to the best interest of the Class I and Class II Lands for the benefit of areas annexed to the District by proceedings known as Annexation No. 1 (1966) upon such terms and conditions as the Board may from time to time establish.

Northing herein contained shall detract from the conditions under which such lands were annexed to the District including that portion reading as follows: “No annexed area nor any of the landowners within the annexed area shall acquire any use or right of use of existing property of the North Kern Water Storage District, real or personal, including but not limited to rights for conveyance of water by reason of the annexation of said territory.

SECTION XVIII. CHANGES IN RULES AND REGULATIONS

These Rules and Regulations shall become effective July 15, 2014, and can or may be added to, amended or repealed at any time by resolution of the Board.

SECTION XVIV. SEVERABILITY OF PROVISIONS

If any provision of these Rules and Regulations, or the application thereof to any person or circumstances, is held invalid, the remainder of these Rules and the application of its provisions to other persons or circumstances shall not be affected
thereby.

ANNEX

1. Map of District - Class I and Class II lands.

2. Copy of resolution of Board of Directors for Adoption of Rules and Regulations effective July 15, 2014.
EXHIBIT "C"

BEFORE THE BOARD OF DIRECTORS OF
NORTH KERN WATER STORAGE DISTRICT

IN THE MATTER OF: RESOLUTION NO. 14-78

AMENDING RULES AND REGULATIONS
FOR DISTRIBUTION AND USE OF WATER

SECTION A:

WHEREAS, this Board of Directors declares and determines as follows:

1. Pursuant to Water Code § 43003.5, the Board of Directors of this District has the power to establish and amend Rules and Regulations for distribution and use of water within the District.

2. With the adoption of Resolution No. 08-76 on August 19, 2008, this District amended and restated its Rules and Regulations for Distribution and Use of Water (hereinafter referred to as "Rules and Regulations").

3. Because of changing circumstances related to administration of the District's Base Service Charges, as more particularly described in the General Manager's memorandum of July 15, 2014, it is appropriate to amend the Rules and Regulations as herein provided.

4. This Board held a noticed public hearing this date concerning the proposed amendment of the Rules and Regulations in accordance with Section XIII (g) of the existing Rules and Regulations.

SECTION B:

NOW, THEREFORE, BE IT RESOLVED AND ORDERED BY THE BOARD OF DIRECTORS OF THIS DISTRICT, AS FOLLOWS:

1. The foregoing recitals and findings, and each of them, are true and correct.

2. The District's Rules and Regulations are amended as set forth in attachment "A" hereto.

3. A certified copy of this resolution shall be recorded with the County Recorder of Kern County.
4. Copies of this resolution together with the District's Rules and Regulations as amended shall be maintained on file and open for inspection and available to District Water Users.

All the foregoing, being on the motion of Director Fornoff, seconded by Director Mendes, and authorized by the following vote:

AYES: Andrew, Waterhouse, Mendes, Fornoff

NOES: None

ABSENT: Glende

ABSTAIN: None

I hereby certify that the foregoing is a true copy of the Resolution of the Board of Directors of NORTH KERN WATER STORAGE DISTRICT as duly passed and adopted by said Board of Directors on July 15, 2014.

[Signature]
Secretary of the Board of Directors
Appendix E
Water Meter Accuracy Verification Form
<table>
<thead>
<tr>
<th>Date</th>
<th>Turnout No</th>
<th>Meter Name and Model</th>
<th>Year Installed</th>
<th>Pipe Size (in)</th>
<th>Flowmeter Reading (gpm) A</th>
<th>Ultrasonic meter Reading (gpm) B</th>
<th>Elapsed Time</th>
<th>Difference (A-B) C</th>
<th>Percent Error (C/B)*100</th>
<th>Test Person Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/3/2012 8-00-29</td>
<td>McCrometer 03-05307-10</td>
<td>2003</td>
<td>10&quot;</td>
<td>950gpm</td>
<td>935gpm</td>
<td>10Min</td>
<td>15gpm</td>
<td>1.6%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/3/2012 8-00-34</td>
<td>McCrometer 02-03-145-10</td>
<td>2002</td>
<td>10&quot;</td>
<td>1450gpm</td>
<td>1504gpm</td>
<td>10Min</td>
<td>54gpm</td>
<td>3.5%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/3/2012 8-00-40</td>
<td>McCrometer</td>
<td>2001</td>
<td>10&quot;</td>
<td>1400gpm</td>
<td>1401gpm</td>
<td>10Min</td>
<td>1gpm</td>
<td>0.7%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/3/2012 8-00-63B</td>
<td>McCrometer 03-02610-10</td>
<td>2003</td>
<td>10&quot;</td>
<td>1000gpm</td>
<td>1132gpm</td>
<td>10Min</td>
<td>132gpm</td>
<td>11.6%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/3/2012 8-00-63A</td>
<td>McCrometer 03-02609-10</td>
<td>2003</td>
<td>10&quot;</td>
<td>1100gpm</td>
<td>1115gpm</td>
<td>10Min</td>
<td>15gpm</td>
<td>1.3%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/4/2012 8-00-60A</td>
<td>McCrometer 97-8729-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1200gpm</td>
<td>1059gpm</td>
<td>10Min</td>
<td>231gpm</td>
<td>21.8%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/4/2012 8-00-60B</td>
<td>McCrometer 97-8727-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>500gpm</td>
<td>482gpm</td>
<td>10Min</td>
<td>18gpm</td>
<td>3.7%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/4/2012 8-00-56</td>
<td>McCrometer 06-66820-12</td>
<td>2006</td>
<td>12&quot;</td>
<td>700gpm</td>
<td>946gpm</td>
<td>10Min</td>
<td>246gpm</td>
<td>26.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/4/2012 8-00-76B</td>
<td>Seametrics 05119468</td>
<td>10&quot;</td>
<td>215gpm</td>
<td>1739gpm</td>
<td>10Min</td>
<td>416gpm</td>
<td>23.0%</td>
<td>SM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/4/2012 8-00-76a</td>
<td>Seametrics 05119483</td>
<td>10&quot;</td>
<td>1953gpm</td>
<td>1844gpm</td>
<td>10Min</td>
<td>119gpm</td>
<td>6.4%</td>
<td>SM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/4/2012 8-17-24b</td>
<td>McCrometer 97-05601-12</td>
<td>1997</td>
<td>12&quot;</td>
<td>2100gpm</td>
<td>1960gpm</td>
<td>10Min</td>
<td>139gpm</td>
<td>7.1%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/8/2012 8-00-43</td>
<td>McCrometer</td>
<td>6&quot;</td>
<td>400gpm</td>
<td>400gpm</td>
<td>10Min</td>
<td>0gpm</td>
<td>0.0%</td>
<td>SM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/8/2012 8-00-24</td>
<td>McCrometer 97-5186-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1400gpm</td>
<td>1414gpm</td>
<td>10Min</td>
<td>14gpm</td>
<td>1.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/8/2012 8-0-25</td>
<td>McCrometer 94-8453-10</td>
<td>1994</td>
<td>10&quot;</td>
<td>1350gpm</td>
<td>1323gpm</td>
<td>10Min</td>
<td>26gpm</td>
<td>2.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/9/2012 8-03-5C</td>
<td>McCrometer 08-04650-08</td>
<td>2008</td>
<td>8&quot;</td>
<td>500gpm</td>
<td>520gpm</td>
<td>10Min</td>
<td>30gpm</td>
<td>5.7%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/9/2012 8-03-25A</td>
<td>McCrometer 08-04039-08</td>
<td>2008</td>
<td>8&quot;</td>
<td>1500gpm</td>
<td>838gpm</td>
<td>10Min</td>
<td>662gpm</td>
<td>78.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 8-03-43A</td>
<td>McCrometer 97-05602-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1900gpm</td>
<td>1740gpm</td>
<td>10Min</td>
<td>160gpm</td>
<td>9.1%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 8-03-43B</td>
<td>McCrometer 99-02340-10</td>
<td>1999</td>
<td>10&quot;</td>
<td>1350gpm</td>
<td>1280gpm</td>
<td>10Min</td>
<td>70gpm</td>
<td>5.4%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 9-07-12B</td>
<td>McCrometer 98-7259-12</td>
<td>1998</td>
<td>12&quot;</td>
<td>2280gpm</td>
<td>2340gpm</td>
<td>10Min</td>
<td>60gpm</td>
<td>2.5%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 9-07-12A</td>
<td>McCrometer 91-12-742</td>
<td>1991</td>
<td>12&quot;</td>
<td>2700gpm</td>
<td>2563gpm</td>
<td>10Min</td>
<td>137gpm</td>
<td>5.3%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 9-00-27</td>
<td>McCrometer 07-12100-08</td>
<td>2007</td>
<td>8&quot;</td>
<td>800gpm</td>
<td>758gpm</td>
<td>10Min</td>
<td>42gpm</td>
<td>5.5%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 9-00-24</td>
<td>McCrometer 08-11724-10</td>
<td>2005</td>
<td>10&quot;</td>
<td>850gpm</td>
<td>857gpm</td>
<td>10Min</td>
<td>7gpm</td>
<td>0.8%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 8-11-8B</td>
<td>McCrometer 97-8730-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1200gpm</td>
<td>1034gpm</td>
<td>10Min</td>
<td>166gpm</td>
<td>16.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/11/2012 8-11-8A</td>
<td>McCrometer 97-8726-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1100gpm</td>
<td>1248gpm</td>
<td>10Min</td>
<td>148gpm</td>
<td>11.8%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-17-6A</td>
<td>McCrometer 03-06877-10</td>
<td>2003</td>
<td>10&quot;</td>
<td>1000gpm</td>
<td>976gpm</td>
<td>10Min</td>
<td>24gpm</td>
<td>2.4%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-17-6C</td>
<td>McCrometer 08-07952-10</td>
<td>2008</td>
<td>10&quot;</td>
<td>1300gpm</td>
<td>1300gpm</td>
<td>10Min</td>
<td>0gpm</td>
<td>0.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-00-87D</td>
<td>McCrometer 03-06880-10</td>
<td>2003</td>
<td>10&quot;</td>
<td>1200gpm</td>
<td>1184gpm</td>
<td>10Min</td>
<td>16gpm</td>
<td>1.3%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-00-87C</td>
<td>McCrometer 06-03483-10</td>
<td>2006</td>
<td>10&quot;</td>
<td>1400gpm</td>
<td>1237gpm</td>
<td>10Min</td>
<td>163gpm</td>
<td>13.1%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-00-87B</td>
<td>McCrometer 99-2717-10</td>
<td>1999</td>
<td>10&quot;</td>
<td>1386gpm</td>
<td>1286gpm</td>
<td>10Min</td>
<td>99gpm</td>
<td>7.6%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-00-87A</td>
<td>McCrometer 97-08275-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1800gpm</td>
<td>1556gpm</td>
<td>10Min</td>
<td>244gpm</td>
<td>15.6%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-21-3A</td>
<td>McCrometer 06-03362-10</td>
<td>2006</td>
<td>10&quot;</td>
<td>1050gpm</td>
<td>1032gpm</td>
<td>10Min</td>
<td>18gpm</td>
<td>1.7%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-17-6B</td>
<td>McCrometer 97-08277-10</td>
<td>1997</td>
<td>10&quot;</td>
<td>1500gpm</td>
<td>1139gpm</td>
<td>10Min</td>
<td>361gpm</td>
<td>31.0%</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>10/14/2012 8-17-6D</td>
<td>McCrometer 03-06880-10</td>
<td>2003</td>
<td>10&quot;</td>
<td>1200gpm</td>
<td>1184gpm</td>
<td>10Min</td>
<td>16gpm</td>
<td>1.3%</td>
<td>SM</td>
<td></td>
</tr>
</tbody>
</table>
### Annual Natural Flow of Kern River at First Point of Measurement
(values in acre-feet unless noted otherwise)

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Annual Runoff</th>
<th>Annual Runoff Index</th>
<th>Variance from Median</th>
<th>Annual Runoff</th>
<th>Annual Runoff Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>424,696</td>
<td>58%</td>
<td>-125,990</td>
<td>-17%</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>519,724</td>
<td>71%</td>
<td>-30,962</td>
<td>-4%</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>407,305</td>
<td>56%</td>
<td>-143,381</td>
<td>-20%</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>1,156,109</td>
<td>158%</td>
<td>605,423</td>
<td>83%</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>1,071,841</td>
<td>147%</td>
<td>521,155</td>
<td>71%</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>252,692</td>
<td>35%</td>
<td>-297,994</td>
<td>-41%</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>517,997</td>
<td>71%</td>
<td>-32,689</td>
<td>-4%</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>470,166</td>
<td>64%</td>
<td>-80,520</td>
<td>-11%</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>910,975</td>
<td>125%</td>
<td>360,289</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>1,374,894</td>
<td>188%</td>
<td>824,208</td>
<td>113%</td>
<td></td>
</tr>
</tbody>
</table>

550,686 Long-Term Median Annual Runoff in acre-feet.

75% Long-Term Median Annual Runoff Index in percent.

Note: Long-Term statistics based on 1894 through 2011.
TABLE OF CONTENTS

SECTION 1 - PURPOSE

Plan Objective 1-1
District 1-1
Plan Elements 1-2
Plan Contact Information 1-5

SECTION 2 - GENERAL

Description of District 2-1
Plan Participants 2-2
Stakeholders 2-2
Advisory Committee 2-2

SECTION 3 - GROUNDWATER BASIN CHARACTERISTICS

General 3-1
Physical Characteristics 3-1

SECTION 4 - BASIN MANAGEMENT OBJECTIVES

General 4-1
Groundwater Resource Protection 4-1
Groundwater Resource Sustainability 4-2
Groundwater Resource Understanding 4-3
Groundwater Basin Understanding 4-3
Information Dissemination 4-4

SECTION 5 - MANAGEMENT STRATEGIES

General 5-1
Saline Water Intrusion Control 5-2
Plan Activities 5-2
Wellhead and Recharge Area Protection 5-3
Plan Activities 5-3
Migration of Contaminated Groundwater Controls 5-4
Plan Activities 5-4
Well Abandonment/Destruction Policies 5-5
Plan Activities 5-5
Well Construction Policies 5-6
Plan Activities 5-6
SECTION 5 - MANAGEMENT STRATEGIES (Cont'd)

Overdraft Mitigation 5-7
Groundwater Recharge Management 5-8
    Plan Activities 5-8
Groundwater Extraction Policies 5-9
    Plan Activities 5-9
Conjunctive Policies 5-10
Surface Water Management 5-11
    Surface Water Quantity 5-11
    Surface Water Quality 5-13
    Plan Activities 5-13
Operation of Facilities 5-15
    Plan Activities 5-15
Groundwater Monitoring 5-16
Land Subsidence Monitoring 5-17
    Plan Activities 5-17
Land Use Planning 5-18
    Plan Activities 5-18
Groundwater Basin and Resource Information Management 5-19
    Plan Activities 5-19
Groundwater Basin and Resource Reports 5-20
    Plan Activities 5-20
Local Agency and Stakeholder Involvement 5-21
    Plan Activities 5-22

SECTION 6 - MONITORING

General 6-1
Groundwater Monitoring 6-1
    Groundwater Levels 6-1
    Groundwater Quality 6-2
    Additional Monitoring 6-6

SECTION 7 - PLAN IMPLEMENTATION

General 7-1
Plan Participation 7-1
Dispute Resolution 7-2
Annual Report 7-2
Plan Evaluation 7-3
Additional Reports 7-3
Schedule 7-3
Plan Funding 7-4
    Grants 7-4
    Cost Sharing Agreements 7-4
    In-lieu Contributions 7-5
    Assessments 7-5
LIST OF TABLES

Table 1-1 - Plan Summary
Table 5-1 - Surface Water Quality Monitoring
Table 6-1 - Groundwater Measurements
Table 7-1 - Implementation Schedule

LIST OF FIGURES

Figure 2-1 - District's Boundaries
Figure 3-1 - Plan Boundaries
Figure 3-2 - Land Use
Figure 3-3 - Surface Conditions
Figure 3-4 - Groundwater Elevations
Figure 3-5 - Average Groundwater Depth

APPENDICES

Appendix A - Plan Participation and Basin Stakeholders
Appendix B - Sample Memorandum of Understanding
Appendix C - Alternative Dispute Resolution Policy
SECTION 1
PURPOSE
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
PLAN OBJECTIVE

The Shafter-Wasco Irrigation District (District) desires to formalize its existing groundwater management practices for the continuance of local management and to enhance existing monitoring activities in a coordinated manner. Through this Groundwater Management Plan (Plan) the District will identify and implement modifications to ongoing practices in order to preserve and enhance groundwater resources. The District will organize existing and expanded groundwater management activities to facilitate the implementation of the Plan.

Preservation and enhancement of the groundwater resource is vital to sustaining the local economy which has been built up in reliance, in whole or in part, on this resource. The District’s objective is to preserve the utility of the groundwater resource, both in terms of quantity and quality at the least possible cost to sustain the agricultural production and support urban development within the boundaries of the District. Enhancement or augmentation of the resource is necessary to mitigate the present level of overdraft and the attendant long-term decline in groundwater levels in the overall groundwater basin. The Plan objectives can be accomplished, at least on a cost basis, by joint implementation of the Plan through the District as opposed to individual implementation by District landowners.

DISTRICT

The District is organizing current and proposed groundwater management activities under provision of Part 2.75 of Division 6 of the California Water Code commencing with Section 1-1.
10750, otherwise known as AB3030, the Groundwater Management Act of 1992. The 1992 Act was amended in 2002 and 2004 to describe specific requirements for the Plan.

For the purpose of groundwater management, powers granted to an entity which adopts a Plan include the powers of a water replenishment district (Part 4, Division 18, California Water Code), to the extent not already possessed by the entity, but not limited to the following:

a. Acquire and operate facilities, waters and rights needed to replenish the groundwater supplies;

b. Store water in groundwater basins, acquire water rights, import water into the District and conserve water;

c. Participate in legal proceedings as required to protect and defend water rights and water supplies and to prevent unlawful exportation of water from the District;

d. Under certain conditions to exercise the right of eminent domain;

e. Act jointly with other entities in order to economically perform required activities;

f. Carry out investigations required to implement the Plan;

g. Fix rates for water for replenishment purposes; and

h. Fix the terms and conditions of contracts for use of surface water in-lieu of groundwater.

**PLAN ELEMENTS**

Part 2.75, Groundwater Management, of the Water Code establishes required (§10753.7) and recommended (§10753.8) elements of a groundwater management plan. Bulletin 118
prepared by the Department of Water Resources (DWR) also provides recommendations for groundwater management plans.

The District’s Plan has been prepared to address the requirements and recommendations for groundwater management plans. Table 1-1 summarizes these elements and their respective location within the District’s Plan.
### TABLE 1-1

**PLAN SUMMARY**

**GROUNDWATER MANAGEMENT PLAN**

**SHAFTER-WASCO IRRIGATION DISTRICT**

<table>
<thead>
<tr>
<th>SECTION REFERENCE</th>
<th>SUBJECT</th>
<th>PLAN LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Plan Elements (Water Code §10753.7 (a))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>Basin management objectives</td>
<td>Section 4</td>
</tr>
</tbody>
</table>
| (1) | Monitoring and Management:  
- groundwater levels  
- groundwater quality  
- land surface subsidence  
- changes and quality | Section 5, Section 6 |
| (2) | Plan to involve other agencies | Section 2, Section 5, Section 7 |
| (3) | Map of groundwater basin and local agencies | Section 2 |
| (4) | Monitoring protocols | Section 6 |
| Recommended Plan Elements (Water Code §10753.8) |
| a. | Saline Water Intrusion | Section 5 |
| b. | Wellhead Protection (Recharge Areas) | Section 5 |
| c. | Migration of Contaminated Water | Section 5 |
| d. | Well Abandonment/Destruction | Section 5 |
| e. | Overdraft Mitigation | Section 5 |
| f. | Groundwater Replenishment | Section 5 |
| g. | Groundwater Extractions | Section 5 |
| h. | Groundwater Monitoring | Section 5, Section 6 |
| i. | Conjunctive Use | Section 5 |
| j. | Well Construction Policies | Section 5 |
| k. | Operation of Facilities | Section 5, Section 7 |
| l. | Relationships with Other Agencies | Section 5 |
| m. | Land Use Planning | Section 5 |
### TABLE 1-1 (cont’d)

**PLAN SUMMARY**

**GROUNDWATER MANAGEMENT PLAN**

**SHAFTER-WASCO IRRIGATION DISTRICT**

<table>
<thead>
<tr>
<th>Additional Plan Elements (DWR Bulletin 118, Appendix C)</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) Advisory Committee of Stakeholders</td>
<td>Section 7, Appendix A</td>
</tr>
<tr>
<td>(5) Groundwater basin description:</td>
<td>Section 2</td>
</tr>
<tr>
<td>- physical features and characteristics</td>
<td></td>
</tr>
<tr>
<td>- historical data</td>
<td></td>
</tr>
<tr>
<td>- issues of concern</td>
<td></td>
</tr>
<tr>
<td>- historical and project water demands and supplies</td>
<td></td>
</tr>
<tr>
<td>(8) Existing and planned management actions</td>
<td>Section 5, Section 6</td>
</tr>
<tr>
<td>(10) Monitoring program features:</td>
<td>Section 6</td>
</tr>
<tr>
<td>- map of monitoring sites</td>
<td></td>
</tr>
<tr>
<td>- type and frequency of monitoring</td>
<td></td>
</tr>
<tr>
<td>(12) Groundwater Management Reports</td>
<td>Section 7</td>
</tr>
<tr>
<td>(13) Plan re-evaluation</td>
<td>Section 7</td>
</tr>
</tbody>
</table>

**Note:** (1) DWR Bulletin 118, Appendix C outlines 14 required and recommended components for groundwater management plans. Required elements have been documented.

**PLAN CONTACT INFORMATION**

Questions or requests for additional information regarding the District’s Plan should be directed to the Program Manager at the following address:

Shafter-Wasco Irrigation District  
16294 Highway 43  
Wasco, CA 93280-8068  
Phone: 661/758-5153  
FAX: 661/758-6167  
Business Hours: 8:00 a.m. – 5:00 p.m.  
Monday through Friday

The District meets on the 2nd Tuesday of each month. District meetings are held at above address and are open to the public.
SECTION 2
GENERAL
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
DESCRIPTION OF DISTRICT

The Shafter-Wasco Irrigation District (District) is a California Irrigation District. The District covers 38,766 acres with approximately 30,300 acres being farmed. The District was formed in 1937 with the primary purpose of finding ways and means to replenishing the dwindling underground water supply. Groundwater levels declined an average of 2.3 feet per year from 1921 to 1949. A contract for Friant Division CVP supply was executed on February 11, 1955, with the first deliveries under the contract taking place in 1957. Continuous deliveries have been made since that time.

As the surface supply is supplemental, groundwater still plays a principal role. AB 3030 provides a means for local agencies to manage their individual water supplies. In order to preserve local management and enhance existing groundwater management programs operated over many years by the District, the Board of Directors of the District, on September 12, 2006, instructed the preparation of this Groundwater Management Plan (Plan) under the provisions of AB 3030. The Plan will enable the District to establish policies that will serve to enhance the overall management of the water supplies available to the District.

In 2002 and 2004, Senate Bill (SB) 1938 and Assembly Bill (AB) 105, respectively, amended the requirements of groundwater management plans. This Plan incorporates the necessary elements to comply with the provisions of that legislation.
AB 3030 provides for the development of a groundwater management plan within the boundaries of the District. The underlying groundwater basin is part of the larger Tulare Lake Basin as identified in State of California Bulletin 118. The management area for the District’s Plan may include, by agreement, adjacent entities whose activities would influence the common groundwater resource. The District’s boundaries are shown on Figure 2-1.

Plan Participants

The District will be responsible for the implementation of the Plan. The District will be the primary Plan Participant. The identification and involvement of additional Plan Participants will result from Plan activities.

A Plan Participant tabulation is presented in Appendix A. This Appendix will be revised from time-to-time to reflect the Plan’s then current participants.

Stakeholders

For the purposes of the Plan, a stakeholder will be defined as any individual, group, or entity located within the Plan Area that may be affected by the implementation of the Plan. Stakeholders can be Plan Participants.

An initial compilation of District Plan stakeholders is presented in Appendix A. Additional stakeholders may be identified through Plan activities.

Advisory Committee

To date, the District has not created an Advisory Committee to oversee the implementation and subsequent refinement of the Plan. This function will be performed by District management, staff and consultants until otherwise determined by the District Board of Directors.
SECTION 3
GROUNDWATER BASIN CHARACTERISTICS
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
SECTION 3
GROUNDWATER BASIN CHARACTERISTICS
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT

GENERAL

The Shafter-Wasco Irrigation District (District) is located within the Kern County Sub-basin of the San Joaquin Valley Groundwater Basin (Basin No. 5-22.13). The Kern County Sub-basin is bounded by the following groundwater sub-basins; Tule River (north) and Tulare Lake (northwest). The District portion of the groundwater basin includes the Poso Creek drainage as its major surface drainage.

Typical annual rainfall in the District is approximately 6.6 inches. The western portion of the Basin is typically more arid. The eastern edge of the Basin along the mountains experiences slightly higher rainfall amounts.

The region encompassed by the District’s Groundwater Management Plan (Plan) is shown on Figure 3-1. The cities of Shafter and Wasco represent the major population centers within the District. The Basin is rural in nature, dominated by agricultural land use as shown in Figure 3-2.

PHYSICAL CHARACTERISTICS

The physical characteristics of the groundwater basin influence the content of the Plan. In particular, the manner in which groundwater is replenished is directly affected by surface and subsurface characteristics, such as the permeability of the overlying and subsurface soils. The permeability of the soils within the groundwater basin is limited. In general, the soils having higher permeability rates are associated with the Poso Creek delta.
The District overlies areas of both unconfined and confined aquifers. There are limited areas of perched water and shallow groundwater tables. These conditions result from subsurface geologic conditions. A general depiction of the aquifer and subsurface geologic conditions is presented on Figure 3-3. Figure 3-4 shows the groundwater elevations for spring, 2004, as compiled and prepared by the Department of Water Resources. Recent average depths to groundwater are presented on Figure 3-5.

The District overlies an unconfined aquifer. There are no perched zones or shallow groundwater tables in the District. The District lies in the San Joaquin Basin Hydrologic Study Area as described in Department of Water Resources Bulletin No. 118-75 and 118-80. The District is located in the Kern Basin which is composed of contiguous older and younger alluvium. The Basin is one (1) of eight (8) in the basin hydrologic study area which has been identified as subject to critical condition of overdraft. There are no District or on-farm surface or subsurface drainage systems installed in the District. Drainage is not a problem in the District.

The groundwater supply is pumped with privately owned wells by individual water users from an unconfined aquifer. The surface water is to be used conjunctively with the groundwater by storing non-storable District surface water in the groundwater reservoir by in-lieu of pumping groundwater recharge.

The District is a surface water groundwater supply conjunctive use district in which the water users' water supply comes from imported water from the Friant Unit of the CVP, local precipitation and groundwater from water user owned pumps. The hydrologic cycle for the San Joaquin River varies greatly, providing a variable surface supply to the District. The frequency and magnitude of the surface supply for the District is expected to continue to fluctuate in the future as it has in the past. The water users stabilize their water supply by maximizing the
surface supply when it is available, and utilizing the groundwater supply when the surface supply is deficient.

The District encompasses 38,766 acres of which approximately 30,290 acres is farmed. Imported water is delivered to 27,100 of the 30,290 farmed acres. The imported water varies from 0.5 acre-feet per acre to 4.0 acre-feet per acre, depending on the water year. The water users recharge the imported water to the groundwater supply in large water years by using the imported water to meet their irrigation requirements and not pumping the groundwater supply. Some of the imported water is also recharged to the groundwater supply through deep percolation.

The District staff monitors the groundwater levels in the District by measuring approximately 74 groundwater wells in January and September of each year. This information is used to monitor the amount of groundwater used by the water users in the District.
FIGURE 3-1

Legend
- Shafter-Wasco Irrigation District
- water_course
- kermoads

KERN COUNTY

VICINITY MAP

PLAN BOUNDARIES
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT

KELLER / WEGLEY
Kern Groundwater Basin

Spring 2004, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles

Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

SOURCE: DEPARTMENT OF WATER RESOURCES

GROUNDWATER ELEVATIONS
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT

KELLER / WEGLEY
**SHAFTER - WASCO IRRIGATION DISTRICT**

**AVERAGE GROUNDWATER DEPTH**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(From North)</td>
<td>Apr 5</td>
<td>May 3</td>
<td>Jun 5</td>
<td>Jul 6</td>
<td>Aug 2</td>
<td>Sep 6</td>
<td>Oct 4</td>
<td>Nov 7</td>
<td>Dec 5</td>
<td>Jan 8</td>
<td>Feb 6</td>
<td>Mar 2</td>
<td>Apr 3</td>
<td>May 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-240</td>
<td>-244</td>
<td>-246</td>
<td>-251</td>
<td>-255</td>
<td>-252</td>
<td>-250</td>
<td>-243</td>
<td>-239</td>
<td>-234</td>
<td>-236</td>
<td>-236</td>
<td>-246</td>
<td>-261</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVERAGE</td>
<td>-234</td>
<td>-238</td>
<td>-244</td>
<td>-248</td>
<td>-251</td>
<td>-246</td>
<td>-243</td>
<td>-238</td>
<td>-233</td>
<td>-229</td>
<td>-230</td>
<td>-230</td>
<td>-241</td>
<td>-262</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Average Groundwater Depth**

**April 06 - May 07**
SECTION 4
BASIN MANAGEMENT OBJECTIVES
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
GENERAL

The Shafter-Wasco Irrigation District (District) has developed five (5) basin management objectives to guide the implementation of the Groundwater Management Plan (Plan). By accomplishing these objectives, the District believes that a more reliable groundwater supply for long-term beneficial uses within the Plan area will be realized. The District’s basin management objectives within the Plan area are:

1. To promote and realize groundwater resource protection;
2. To facilitate groundwater resource sustainability;
3. To develop groundwater resource understanding;
4. To develop groundwater basin understanding; and
5. To promote and facilitate information dissemination regarding the groundwater resource.

Each basin management objective is described below.

GROUNDWATER RESOURCE PROTECTION

Groundwater needs to have water quality that will sustain its beneficial uses to remain a viable water resource within the groundwater basin. This objective focuses the District’s management strategies to maintain the good water quality of the Plan Area's groundwater. The District will utilize the following strategies to achieve this objective.
Wellhead/Recharge Area Protection;
- Migration of Contaminated Water Controls;
- Well Abandonment and Destruction Policies; and
- Well Construction Policies.

Protection of the groundwater beneath the District ensures that the maximum amount of groundwater remains available. Achieving this basin management objective minimizes the potential to lose groundwater volumes to contamination.

**GROUNDWATER RESOURCE SUSTAINABILITY**

Groundwater is the primary water supply in the Plan Area for both domestic and agricultural purposes. This objective emphasizes the maintenance and/or increase of the available groundwater supply. The following management strategies will be used toward achieving this objective:

- Overdraft Mitigation;
- Groundwater Recharge Policies;
- Groundwater Extraction Management;
- Conjunctive use Policies; and
- Operation of Facilities.

This basin management objective will identify and quantify the surface and groundwater supplies available to the District landowners and define the interaction between these supplies. Groundwater storage is affected by groundwater pumping and groundwater recharge as water users attempt to meet their water use demands. The net result of the interactions between the
available water supplies and the demands for water is a change in groundwater storage. This basin management objective is intended to provide the District with the information and tools required to maintain and improve the total water supply through coordinated management of groundwater.

GROUNDWATER RESOURCE UNDERSTANDING

The purpose of this basin management objective is to further develop knowledge regarding the Plan Area's groundwater. With detailed information regarding the groundwater resource, improved characterization will lead to future groundwater management decisions. The primary Plan element that will achieve this objective is groundwater monitoring.

Continued monthly monitoring of six (6) wells and semi-annual monitoring of 64 wells will assist in conclusions as to the status (availability) of the resource. Groundwater levels also reveal the effectiveness of other strategies, such as groundwater recharge efforts. Monitoring data developed over time will serve as the foundation of conclusions regarding groundwater reliability and management strategy effectiveness.

GROUNDWATER BASIN UNDERSTANDING

This basin management objective garner basin information to facilitate evaluations regarding basin features and potential groundwater resource impacts.

Changes to the groundwater basin's topographic, geologic and hydrologic conditions may adversely affect the groundwater. Land use development can impact both the quantity and
quality of groundwater. The availability of surface water reduces overall demand on the groundwater.

This objective will be achieved through the following management strategies:

- Land Subsidence Monitoring;
- Land Use Planning; and
- Surface Water Management.

Through these strategies, the District will remain familiar with the Plan Area’s topographic, geologic and hydrologic conditions that may affect the groundwater resource. The District will have the capability to react to proposed projects and changing conditions and potentially avoid adverse groundwater impacts.

INFORMATION DISSEMINATION

Groundwater resource and basin information and knowledge will result from the active implementation of this Plan. The District will serve as the primary conduit of information regarding the Plan and subsequent results.

This Basin management objective will result from the following plan elements:

- Groundwater Basin and Resource Information Management;
- Groundwater Basin and Resource Reports; and
- Local Agency and Stakeholder Involvement.

The Plan and its management strategies will result in the compilation of various data and information regarding the groundwater basin and its resources. The District will compile, manage and disseminate this information to facilitate improved coordination and use of the Plan.
Area's hydrologic resources. The Plan will also result in various opportunities for the Basin's stakeholders to respond to basin management efforts.
SECTION 5
MANAGEMENT STRATEGIES
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
GENERAL

California Water Code Sections 10753.7 and 10753.8 set forth required and recommended elements that establish strategies for groundwater management. Each strategy and the Shafter-Wasco Irrigation District's (District) planned activities conducted in support of the strategy are described in this section. Some activities have been in use since the inception of the District. Planned activities describe proposed District efforts that will be utilized during the implementation of this Plan.
SALINE WATER INTRUSION CONTROL

The Groundwater Basin underlying the District is a subbasin of the Tulare Lake Hydrologic Region. The western edge of the Plan Area is situated about 90 miles from the Pacific Ocean. The District does not consider saline water intrusion controls a management strategy that warrants consideration.

Plan Activities

None - The District reserves the right to decide whether or not it will be involved with this strategy in the future as authorized by Water Code Section 10753.8.
**WELLHEAD AND RECHARGE AREA PROTECTION**

The management strategy consists of the identification, establishment and management of wellhead and recharge protection areas. Areas where groundwater pumping and recharge occur warrant dedicated attention by the District. Wells represent a direct conduit to groundwater. No wells are currently owned by the District. No recharge basins currently exist within the District boundaries. The District does, however, participate in out of District recharge areas.

The District will monitor and participate in land use development activities within the recharge areas. As all areas within the District are currently farmed, the District has evaluated areas where land being farmed does not have to be taken out of production. Fortunately, these areas are adjacent to the District to the east and have a direct nexus to groundwater underlying lands within the District.

**Plan Activities**

1. Land use and development monitoring;
2. Participation in pertinent land use/zoning planning procedures; and
3. Incorporation of security measures such as fencing, as necessary.
MIGRATION OF CONTAMINATED GROUNDWATER CONTROLS

This management strategy incorporates regulations and controls for contaminated groundwater. The District has not identified specific plumes of contaminated groundwater. Source specific plumes of contaminated groundwater, such as those from leaking underground storage tanks, fall under the jurisdiction of various state and federal agencies. The District is not in a position at this time to pursue regulations regarding unattributed groundwater contamination.

The District will develop and implement protocols to obtain and compile information regarding contaminated groundwater. Monitoring of groundwater quality will also be conducted.

Plan Activities

1. Monitoring of regulatory activities and records regarding contaminated groundwater within Plan Area; and
2. Complete an inventory of and evaluate available groundwater quality data.
WELL ABANDONMENT/DESTRUCTION POLICIES

Improper well abandonment may allow contamination of the groundwater. Well abandonment must be conducted in conformance with standards adopted by the County of Kern. The District will monitor these activities by reviewing abandonment records compiled by the County. Appropriate information on proper abandonment of wells within the Plan area will be made available through the District.

In lieu of well abandonment, the District will pursue the conversion of a production well to a monitoring well if such suitable opportunities arise and funding is available.

Plan Activities

1. Establish and maintain a protocol with Kern County regarding review of well abandonment records;
2. Develop record keeping system/database of abandoned wells;
3. Establish public education activity to inform stakeholders of well standards and policies; and
4. Develop and implement program to convert abandoned production wells to monitoring wells.
WELL CONSTRUCTION POLICIES

The increase in groundwater extraction resulting from the construction of additional wells affects the long-term water balance of the region. Well construction may allow contamination of the groundwater if not done properly. Well construction must be conducted in conformance with standards adopted by the County of Kern. The District will monitor these activities by reviewing well construction records compiled by the County. Appropriate information on proper construction of wells within the Plan area will be made available through the District.

Opportunities for additional groundwater monitoring wells may arise through the abandonment of existing production wells. The District will consider such a conversion to eliminate the construction of additional wells.

Plan Activities

1. Establish and maintain a protocol with Kern County regarding review of well construction records;
2. Develop a record keeping system/database of constructed wells;
3. Establish public education activity to inform stakeholders of well construction standards and policies; and
4. Develop guidelines for monitoring well conversion.
OVERDRAFT MITIGATION

The groundwater basin is experiencing groundwater overdraft as evidenced by lower groundwater levels within the Plan Area.

This management strategy is best achieved through the implementation of several companion management strategies. Overdraft mitigation is accomplished through the integration of the following strategies:

- Groundwater Recharge/Management;
- Groundwater Extraction Policies;
- Conjunctive Use Policies; and
- Surface Water Management.

These strategies will be implemented to attempt to achieve a hydrologic balance within the Plan area, thereby reducing overdraft of the groundwater resource.
GROUNDWATER RECHARGE MANAGEMENT

The replenishment of the underlying groundwater occurs naturally and through deliberate, controlled means. The District's groundwater replenishment is achieved by controlled means principally through the delivery of surface water, when available, to lands otherwise relying on the groundwater resource.

Direct recharge is achieved through the placement of surface water in areas to the east of the District on permeable soils for the express purpose of percolation to the underground. It is the intention of the District to expand the opportunities with neighboring districts. The monitoring of groundwater conditions under this Plan will enable the District to identify the extent of need in this regard.

Delivery of surface water for irrigation purposes reduces the need for water users to draw on groundwater, thereby conserving the water available in the aquifer for later use. The use of surface water in this manner is known as in-lieu recharge and is practiced by the District landowners. Some additional benefit is derived when irrigation water applied beyond crop water needs percolates to the underground.

Plan Activities

1. Maintain and/or expand relationships involving networks of groundwater recharge facilities;
2. Maintain and/or expand surface water deliveries within the Plan area; and
3. Pursue additional surface water supplies for specific purposes of in-lieu groundwater recharge.

5–8
GROUNDWATER EXTRACTION POLICIES

Effective groundwater replenishment and maintenance of groundwater levels involves the management of water supplies available to the basin and extractions from the basin. Groundwater extractions within the management area are primarily by private wells. Management of groundwater extractions can best be achieved through economic incentives, rather than through the regulation of extractions. This current practice will continue to be implemented through the pricing of surface water at rates which encourage water users to use surface water in-lieu of pumping groundwater.

Plan Activities

1. Secure surface water quantities and establish subsequent pricing that encourages maximum surface water use;

2. Develop and implement an educational program focused on:
   a) Timing of use of groundwater;
   b) Timing of use of surface water; and

3. Evaluate grower incentive based banking program.
CONJUNCTIVE USE POLICIES

Groundwater management in California is rooted in the conjunctive use of surface and groundwater resources. Use of the water supplies from the two sources is integrated to accomplish the optimum utilization of each source.

In years of shortage, that previously stored water is pumped to supplement available surface water. District landowners will be encouraged to maximize the utilization of available facilities and resources for conjunctive use through cooperative management.

Conjunctive use opportunities motivated the District to enter into a long-term contract with the United States beginning in the 1950’s for the importation of supplemental surface water supply from the Friant Unit of the CVP.

Water transfers and exchanges are an integral part of the existing conjunctive use programs. Under the Plan, the District will seek to preserve and enhance conjunctive use activities through coordinated use of available supplies made possible by water transfers and exchanges and through expansion of recharge facilities. Enhancement of conjunctive use activities could include the development of water banking arrangements with other agencies by utilizing available groundwater storage capacity for the temporary storage of water. This management strategy will result from the integration of the following plan elements:

- Groundwater Recharge Policies;
- Groundwater Extraction Policies; and
- Surface Water Management.
SURFACE WATER MANAGEMENT

Surface Water Quantity

The District imports surface water supplies from the Central Valley Project through the Friant Division under a long-term contract with the United States. Also, the District makes short-term and year-to-year arrangements to secure additional Central Valley Project (CVP) water and other supplies. The District has in place and operates an extensive system of conveyance, distribution and recharge exchange facilities throughout their service area to make use of available surface supplies. The contract of Class 1 supply and water supply amounts available to the District consist of 50,000 af of Class 1 supply and 39,600 af of Class 2 supply.

Under this Plan, the District will seek to preserve the existing water rights and contract and will pursue opportunities to supplement these supplies through importation of additional water supplies for District landowners. Supplemental supplies may be obtained through purchase of additional CVP water from other entities, "Section 215 water" from the United States and through other programs as may be available. Efficient water use and distribution within the management area will be encouraged through the use of transfers and exchanges among District water users.

Importation of affordable water supplies, in quantities sufficient to achieve a long-term water balance within the service area of the District, is a prerequisite for successful implementation of the recharge groundwater management strategy. All opportunities to supplement the regular supplies of the District through water exchange and banking agreements with outside entities, proposed by individual District landowners, will be evaluated for compatibility with the goals of this Plan.
This evaluation process will consist of the following steps:

1. Submittal of a written proposal and technical report to the District;
2. District and consultant evaluation;
3. Proponent and District Coordination; and
4. District staff recommendation and Board of Directors action.

For any proposed Project, the Proponent will initiate the process through the transmittal of a written proposal describing the Project, including the anticipated benefits. A technical report will be prepared by the Proponent and evaluated by the District. The report must describe:

1. Quantities and sources of water;
2. Structures and other physical features of the proposed Project;
3. Water accounting measures and/or methods;
4. Funding;
5. Schedule, including CEQA compliance;
6. Anticipated benefits; and

The District staff and consultant will evaluate the Technical Report prior to any Board determination regarding the proposed Project.

The District will utilize outside consultants, as necessary, for further evaluations. The proposal and technical report will be reviewed for consistency with the Plan's basin management objectives and utilization of adopted management strategies.

The resulting evaluation will be returned to the Project Proponent. The District will coordinate with the Proponent to develop the final proposed Project. Upon finalization of the
proposed Project, the District Board of Directors will act to determine the compatibility of the proposed Project with the goals of this Plan. Similarly, water exchange and banking agreements among the District and adjacent banking partners will be used where they may enable the District to distribute water to areas identified under this Plan as suffering from groundwater depletion and as being suitable for groundwater storage.

Surface Water Quality

The surface waters of the Plan area are singular. Imported surface water originates in the San Joaquin Delta for exchange with waters from the San Joaquin River watershed (Friant-Kern Canal). Current surface water monitoring programs are summarized in Table 5-1. Under this management strategy, the District will review results of existing monitoring programs. Additional surface water quality monitoring will be developed if deemed necessary.

Plan Activities

1. Maintain or increase quantities of imported surface water;
2. Preserve existing surface water rights;
3. Promote efficient water use through the use of water exchanges and transfers;
4. Investigate potential for water banking opportunities adjacent to the Plan area;
5. Develop additional water storage capacity within the Plan area; and
6. Monitor existing surface water quality testing efforts by other agencies.
<table>
<thead>
<tr>
<th>SURFACE WATER</th>
<th>MONITORING AGENCY</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friant-Kern Canal</td>
<td>Reclamation District 770</td>
<td>Annually</td>
</tr>
<tr>
<td></td>
<td>Terra Bella Irrigation District</td>
<td>Varies - monthly to annually</td>
</tr>
</tbody>
</table>
OPERATION OF FACILITIES

This management strategy consists of the construction and operation of facilities that address groundwater recharge, storage extraction, conservation contamination clean-up and water recycling. Current efforts primarily address groundwater recharge through percolation basins and unlined irrigation distribution channels. In general, the current projects are implemented jointly with adjacent water supply districts.

Additional groundwater facilities will be needed to sustain the resource as demands placed on the groundwater resource increase. The District will evaluate potential projects that will address this need. The current scope of this strategy will be expanded as necessary. Opportunities to incorporate recycling and reclamation and water conservation may be possible through coordination with domestic utility providers.

Plan Activities

1. Maintain policy which facilitates maintenance of joint recharge areas.
2. Develop and implement protocol to identify operations projects.
3. Upgrade and expand surface water conveyance facilities.
GROUNDWATER MONITORING

Groundwater monitoring will be used by the District to assess the quantity and quality of the groundwater resource. The details of this management strategy are described in Section 6.

The District currently participates in annual monitoring of groundwater levels. Additional groundwater level information is available from domestic water providers.

In general, regular groundwater quality assessments are conducted by domestic water providers within the region. The District will develop a protocol to compile groundwater quality data. Additional groundwater quality monitoring efforts will be developed as needed.
LAND SUBSIDENCE MONITORING

The District does not have any substantial information regarding land subsidence within the Plan area. This management strategy consists of developing and implementing monitoring protocols to determine the pressure of land subsidence. The District's efforts will establish a starting point for future evaluations.

Plan Activities

1. Identify and establish an elevation control network throughout the Plan area.
2. Conduct periodic survey of control network to determine presence, if any, of land subsidence.
LAND USE PLANNING

This management strategy consists of reviewing land use plans and coordination with local planning agencies. Under this strategy, the District will review projects and basin activities that affect land use and the potential for groundwater resource impacts.

Plan Activities

1. Develop and maintain protocols to participate in local land use planning efforts.

2. Continue participation in California Environmental Quality Act as a responsible agency.
GROUNDWATER BASIN AND RESOURCE INFORMATION MANAGEMENT

Many strategies to be utilized by the District will produce groundwater resource and basin data or information. This information will need to be completed and inventoried.

The purpose of this management strategy is to ensure that data and information gathered during the implementation of the Plan is readily available for evaluation purposes. Many Plan efforts could be implemented by other Plan Participants. Centralizing this data and information will be critical to groundwater management.

Under this management strategy, the District will also conduct assessments and evaluations of the implementation data. These efforts will serve as the basis of development for the District's annual reports and other Plan documents.

A conjunctive groundwater use model has not been developed by the District. Such a model could be a productive tool which could provide an additional method to evaluate Plan data and conduct groundwater resource assessments.

Plan Activities

1. Establish data management authority and responsibilities.

2. Develop and implement data collection and inventory protocols and standards.

3. Determine feasibility of development and use of predictive groundwater model.
GROUNDWATER BASIN AND RESOURCE REPORTS

This management element consists of the preparation of reports and other documents used by the District to disseminate information and findings regarding its efforts under the Plan. Reports will be used to document Plan activities and subsequent effectiveness. These reports will also be used to present new and/or additional knowledge regarding the Basin characteristics and resources.

Detailed information regarding the District's reporting efforts can be found in Section 7, Implementation.

Plan Activities


2. Prepare technical memoranda as necessary to disseminate information regarding Plan activities.
LOCAL AGENCY AND STAKEHOLDER INVOLVEMENT

This management strategy consists of efforts to engage individuals and agencies within the Plan area in Plan participation. Three primary elements will form the foundation of this management strategy: Plan participation, Advisory Committee and Public Review. The first element is Plan Participation. There exists many agencies within the Plan area that will realize benefits from the District’s coordinated Plan efforts to manage the groundwater resource. The District will pursue opportunities to engage such agencies as Plan Participants. Additional Plan Participants increase the extent of coordinated groundwater resource management and the amount of resources available to implement the Plan.

The second element of this strategy is the consideration of the development and utilization of a Plan Advisory Committee (Committee) to assist in the implementation of the Plan. The District will establish the need for such a Committee and, if need is determined to exist, will establish the criteria regarding Committee formation and participation. To be effective, the Committee must include individuals and agencies that represent the various resource interests of the Plan area. The District will endeavor to enlist sufficient representation for the Committee. Additional committees may be created as necessary to facilitate implementation of the Plan.

The third element of this strategy consists of public participation and review. The meetings of the District are open to the public. Public notification will be developed to encourage public participation. During Plan reporting efforts, the public will be afforded opportunity to review and publicly comment on the Plan and its implementation. The Plan will be considered public record and available for inspection.
Plan Activities

1. Pursue Plan participation by local agencies within Plan Area;

2. Maintain advisory committee of Plan Participants and Plan stakeholders; and

3. Establish and maintain public notification and participation procedures regarding Plan activities.
SECTION 6
MONITORING
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
GENERAL

Optimal use of the groundwater resource is dependent on the acquisition of good basic data respecting both geology and hydrology. The purpose of this element of the Shafter-Wasco Irrigation District’s (District) Groundwater Management Plan (Plan) is to monitor conditions within the groundwater basin to identify changing conditions which may require attention. Monitoring includes gathering and analyzing basic data generated from Plan management activities to characterize the basin to provide the information necessary for future management decisions. Existing and proposed management activities in this regard may be enhanced to provide a more complete picture of the condition of the groundwater resource. The Plan's primary monitoring effort will be directed at the groundwater resource. Additional monitoring efforts will result from activities proposed by management strategies.

GROUNDWATER MONITORING

Groundwater monitoring will consist of two components which are groundwater levels and groundwater quality.

Groundwater Levels

Data regarding groundwater levels is used to evaluate groundwater movement and storage conditions. Groundwater contour maps showing lines of equal elevation of the water surface indicate the direction of groundwater movement and can be used to develop estimates of
groundwater flow entering or leaving the management area. Maps of depth to groundwater can provide insight into the distribution of pumping lifts and resulting energy costs for extraction. Maps showing changes in groundwater levels, when used in conjunction with data on specific yield, can also be used to estimate changes in groundwater storage.

The District staff routinely measures groundwater levels in approximately 64 wells. The locations and details related to the current wells are presented in Table 6-1. Measurements are made in the spring and fall of each year. The present monitoring networks will be maintained or enhanced to assure the availability of sufficient data for the preparation of groundwater contour maps. Measurement of groundwater levels will continue to be performed in both spring and fall in order to show seasonal variations.

Groundwater Quality

Monitoring of groundwater quality provides the information required for determinations of the suitability of groundwater for various uses. Comprehensive groundwater quality data for the Plan area does not exist. The District will develop protocols to obtain groundwater quality data from domestic water providers and other sources and consolidate it for management purposes.

Sampling of District landowner wells will be considered, if necessary, to provide sufficient data to allow identification of water quality problem areas. Supplemental sampling may also be performed to better define localized areas of impaired water quality. Testing will typically include standard agricultural type analysis, but may also include additional testing such as Title 22 parameters, as required.
### TABLE 6-1

#### GROUND-WATER MEASUREMENTS

<table>
<thead>
<tr>
<th>AGENCY NO.</th>
<th>AGENCY</th>
<th>Shafter-Wasco I.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>5614</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USBR WELL NUMBER</th>
<th>Tape Reading</th>
<th>Date</th>
<th>N</th>
<th>Q</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWP</td>
<td>Range</td>
<td>Sec.</td>
<td>Tr.No</td>
<td>BM</td>
<td>at M.P.</td>
</tr>
<tr>
<td>26S</td>
<td>24E</td>
<td>32</td>
<td>J</td>
<td>5</td>
<td>M</td>
</tr>
<tr>
<td>26S</td>
<td>24E</td>
<td>34</td>
<td>R</td>
<td>1</td>
<td>M</td>
</tr>
<tr>
<td>26S</td>
<td>24E</td>
<td>36</td>
<td>M</td>
<td>3</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>36</td>
<td>P</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>3</td>
<td>H</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>13</td>
<td>N</td>
<td>1</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>14</td>
<td>F</td>
<td>1</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>15</td>
<td>R</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>24</td>
<td>E</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>26</td>
<td>H</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>27</td>
<td>F</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>28</td>
<td>R</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>34</td>
<td>J</td>
<td>2</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>35</td>
<td>J</td>
<td>1</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>36</td>
<td>A</td>
<td>1</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>7</td>
<td>R</td>
<td>1</td>
<td>M</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>18</td>
<td>F</td>
<td>1</td>
<td>M</td>
</tr>
</tbody>
</table>

**NO MEASUREMENT**

1. Pumping
2. Pump House locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well destroyed
7. Special
8. Casing leaking
9. Temporarily inaccessible
10. Air gauge mea.

**Questionable Measurement**

1. Pumping
2. Nearby Pumping
3. Casing leaking
4. Pumped recently
5. Acoustical sounding
6. M.P. change
7. Recharge
8. Oil in casing
9. Casing leaking
10. Air gauge mea.
# Table 6-1

## Ground-Water Measurements

<table>
<thead>
<tr>
<th>Agency No.</th>
<th>AGENCY</th>
<th>Shafter-Wasco I.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5614</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USBR Well Number</th>
<th>Tape Reading</th>
<th>Date</th>
<th>N Q</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>at M.P.</td>
<td>at W.S.</td>
<td>mm-dd-yy</td>
<td></td>
</tr>
<tr>
<td>TWP</td>
<td>Range</td>
<td>Sec.</td>
<td>Tri No</td>
<td>BM</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>--------</td>
<td>-----</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>19 C</td>
<td>2 M</td>
<td>245</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>19 N</td>
<td>3 M</td>
<td>256</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>19 P</td>
<td>3 M</td>
<td>259</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>29 H</td>
<td>3 M</td>
<td>261</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>30 J</td>
<td>3 M</td>
<td>259</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>31 D</td>
<td>3 M</td>
<td>252</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>32 A</td>
<td>3 M</td>
<td>259</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>34 E</td>
<td>3 M</td>
<td>264</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>34 P</td>
<td>3 M</td>
<td>261</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>1 L</td>
<td>1 M</td>
<td>242</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>2 A</td>
<td>1 M</td>
<td>244</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>3 R</td>
<td>1 M</td>
<td>241</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>10 R</td>
<td>1 M</td>
<td>242</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>11 F</td>
<td>2 M</td>
<td>246</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>12 J</td>
<td>2 M</td>
<td>250</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>12 M</td>
<td>2 M</td>
<td>252</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>2 N</td>
<td>1 M</td>
<td>254</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>3 J</td>
<td>2 M</td>
<td>255</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>4 L</td>
<td>2 M</td>
<td>253</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>5 F</td>
<td>1 M</td>
<td>252</td>
</tr>
</tbody>
</table>

NO MEASUREMENT

- Measurement Disc.
- Well destroyed
- Caved or other Obs.
- M.P change

Questionable Measurement

- Pumping
- Special
- Nearby Pumping
- Oil in casing
- Casing leaking
- Accoustical
- Pumped recently
- Air gauge mea.
<table>
<thead>
<tr>
<th>TWP</th>
<th>Range</th>
<th>Sec.</th>
<th>Tr. No.</th>
<th>BM at M.P.</th>
<th>at W.S.</th>
<th>Date</th>
<th>N</th>
<th>Q</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>28S</td>
<td>25E</td>
<td>6</td>
<td>B</td>
<td>M</td>
<td>254</td>
<td>01 29 07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>7</td>
<td>J</td>
<td>2</td>
<td>M</td>
<td>250</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>8</td>
<td>M</td>
<td>1</td>
<td>M</td>
<td>252</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>10</td>
<td>D</td>
<td>2</td>
<td>M</td>
<td>253</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>14</td>
<td>C</td>
<td>3</td>
<td>M</td>
<td>249</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>14</td>
<td>L</td>
<td>1</td>
<td>M</td>
<td>228</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>15</td>
<td>R</td>
<td>1</td>
<td>M</td>
<td>239</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>16</td>
<td>R</td>
<td>1</td>
<td>M</td>
<td>240</td>
<td>01 29 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>17</td>
<td>G</td>
<td>1</td>
<td>M</td>
<td>242</td>
<td>01 25 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>17</td>
<td>R</td>
<td>1</td>
<td>M</td>
<td>244</td>
<td>01 25 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>18</td>
<td>C</td>
<td>1</td>
<td>M</td>
<td>246</td>
<td>01 25 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>20</td>
<td>J</td>
<td>1</td>
<td>M</td>
<td>240</td>
<td>01 25 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>21</td>
<td>M</td>
<td>1</td>
<td>M</td>
<td>237</td>
<td>01 25 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>22</td>
<td>G</td>
<td>1</td>
<td>M</td>
<td>231</td>
<td>01 25 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>23</td>
<td>K</td>
<td>1</td>
<td>M</td>
<td>237</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>26</td>
<td>C</td>
<td>2</td>
<td>M</td>
<td>226</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>26</td>
<td>N</td>
<td>2</td>
<td>M</td>
<td>218</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>28</td>
<td>R</td>
<td>2</td>
<td>M</td>
<td>235</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>29</td>
<td>L</td>
<td>M</td>
<td></td>
<td>238</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>36</td>
<td>J</td>
<td>1</td>
<td>M</td>
<td>200</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>26E</td>
<td>19</td>
<td>A</td>
<td>2</td>
<td>M</td>
<td>240</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>26E</td>
<td>30</td>
<td>A</td>
<td>1</td>
<td>M</td>
<td>224</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>26E</td>
<td>30</td>
<td>J</td>
<td>1</td>
<td>M</td>
<td>206</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28S</td>
<td>26E</td>
<td>31</td>
<td>J</td>
<td>1</td>
<td>M</td>
<td>196</td>
<td>01 26 07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### No Measurement
- Measurement Disc.
- Well destroyed
- Caved or other Obs.
- M.P change

### Questionable Measurement
- Pumping
- Special
- Nearby Pumping
- Recharge
- Casing leaking
- Nearby Pumping
- Oil in casing
- Temporarily inaccessible
- Casing leaking
- Acoustical sounding
- Pumped recently
- Air gauge mea.
ADDITIONAL MONITORING

Data related to the hydrologic inventory will be collected annually for quantification and analysis. Components of the inventory include precipitation, runoff, imported supplies, amounts of groundwater replenished and quantities of groundwater extracted. Additional monitoring efforts will result from the following Plan management strategies:

- Groundwater Recharge Management;
- Groundwater Extraction Policies;
- Surface Water Management;
- Land Use Planning;
- Well Abandonment/Destruction Policies; and
- Well Construction Policies.
SECTION 7
PLAN IMPLEMENTATION
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
SECTION 7
PLAN IMPLEMENTATION
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT

GENERAL

The Shafter-Wasco Irrigation District (District) will serve as the custodian of the District's Groundwater Management Plan (Plan). The District will act as the Plan's resource center and data clearinghouse. Monitoring Data and information gathered during Plan Implementation will be compiled and stored at the District office. The District will also lead Plan activity, report preparation and information dissemination efforts.

PLAN PARTICIPATION

The Plan officially recognizes stakeholders through the execution of a Memorandum of Understanding (MOU) between the District and an interested entity. The purpose of the MOU is to document the interests and responsibilities of participants in the adoption and implementation of the Plan. The MOU also promotes the sharing of information, the development of a course of action and the resolving of differences that may arise regarding the Plan. It is foreseen that stakeholder involvement will increase with time. The District will continue to pursue new stakeholder involvement and shall endeavor to enter into an agreement with other local agencies in the form of a Memorandum of Understanding in compliance with California Water Code § 10750.8. A sample of one form of Memorandum of Understanding is included in Appendix "B".
DISPUTE RESOLUTION

The Plan acknowledges that controversial issues could arise concerning the groundwater resource. Stakeholders are encouraged to work through the Plan in addressing and resolving differences. When this process proves insufficient, the District has adopted in this Plan, an applicable policy for dispute resolution. The policy is presented in Appendix “C”.

ANNUAL REPORT

Documentation in the form of an annual report will be prepared as required to record the results of the management activities monitoring elements of the Plan. The contents of the annual report will include:

1. Maps and/or tables showing:
   - spring and fall groundwater elevations;
   - changes in groundwater levels between subsequent spring readings; and
   - groundwater quality;

2. Estimation of the changes in groundwater storage computed using specific yield data and maps of change in groundwater levels;

3. Summary of water resource data; and

4. Assessment of the effectiveness of management activities.
PLAN OF EVALUATION

The Plan will be re-evaluated annually subsequent to the findings of the Plan's annual report. The District staff will be responsible for monitoring the Plan's activities and progress towards its management objectives.

The re-evaluation of the Plan will include an assessment of the effectiveness of Plan activities and a determination of potential modification(s) to the Plan.

ADDITIONAL REPORTS

Additional reports and technical memoranda may be produced as a result of Plan activities, grant funding requirements or other need for documentation. The content of any supplemental documents will address the informational requirements.

SCHEDULE

Implementation of the District’s Plan will be structured according to the schedule presented in Table 7-1.
TABLE 7-1
IMPLEMENTATION SCHEDULE
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT

<table>
<thead>
<tr>
<th>PLAN ACTIVITY</th>
<th>OCCURRENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan Management Strategies and Activities</td>
<td>Monthly (As Required)</td>
</tr>
<tr>
<td>District General Meeting</td>
<td>Monthly</td>
</tr>
<tr>
<td>Plan Report</td>
<td>Annually</td>
</tr>
<tr>
<td>Plan Re-evaluation</td>
<td>5-year Basis</td>
</tr>
<tr>
<td>Groundwater Monitoring</td>
<td>Annually (Additional As Required)</td>
</tr>
</tbody>
</table>

PLAN FUNDING

Implementing the Plan will require dedicated funding through the District and potentially with Plan Participants. In general, funding for the Plan and its activities will be derived from grants, in-lieu contributions, cost-sharing agreements and/or assessments.

Grants

The District will pursue opportunities to fund Plan activities through grants offered by DWR and other agencies. Plan participants may be asked to support grant applications.

Cost-Sharing Agreements

Costs for annual groundwater reports, Plan updates and other reporting efforts will be distributed according to any cost-sharing provisions entered into as part of participation agreement provisions.

Additional cost-sharing agreements may be developed as necessary to fund other projects considered during the implementation of the Plan.
**In-lieu Contributions**

Some Plan activities, such as groundwater elevation activities will be funded through the District's own operations.

**Assessments**

Upon adoption of this Plan, the District is authorized to levy and collect general groundwater replenishment assessments, as well as water extraction fees based on the amount of groundwater extracted from the aquifer within the Plan Area. Any assessment or fees proposed to be collected by the District under this Plan for the purpose of groundwater management must be approved by an area-wide election as provided in AB 3030.
APPENDIX A
PLAN PARTICIPANTS AND STAKEHOLDERS
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
<table>
<thead>
<tr>
<th>PARTICIPANT</th>
<th>DATE OF FORMALIZED PARTICIPATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>STAKEHOLDER</td>
<td>INTEREST</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>District Landowners</td>
<td></td>
</tr>
<tr>
<td>City of Wasco</td>
<td>Domestic Water Supply/Use</td>
</tr>
<tr>
<td>City of Shafter</td>
<td>Domestic Water Supply/Use</td>
</tr>
<tr>
<td>Kern Wildlife Refuge</td>
<td>Wildlife</td>
</tr>
<tr>
<td>Bureau of Reclamation</td>
<td>Surface Water Supplies</td>
</tr>
<tr>
<td>Friant Water Authority</td>
<td>Surface Water Supplies</td>
</tr>
<tr>
<td>National Resources Conservation Service</td>
<td>Natural Resources</td>
</tr>
<tr>
<td>Audubon Society</td>
<td>Wildlife/Monitoring</td>
</tr>
<tr>
<td>Kern County</td>
<td>Land Use/Planning</td>
</tr>
</tbody>
</table>
APPENDIX B
SAMPLE MEMORANDUM OF UNDERSTANDING
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
MEMORANDUM OF UNDERSTANDING

AND

SHAFTER-WASCO IRRIGATION DISTRICT

ARTICLE I - AGREEMENT

The articles and provisions contained herein constitute a bilateral and binding agreement by and between SHAFTER-WASCO IRRIGATION DISTRICT (hereinafter the "District") and ____________________________ (hereinafter "Agency").

ARTICLE II - RECOGNITION

The District has developed a Groundwater Management Plan (hereinafter the "Plan") with input from several local agencies located within the District. It is the intent of the District to allow and encourage such agencies to coordinate efforts and be a part of the District's Plan by means of a separate Memorandum of Understanding (hereinafter the "MOU") between each agency and District.

ARTICLE III - PURPOSE

It is the purpose of the MOU, entering into willingly, between District and Agency, to document the interests and responsibilities of both parties in the adoption and implementation of the Plan. It is also hoped that such MOU will promote and provide a means to establish an orderly process to share information, develop a course of action and resolve any misunderstandings or differences that may arise regarding the Plan.

ARTICLE IV - COORDINATE

There shall be an annual coordinating meeting (hereinafter the "Meeting") between the District and the Agency. District shall give notice to the Agency thirty (30) days prior to date of the Meeting to discuss the manner in which the Plan is being implemented and other items related to the Plan. If there are concerns or questions regarding the Plan, Agency shall transmit its concerns in writing to District seven (7) days prior to the Meeting.
ARTICLE V – OBLIGATIONS

The Plan shall be binding on the parties hereto unless superseded by the MOU or amendment thereto.

ARTICLE VI – AREA OF PLAN

The Plan shall be effective in all areas within the Agency boundaries. The Plan shall also be effective in any area annexed to the Agency subsequent to the adoption of the Plan.

ARTICLE VII – TERM

The initial term of the MOU shall commence on ________ and continue for five (5) years, and shall continue year to year thereafter, unless terminated by written notice given at least one (1) year prior to such termination.

This Memorandum of Understanding is made and entered into this ______ day of ________________, 2007.

SHAFTER-WASCO IRRIGATION DISTRICT

By: ____________________ By: ____________________
Title: ____________________ Title: ____________________

By: ____________________ By: ____________________
Title: ____________________ Title: ____________________
APPENDIX C
ALTERNATIVE DISPUTE RESOLUTION POLICY
GROUNDWATER MANAGEMENT PLAN
SHAFTER-WASCO IRRIGATION DISTRICT
Purpose. The District recognizes that defending or prosecuting lawsuits can be expensive and time-consuming, resulting in a drain on District resources that should be avoided, if reasonably possible. To that end, the District hereby implements this policy to encourage the resolution of disputes, claims and lawsuits through alternative dispute resolution procedures related to their adopted Groundwater Management Plan.

Procedures. Whenever the District is named in a lawsuit or receives a written claim or a serious threat of imminent litigation, the District staff shall immediately consult with the District General Counsel regarding the same. Together, the District staff and the District General Counsel shall formulate a recommended response to be considered by the Board of Directors at its next meeting.

Whenever the District becomes aware of any unasserted potential lawsuit, claim or dispute, with a reasonable likelihood of being asserted, against the District, the District staff shall consult with the District’s counsel regarding the best method for responding to the same. Possible responses include, but are not limited to, the following:

1. Do nothing.
2. A verbal communication from the District or its general counsel.
3. A written communication from the District or its general counsel.
4. An offer to meet and discuss the matter with District personnel.
5. An offer to mediate the matter before a neutral third-party mediator.
6. An offer to arbitrate the matter before the American Arbitration Association.
7. An offer to arbitrate the matter using the rules of judicial arbitration found in California statutes.

District staff shall advise the Board of Directors of any unasserted lawsuit, claim or dispute, with a reasonable likelihood of being asserted, including the District’s response to the same. The Board of Directors shall be advised whether or not the matter is resolved. If the potential lawsuit, claim or dispute becomes an actual lawsuit, claim or dispute, the response of the District shall be handled as set forth above in the previous paragraphs.

It shall be the practice of the District to encourage mediation of lawsuits, claims or disputes, whenever reasonably practical, in order to resolve such matters. Mediation shall be by a neutral third-party qualified to mediate such matters.
APPENDIX C
SOURCE: Kenneth D. Schmidt and Associates
Confinement decreases to the south as the Corcoran thins and becomes less effective.

Source: Figure 9, Analysis of Groundwater Resources. Provost and Pritchard 2001.
EXPLANATION

WATER LEVEL ELEVATION CONTURS (FT MSL)
WATER LEVEL ELEVATION CONTURS IN LOWER ZONE
WATER LEVEL ELEVATION CONTURS IN LOWER ZONE (HORZ. METR. 5 MSL)
DIRECTION OF GROUNDWATER FLOW

FIGURE 3
WATER - LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW IN FOREBAY AREA AND LOWER ZONE, SPRING 1995

SCALE 1 OF 1000
FIGURE 5
WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR THE FOREBAY AREA AND LOWER ZONE (SPRING 2002)

EXPLANATION

Wall and water-level elevation (ft above M.S.L.)
Direction of groundwater flow
Water-level elevation contours (ft. above M.S.L.) for forebay area.
Water-level elevation contours (ft. above M.S.L.) for lower zone.

SEMITROPIC WATER STORAGE DISTRICT

SCALE OF MILES

1 2 3
FIGURE 6
WATER - LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR THE FOREBAY AREA AND LOWER ZONE (SPRING 2003)

EXPLANATION
- Well and water-level elevation (ft. above M.S.L.)
- Direction of groundwater flow
- Water-level elevation contours (ft. above M.S.L.) for Forebay area.
- Water-level elevation contours (ft. above M.S.L.) for lower zone.

SEMITROPIC WATER STORAGE DISTRICT

SCALE OF MILES

1 2 3
FIGURE 5
WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR THE FOREBAY AREA AND LOWER ZONE (SPRING 2006)

EXPLANATION
- Well and water-level elevation (ft. above M.S.L.)
- Direction of groundwater flow
- Water-level elevation contours (ft. above M.S.L.) for forebay area
- Water-level elevation contours (ft. above M.S.L.) for lower zone

SEMITROPIC WATER STORAGE DISTRICT
(FIGURE 6)
WATER-LEVEL ELEVATIONS
AND DIRECTION OF GROUNDWATER FLOW
FOR THE FOREBAY AREA AND LOWER ZONE
(SPRING 2007)

EXPLANATION
- Well and water-level elevation (ft. above M.S.L.)
- Direction of groundwater flow
- Water-level elevation contours (ft. above M.S.L.)
  for forebay area.
- Water-level elevation contours (ft. above M.S.L.)
  for lower zone.

SEMITROPIC WATER STORAGE DISTRICT
FIGURE 5-
Water-Level Elevations and Direction of Groundwater Flow for the Forebay Area and Lower Zone (Spring 2010)

Legend

- Wall & Water-Level Elevation (Ft. Relative to M.S.L.)
- Direction of Groundwater Flow
- Water-Level elevation Contours (Ft. Relative to M.S.L.) for Forebay Area.
- Water-Level elevation Contours (Ft. Relative to M.S.L.) for Lower Zone.
FIGURE 4- Water-Level Elevations And Direction of Groundwater Flow For the Forbay Area and Lower Zone (Spring 2011)

Legend

- Well & Water-Level Elevation (Feet)
- Direction of Groundwater Flow
- Water-Level Elevation Contours (ft. Relative to M.S.L.) For Forbay Area.
- Water-Level Elevation Contours (ft. Relative to M.S.L.) For Lower Zone.
Figure 6

Water-Level Elevations and Direction of Groundwater Flow for the Forebay Area and Lower Zone (Spring 2013)

Legend

- Well Location
- Direction of Groundwater Flow
- Water-Level Elevation Contours (ft. Relative to M.S.L.) for Forebay Area.
- Water-Level Elevation Contours (ft. Relative to M.S.L.) for Lower Zone.
FIGURE 7-
Water-Level Elevations and Direction of Groundwater Flow for the Forebay Area and Lower Zone (Spring 2015)

Legend
- Well & Water-Level Elevation (ft. Relative to M.S.L)
- Direction of Groundwater Flow
- Water-Level Elevation Contours (ft. Relative to M.S.L) for Forebay Area
- Water-Level Elevation Contours (ft. Relative to M.S.L) for Lower Zone
Water-Level Elevations and Direction of Groundwater Flow for the Forebay Area and Lower Zone (Spring 2016)

**Legend**
- † Well Location
- Direction of Groundwater Flow
- Water-Level Elevation Contours (Ft. Relative to M.S.L) for Forebay Area.
- Water-Level Elevation Contours (Ft. Relative to M.S.L) for Lower Zone.
FIGURE 6-
Water-Level Elevations and Direction of Groundwater Flow for the Forebay Area and Lower Zone (Spring 2017)

Legend

- Wall Location
- Direction of Groundwater Flow
- Water-Level Elevation Contours (ft. Relative to M.S.L.) for Forebay Area.
- Water-Level Elevation Contours (ft. Relative to M.S.L.) for Lower Zone.

1 0.5 0 1 2 3 4
Miles
Contour interval = 50 feet

Dashed contour lines indicate estimated values.
GROUNDWATER SURFACE ELEVATION

SPRING 2001

Contour Interval = 50 feet

Dashed contour lines indicate estimated values.
Plate 5a. Groundwater Surface Elevation Unconfined Aquifer Spring 2006
Dashed contour lines indicate estimated values.

Groundwater basin boundary.

Feet above mean sea level.

Contour interval = 50 feet.
FIGURE 7
WATER - LEVEL CHANGE FOR THE FOREBAY AREA AND LOWER ZONE
(SPRING 1985-SPRING 2005)

EXPLANATION

- Wall and water-level change (feet)
- Water-level contour
- Water-level decline

+20 — Contour of water-level change (feet)

SEMITROPIC WATER STORAGE DISTRICT

SCALE OF MILES

1 2 3
Figure 7
Water-Level Changes For The Forebay Area & Lower Zone
(Spring 1995 - 2017)

Legend
△ Well Location
- Water-Level Decline
-40 Contour of Water-level Change (Feet)
<table>
<thead>
<tr>
<th>CASGEM ID</th>
<th>SWN</th>
<th>DMS ID</th>
<th>Well Name</th>
<th>Well Type</th>
<th>Township</th>
<th>Range</th>
<th>Section</th>
<th>Quarter</th>
<th>RP Elevation feet MSL</th>
<th>GS Elevation (Approximat e feet MSL)</th>
<th>Perforation Top (bgs)</th>
<th>Perforation Bottom (bgs)</th>
<th>Aquifer Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>356330N1192838W001</td>
<td>26S25E27N001M</td>
<td>5581</td>
<td>99-22-14</td>
<td>Production</td>
<td>26S</td>
<td>25E</td>
<td>27</td>
<td>N</td>
<td>357.44</td>
<td>356.64</td>
<td>440</td>
<td>922</td>
<td>Lower</td>
</tr>
<tr>
<td>356492N1192812W001</td>
<td>26S25E21K001M</td>
<td>7185</td>
<td>26S/25E-21K01</td>
<td>Production</td>
<td>26S</td>
<td>25E</td>
<td>21</td>
<td>K</td>
<td>348.44</td>
<td>347.14</td>
<td>0</td>
<td>580</td>
<td>Upper/Lower</td>
</tr>
<tr>
<td>356441N1192752W001</td>
<td>26S25E27B001M</td>
<td>8397</td>
<td>26S/25E-27B01</td>
<td>Production</td>
<td>26S</td>
<td>25E</td>
<td>27</td>
<td>B</td>
<td>361.64</td>
<td>360.44</td>
<td>600</td>
<td>710</td>
<td>Lower</td>
</tr>
<tr>
<td>356311N1192866W001</td>
<td>26S25E28Q001M</td>
<td>7183</td>
<td>26S/25E-28Q01</td>
<td>Production</td>
<td>26S</td>
<td>25E</td>
<td>28</td>
<td>Q</td>
<td>351.14</td>
<td>349.64</td>
<td>730</td>
<td>900</td>
<td>Lower</td>
</tr>
<tr>
<td>356025N1192413W001</td>
<td>27S25E01N001M</td>
<td>3712</td>
<td>27S/25E-01N01</td>
<td>Monitoring</td>
<td>27S</td>
<td>25E</td>
<td>01</td>
<td>N</td>
<td>396.66</td>
<td>396.66</td>
<td>0</td>
<td>580</td>
<td>Upper/Lower</td>
</tr>
<tr>
<td>356025N1192387W001</td>
<td>27S25E01N002M</td>
<td>3838</td>
<td>27S/25E-01N02</td>
<td>Monitoring</td>
<td>27S</td>
<td>25E</td>
<td>01</td>
<td>N</td>
<td>398.77</td>
<td>397.67</td>
<td>600</td>
<td>710</td>
<td>Lower</td>
</tr>
<tr>
<td>356025N1192414W001</td>
<td>27S25E01N003M</td>
<td>5803</td>
<td>27S/25E-01N03</td>
<td>Monitoring</td>
<td>27S</td>
<td>25E</td>
<td>01</td>
<td>N</td>
<td>396.66</td>
<td>396.66</td>
<td>730</td>
<td>900</td>
<td>Lower</td>
</tr>
<tr>
<td>356119N1192595W001</td>
<td>27S25E3H001M</td>
<td>5842</td>
<td>27S/25E-03H01</td>
<td>Production</td>
<td>27S</td>
<td>25E</td>
<td>03</td>
<td>H</td>
<td>379.35</td>
<td>374.65</td>
<td>340</td>
<td>800</td>
<td>Lower</td>
</tr>
<tr>
<td>355997N1192648W001</td>
<td>27S25E10B001M</td>
<td>6930</td>
<td>27S/25E-10B01</td>
<td>Production</td>
<td>27S</td>
<td>25E</td>
<td>10</td>
<td>B</td>
<td>378.05</td>
<td>378.75</td>
<td>340</td>
<td>800</td>
<td>Lower</td>
</tr>
<tr>
<td>355922N1192598W001</td>
<td>27S25E10J001M</td>
<td>2470</td>
<td>27S/25E-10J01</td>
<td>Production</td>
<td>27S</td>
<td>25E</td>
<td>10</td>
<td>J</td>
<td>384.16</td>
<td>382.36</td>
<td>250</td>
<td>676</td>
<td>Lower</td>
</tr>
<tr>
<td>355872N1192762W001</td>
<td>27S25E10N001M</td>
<td>2664</td>
<td>27S/25E-10N01</td>
<td>Production</td>
<td>27S</td>
<td>25E</td>
<td>10</td>
<td>N</td>
<td>378.35</td>
<td>376.95</td>
<td>342</td>
<td>800</td>
<td>Lower</td>
</tr>
<tr>
<td>--</td>
<td>27S25E15N001M</td>
<td>13794</td>
<td>27S/25E-15N01</td>
<td>Production</td>
<td>27S</td>
<td>25E</td>
<td>15</td>
<td>N</td>
<td>#N/A</td>
<td>#N/A</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>356181N1192394W001</td>
<td>--</td>
<td>9956</td>
<td>88-29-12</td>
<td>Production</td>
<td>28S</td>
<td>25E</td>
<td>36</td>
<td>Q</td>
<td>400.07</td>
<td>399.25</td>
<td>400</td>
<td>1020</td>
<td>Lower</td>
</tr>
<tr>
<td>--</td>
<td>28S25E12A001M</td>
<td>16261</td>
<td>28S/25E-12A01</td>
<td>Unknown</td>
<td>28S</td>
<td>25E</td>
<td>12</td>
<td>A</td>
<td>#N/A</td>
<td>#N/A</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>--</td>
<td>28S25E12Q001M</td>
<td>11685</td>
<td>28S/25E-12Q01</td>
<td>Unknown</td>
<td>28S</td>
<td>25E</td>
<td>12</td>
<td>Q</td>
<td>#N/A</td>
<td>#N/A</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>--</td>
<td>28S25E13F001M</td>
<td>17651</td>
<td>28S/25E-13F01</td>
<td>Unknown</td>
<td>28S</td>
<td>25E</td>
<td>13</td>
<td>F</td>
<td>#N/A</td>
<td>#N/A</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>354563N1191283W001</td>
<td>--</td>
<td>9955</td>
<td>88-1-13</td>
<td>Production</td>
<td>28S</td>
<td>26E</td>
<td>25</td>
<td>P</td>
<td>393.71</td>
<td>393.52</td>
<td>400</td>
<td>1000</td>
<td>Lower</td>
</tr>
<tr>
<td>354529N1192153W001</td>
<td>--</td>
<td>8136</td>
<td>88-7-4</td>
<td>Production</td>
<td>28S</td>
<td>26E</td>
<td>6</td>
<td>C</td>
<td>418.03</td>
<td>418.03</td>
<td>442</td>
<td>944</td>
<td>Lower</td>
</tr>
<tr>
<td>354780N1191721W001</td>
<td>28S25E21H001M</td>
<td>9243</td>
<td>28S/26E-21H01</td>
<td>Monitoring</td>
<td>28S</td>
<td>26E</td>
<td>21</td>
<td>H</td>
<td>391.22</td>
<td>390.72</td>
<td>0</td>
<td>785</td>
<td>Upper/Lower</td>
</tr>
<tr>
<td>354780N1191721W001</td>
<td>28S25E21H002M</td>
<td>4117</td>
<td>28S/26E-21H02</td>
<td>Monitoring</td>
<td>28S</td>
<td>26E</td>
<td>21</td>
<td>H</td>
<td>391.22</td>
<td>390.72</td>
<td>815</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>354780N1191721W003</td>
<td>28S25E21H003M</td>
<td>5957</td>
<td>28S/26E-21H03</td>
<td>Monitoring</td>
<td>28S</td>
<td>26E</td>
<td>21</td>
<td>H</td>
<td>391.22</td>
<td>390.72</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>354714N1192174W001</td>
<td>28S25E3C001M</td>
<td>9263</td>
<td>28S/26E-3C01</td>
<td>Production</td>
<td>28S</td>
<td>26E</td>
<td>30</td>
<td>C</td>
<td>358.31</td>
<td>356.91</td>
<td>208</td>
<td>486</td>
<td>Lower</td>
</tr>
</tbody>
</table>

Hydrograph Summary
North Kern Water Storage District
Groundwater Hydrograph: T28S-R26E

Hydrogeologic Conceptual Model
North Kern Water Storage District
Kern County, CA

February 2019

Figure X
Groundwater Hydrograph: T27S-R25E

Kern County, CA

February 2019
<table>
<thead>
<tr>
<th>Group</th>
<th>CASGEM ID</th>
<th>SWN</th>
<th>DMS ID</th>
<th>Well Name</th>
<th>Well Type</th>
<th>Township</th>
<th>Range</th>
<th>Section</th>
<th>Quarter</th>
<th>RP Elevation (ft msl)</th>
<th>GS Elevation (Approximate)</th>
<th>Perforation Top (bgs)</th>
<th>Perforation Bottom (bgs)</th>
<th>Aquifer Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>356083N1193806W001</td>
<td>27524E03M002M</td>
<td>8699</td>
<td>275/24E-03M02</td>
<td>Production</td>
<td>27</td>
<td>24</td>
<td>3</td>
<td>M</td>
<td>296</td>
<td>296</td>
<td>440</td>
<td>990</td>
<td>Lower</td>
</tr>
<tr>
<td>1</td>
<td>356017N1193937W001</td>
<td>27524E04P001M</td>
<td>2262</td>
<td>275/24E-04P01</td>
<td>Production</td>
<td>27</td>
<td>24</td>
<td>4</td>
<td>P</td>
<td>293</td>
<td>292</td>
<td>301</td>
<td>301</td>
<td>Lower</td>
</tr>
<tr>
<td>1</td>
<td>356094N1194028W001</td>
<td>27524E05H001M</td>
<td>1870</td>
<td>275/24E-05H01</td>
<td>Production</td>
<td>27</td>
<td>24</td>
<td>5</td>
<td>H</td>
<td>282</td>
<td>282</td>
<td>282</td>
<td>282</td>
<td>Lower</td>
</tr>
<tr>
<td>1</td>
<td>355947N1193717W001</td>
<td>27524E10G001M</td>
<td>8702</td>
<td>275/24E-10G01</td>
<td>Production</td>
<td>27</td>
<td>24</td>
<td>10</td>
<td>G</td>
<td>302</td>
<td>301</td>
<td>300</td>
<td>300</td>
<td>Lower</td>
</tr>
<tr>
<td>2</td>
<td>354769N1192476W001</td>
<td>28525E23K001M</td>
<td>9290</td>
<td>285/25E-23K01</td>
<td></td>
<td>28</td>
<td>25</td>
<td>23</td>
<td>K</td>
<td>335</td>
<td>334</td>
<td>333</td>
<td>333</td>
<td>Lower</td>
</tr>
<tr>
<td>2</td>
<td>354703N1192517W001</td>
<td>28525E26C002M</td>
<td>9295</td>
<td>285/25E-26C02</td>
<td></td>
<td>28</td>
<td>25</td>
<td>26</td>
<td>C</td>
<td>338</td>
<td>338</td>
<td>338</td>
<td>338</td>
<td>Lower</td>
</tr>
<tr>
<td>3</td>
<td>355186N1193430W001</td>
<td>28524E01L001M</td>
<td>9301</td>
<td>285/24E-01L01</td>
<td></td>
<td>28</td>
<td>24</td>
<td>1</td>
<td>L</td>
<td>324</td>
<td>323</td>
<td>323</td>
<td>323</td>
<td>Lower</td>
</tr>
<tr>
<td>3</td>
<td>355152N1193602W001</td>
<td>28524E02P001M</td>
<td>7186</td>
<td>285/24E-02P01</td>
<td>Production</td>
<td>28</td>
<td>24</td>
<td>2</td>
<td>P</td>
<td>316</td>
<td>315</td>
<td>316</td>
<td>316</td>
<td>Lower</td>
</tr>
<tr>
<td>3</td>
<td>355358N1193498W001</td>
<td>27524E35J001M</td>
<td>3620</td>
<td>275/24E-35J01</td>
<td>Production</td>
<td>27</td>
<td>24</td>
<td>35</td>
<td>J</td>
<td>321</td>
<td>320</td>
<td>320</td>
<td>320</td>
<td>Lower</td>
</tr>
<tr>
<td>3</td>
<td>355369N1192773W001</td>
<td>27525E34E003M</td>
<td>10535</td>
<td>275/25E-34E03</td>
<td>Production</td>
<td>27</td>
<td>25</td>
<td>34</td>
<td>E</td>
<td>370</td>
<td>370</td>
<td>370</td>
<td>370</td>
<td>Lower</td>
</tr>
</tbody>
</table>
Below Normal WY
Above Normal WY

28S/25E-23G01
28S/25E-22G01

Groundwater Hydrograph:
Group 2

February 2019

Kern County, CA

Figure X
Hydrogeologic Conceptual Model
Shafer-Wasco Irrigation District

Kern County, CA

Groundwater Hydrograph:
Group 3

February 2019

Figure X
NORTH KERN WATER STORAGE DISTRICT
<table>
<thead>
<tr>
<th>Well Number</th>
<th>Perforated Interval</th>
<th>Well Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>26/24-10F</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-11P</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-12R</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-25F</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-26P</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-34P</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-35F(a)</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/24-36J</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-07R</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-08P</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-09R</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-15R</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-16R</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-19R</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>26/25-21K</td>
<td>340</td>
<td>District</td>
</tr>
<tr>
<td>26/25-22H</td>
<td>340</td>
<td>Private</td>
</tr>
<tr>
<td>26/25-23R</td>
<td>340</td>
<td>Private</td>
</tr>
<tr>
<td>26/25-25R</td>
<td>340</td>
<td>Private</td>
</tr>
<tr>
<td>26/25-26N</td>
<td>400</td>
<td>District</td>
</tr>
<tr>
<td>26/25-27B</td>
<td>400</td>
<td>District</td>
</tr>
<tr>
<td>26/25-28Q</td>
<td>340</td>
<td>District</td>
</tr>
<tr>
<td>26/25-30H</td>
<td>340</td>
<td>District</td>
</tr>
<tr>
<td>26/25-31R</td>
<td>340</td>
<td>Private</td>
</tr>
<tr>
<td>26/25-34R</td>
<td>340</td>
<td>District</td>
</tr>
<tr>
<td>26/25-35B</td>
<td>340</td>
<td>District</td>
</tr>
<tr>
<td>26/25-36E</td>
<td>336</td>
<td>District</td>
</tr>
<tr>
<td>27/25-01N</td>
<td>336</td>
<td>District</td>
</tr>
<tr>
<td>27/25-03H</td>
<td>340</td>
<td>District</td>
</tr>
<tr>
<td>27/25-03J(a)</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-04H</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-05H</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-06N</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-07L(a)</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-10J</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-10L</td>
<td>342</td>
<td>District</td>
</tr>
<tr>
<td>27/25-12F(a)</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-14G(a)</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>27/25-15J</td>
<td></td>
<td>Private</td>
</tr>
<tr>
<td>Number</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>27/25-16H</td>
<td>District</td>
<td></td>
</tr>
<tr>
<td>27/25-21K</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-22J</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-23C</td>
<td>District</td>
<td></td>
</tr>
<tr>
<td>27/25-24C</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-25J</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-26K</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-27C</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-34A</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-35L</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>27/25-36J</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>28/25-01C</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>28/25-02A</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>28/25-12Q</td>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>28/25-13F</td>
<td>Private</td>
<td></td>
</tr>
</tbody>
</table>

(a) Not included for lack of "recent" or anomalous data.
NORTH KERN WATER STORAGE DISTRICT
WATER LEVEL HYDROGRAPH FOR WELL #26/25-09R

DEPTH TO WATER (feet)

ELEVATION OF WATER SURFACE
NORTH KERN WATER STORAGE DISTRICT
WATER LEVEL HYDROGRAPH FOR WELL #26/25-15R
NORTH KERN WATER STORAGE DISTRICT

WATER LEVEL HYDROGRAPH FOR WELL #27/25-01N (336-800)
NORTH KERN WATER STORAGE DISTRICT
WATER LEVEL HYDROGRAPH FOR WELL #27/25-04H
NORTH KERN WATER STORAGE DISTRICT
WATER LEVEL HYDROGRAPH FOR WELL #27/25-27C
NORTH KERN WATER STORAGE DISTRICT
WATER LEVEL HYDROGRAPH FOR WELL #27/25-36J
NORTH KERN WATER STORAGE DISTRICT
WATER LEVEL HYDROGRAPH FOR WELL #28/25-13F

DEPTH TO WATER (feet)

ELEVATION OF WATER SURFACE

SHAFTER-WASCO IRRIGATION DISTRICT
WATER-LEVEL HYDROGRAPH FOR WELL T26S/R24E-34R
APPENDIX F
Hydrogeologic Conceptual Model
Kern County Subbasin

Kern County, CA

Monitoring Agency/Groundwater Hydrograph:
P545 Subsidence and Nearby Hydrographs

GEI Consultants

February 2019

Figure X
Hydrogeologic Conceptual Model
Kern County Subbasin

Monitoring Agency/Groundwater Hydrograph:
P563 Subsidence and Nearby Hydrographs

Kern County, CA

GEI Consultants
February 2019
Hydrogeologic Conceptual Model
Kern County Subbasin

Monitoring Agency/Groundwater Hydrograph:
SWSD Extensometer and Nearby Hydrographs

Kern County, CA

February 2019

Figure X
Hydrogeologic Conceptual Model
Kern County Subbasin

Monitoring Agency/Groundwater Hydrograph:
P564 Subsidence and Nearby Hydrographs

Kern County, CA

February 2019

Figure X
MEMORANDUM

To: Ram Venkatesan – North Kern Water Storage District
From: Timothy Odom, PLS – Provost & Pritchard
Subject: Subsidence Monitoring Survey
Date: July 25, 2017

Provost & Pritchard has completed a survey to determine the current elevations of 20 monuments surveyed by RBF Consulting in the Spring of 2012. The results of our survey are detailed below and depicted on the attached map.

Summary of Survey Techniques
Coordinates and elevations for the survey control points were established by making simultaneous static GPS observations of the monuments. Each observation lasted at least 2 hours.

The data was processed through the National Geodetic Survey's OPUS Projects software, which utilizes observation data from Continuously Operating Reference Stations (CORS) to tie the new survey control points to the National Spatial Reference System and establish coordinates in a local coordinate system. We utilized the same reference stations that were used in the survey by RBF Consulting, with the exception of stations ARM2 and P564, for which the corresponding reference data was not available for processing through OPUS Projects, and BKR2, which has been decommissioned since the previous survey was completed.

The following table lists the Northing and Easting coordinates of each point in the California Coordinate System of 1983 (Zone 5, US Survey feet), and Elevations in the North American Vertical Datum of 1988, which were computed utilizing Geoid Model 12B.
# Tabulated Survey Results

North Kern Water Storage District Subsidence Monitoring Survey  
Provost & Pritchard Consulting Group July, 2017

<table>
<thead>
<tr>
<th>STATION</th>
<th>NORTHING</th>
<th>EASTING</th>
<th>2017 ELEVATION</th>
<th>2012 ELEVATION BY RBF</th>
<th>ELEVATION DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>88_03_12</td>
<td>2363387.25</td>
<td>6211236.14</td>
<td>393.71</td>
<td>398.34</td>
<td>-4.63</td>
</tr>
<tr>
<td>88_03_36</td>
<td>2365612.45</td>
<td>6207761.88</td>
<td>393.14</td>
<td>393.32</td>
<td>-0.18</td>
</tr>
<tr>
<td>88_05_11</td>
<td>2378360.36</td>
<td>6199844.81</td>
<td>409.99</td>
<td>410.42</td>
<td>-0.43</td>
</tr>
<tr>
<td>88_07_04</td>
<td>2381111.29</td>
<td>6200048.43</td>
<td>417.41</td>
<td>418.03</td>
<td>-0.62</td>
</tr>
<tr>
<td>88_07_06</td>
<td>2381143.57</td>
<td>6197692.15</td>
<td>407.02</td>
<td>407.62</td>
<td>-0.60</td>
</tr>
<tr>
<td>88_09_09</td>
<td>2383806.82</td>
<td>6194815.65</td>
<td>401.89</td>
<td>402.50</td>
<td>-0.61</td>
</tr>
<tr>
<td>88_17_22</td>
<td>2394545.97</td>
<td>6191317.29</td>
<td>402.81</td>
<td>403.50</td>
<td>-0.69</td>
</tr>
<tr>
<td>88_17_23</td>
<td>2399147.36</td>
<td>6191415.40</td>
<td>401.20</td>
<td>401.89</td>
<td>-0.69</td>
</tr>
<tr>
<td>88_17_24</td>
<td>2401121.87</td>
<td>6191433.01</td>
<td>397.55</td>
<td>397.90</td>
<td>-0.35</td>
</tr>
<tr>
<td>88_19_03</td>
<td>2398338.54</td>
<td>6196347.42</td>
<td>416.30</td>
<td>416.74</td>
<td>-0.44</td>
</tr>
<tr>
<td>88_25_16</td>
<td>2410308.53</td>
<td>6193723.34</td>
<td>393.51</td>
<td>393.51</td>
<td>0.00</td>
</tr>
<tr>
<td>88_29_31</td>
<td>2412879.54</td>
<td>6192812.14</td>
<td>391.01</td>
<td>391.10</td>
<td>-0.09</td>
</tr>
<tr>
<td>88_29_14</td>
<td>2415344.33</td>
<td>6197733.91</td>
<td>396.80</td>
<td>396.69</td>
<td>0.11</td>
</tr>
<tr>
<td>88_29_15</td>
<td>2414720.36</td>
<td>6195301.12</td>
<td>395.23</td>
<td>395.18</td>
<td>0.05</td>
</tr>
<tr>
<td>99_02_04</td>
<td>2357669.83</td>
<td>6215615.84</td>
<td>377.62</td>
<td>377.49</td>
<td>0.13</td>
</tr>
<tr>
<td>99_22_14</td>
<td>2418443.04</td>
<td>6182418.29</td>
<td>361.98</td>
<td>362.00</td>
<td>-0.02</td>
</tr>
<tr>
<td>MINTER</td>
<td>2379521.39</td>
<td>6201119.57</td>
<td>419.02</td>
<td>419.49</td>
<td>-0.47</td>
</tr>
<tr>
<td>ROSEDALE</td>
<td>2356714.36</td>
<td>6215430.79</td>
<td>374.25</td>
<td>374.27</td>
<td>-0.02</td>
</tr>
<tr>
<td>SEC 27</td>
<td>2419709.19</td>
<td>6184843.27</td>
<td>363.72</td>
<td>363.69</td>
<td>0.03</td>
</tr>
<tr>
<td>SWITCH</td>
<td>2411972.94</td>
<td>6195572.63</td>
<td>400.60</td>
<td>400.69</td>
<td>-0.09</td>
</tr>
</tbody>
</table>

## Control Stations

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ISLK</td>
<td>2427700.41</td>
<td>6420764.73</td>
<td>2802.04</td>
<td>2802.21</td>
</tr>
<tr>
<td>P545</td>
<td>2371732.67</td>
<td>6104523.65</td>
<td>282.64</td>
<td>282.56</td>
</tr>
<tr>
<td>P563</td>
<td>2341686.43</td>
<td>6138227.66</td>
<td>301.01</td>
<td>301.00</td>
</tr>
<tr>
<td>P565</td>
<td>2459339.75</td>
<td>6194657.73</td>
<td>318.13</td>
<td>318.07</td>
</tr>
<tr>
<td>P567</td>
<td>2340363.48</td>
<td>6337139.85</td>
<td>2423.97</td>
<td>2424.06</td>
</tr>
</tbody>
</table>

## Summary of Survey Results

The difference in the Northing and Easting values for each station from the RBF Consulting survey and the current survey were very minimal, so the older values were omitted from the results table above.

In the northern portion of the project, from Whistler Road down to Highway 46, and the extreme southern portion of the project, at the Rosedale Spreading Basin, very little change in elevation was seen between the two surveys. The observed differences in these areas are near or within the expected error for the method of surveying used in both 2012 and 2017.
In the area between Highway 46 and Lerdo Highway, the differences between the two surveys appear to reveal a depression with the most-effected areas lying along the Friant Kern Canal, and having elevations 0.69' lower in 2017 than were observed in 2012.

One outlier exists, at Station 88_03_12, located on the South side of the Friant Kern Canal between the Rosedale Spreading Basin and Lerdo Highway. At this station a change of -4.63' was observed between the 2012 and 2017 surveys, though the nearest stations up and down the canal reveal practically no change at all. Due to the magnitude and apparent isolation of this change I've reviewed the field data and processing information to identify any sources of error in the current survey or the 2012 survey that could be skewing this result. In each survey a standard 2 meter (6.562') survey pole was used at this station, so if the antenna height was not taken into account in the 2012 survey, then the 2012 survey value would be lower by that amount, and thus lower than the 2017 value by nearly two feet, which would not make sense. I have double-checked the current survey to ensure that the proper antenna height was used. The 2012 and 2017 surveys utilized different geoid models (a product created and periodically updated by the National Geodetic Survey that is used in the computation of elevations from GPS data) but the difference between the two models in this location is minimal, as can be seen in the comparison of the elevations of the control stations used. The 2012 survey report and processing information have been reviewed and no typographical errors were found in the reported elevations. Being confident in the data and methods of the current survey, I have to conclude that either some blunder occurred in the preliminary stages of the 2012 survey in regards to this station or there has been a localized change causing the observed difference in elevation at this point.

Sincerely,

Timothy M. Odom, PLS 8468
APPENDIX H
Well Type
- Monitor Well
- Supply Well
- Monthly Measurement
- "Continuous" Measurement

North Kern WSD
- Spreading Basin
- Rosedale Ranch ID

SOURCE: California Spatial Information Library, 2008; Semitropic Water Storage District, 2008; Kern County Water Agency, 2006

2012 Groundwater Management Plan
Kern County, California

GEI Consultants
JULY 2012
FIGURE 14
### Table 7: Summary of Monitor Wells

<table>
<thead>
<tr>
<th>Well No.</th>
<th>Owner</th>
<th>Location T-R-S</th>
<th>Well Type</th>
<th>Perforated Interval (ft bgs)</th>
<th>Water Level Measurement Frequency</th>
<th>Sampling Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-1</td>
<td>NK</td>
<td>26S-25E-27L</td>
<td>M</td>
<td>70-240</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>MW-2</td>
<td>NK</td>
<td>27S-25E-01B</td>
<td>M</td>
<td>70-240</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>MW-3</td>
<td>NK</td>
<td>28S-26E-06B</td>
<td>M</td>
<td>70-240</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>MW-4</td>
<td>NK</td>
<td>28S-26E-27G</td>
<td>M</td>
<td>70-240</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>88-1-13</td>
<td>NK</td>
<td>28S-26E-25P</td>
<td>S</td>
<td>400-1000</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>88-7-04</td>
<td>NK</td>
<td>28S-26E-6C</td>
<td>S</td>
<td>442-944</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>88-29-12</td>
<td>NK</td>
<td>26S-25E-36R</td>
<td>S</td>
<td>400-1020</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>99-22-14</td>
<td>NK</td>
<td>26S-25E-27N</td>
<td>S</td>
<td>440-922</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>27S-25E-01N001</td>
<td>USBR</td>
<td>27S-25E-01N</td>
<td>M</td>
<td>0-785</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>27S-25E-01N002</td>
<td>USBR</td>
<td>&quot;</td>
<td>M</td>
<td>815-xxx</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>27S-25E-01N003</td>
<td>USBR</td>
<td>&quot;</td>
<td>M</td>
<td>xxx-xxx</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28S-26E-21H001</td>
<td>USBR</td>
<td>28S-26E-21H</td>
<td>M</td>
<td>0-580</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28S-26E-21H002</td>
<td>USBR</td>
<td>&quot;</td>
<td>M</td>
<td>600-710</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28S-26E-21H003</td>
<td>USBR</td>
<td>&quot;</td>
<td>M</td>
<td>730-900</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td>SWSD</td>
<td>25S-24E-36Q</td>
<td>M</td>
<td>381 - 431</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>S-7A</td>
<td>SWSD</td>
<td>26S-24E-13N</td>
<td>M</td>
<td>550 - 600</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>S-7B</td>
<td>SWSD</td>
<td>&quot;</td>
<td>M</td>
<td>330 - 380</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>S-14A</td>
<td>SWSD</td>
<td>26S-24E-16J</td>
<td>M</td>
<td>670 - 710</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>S-14B</td>
<td>SWSD</td>
<td>&quot;</td>
<td>M</td>
<td>430 - 480</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>S-16A</td>
<td>SWSD</td>
<td>26S-24E-27R</td>
<td>M</td>
<td>620 - 670</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>S-16B</td>
<td>SWSD</td>
<td>&quot;</td>
<td>M</td>
<td>370 - 410</td>
<td>C</td>
<td>✓</td>
</tr>
</tbody>
</table>

(1) **Well Type**: M = Monitor; S = Supply

(2) **Water Level Measurement Frequency**: C = “Continuous”; Number = Number of times per year (e.g., “12” implies monthly)
Subsidence Monitoring Network

6 Plan Implementation

Plan implementation includes the following elements, each of which is addressed in this section:

- Monitoring
- Reporting
- Public and Agency Involvement
- Plan Review and Update

6.1 Monitoring

Management of the groundwater resource is dependent on good basic data respecting both geology and hydrology. The purpose of this element of the Management Plan is to characterize the conditions within the groundwater basin over time so as to identify any changes or trends. This will provide a measure of the Plan’s accomplishments relative to the Basin Management Objectives. Monitoring includes collecting the basic data and analyzing these data to characterize the basin and will be subject to modification, as needed, to reflect changes or additions in the programs implemented under the Management Plan. In order to ensure comparability of the data gathered over time, monitoring requires some level of consistency in monitored locations and in monitoring frequency and protocols. Finally, monitoring is essential to gauging Plan performance and making future management decisions.

Implementation of the Semitropic Groundwater Banking Project involved the establishment of a Groundwater Monitoring Committee (in 1994) to develop and oversee a groundwater monitoring program. In 1996, a sampling plan was prepared for use by the participating districts, which include North Kern. The sampling plan “…provides the acceptable procedures to be used for measuring water levels and collecting, preserving, and analyzing water samples …” (a copy of the sampling plan is included in Appendix A). Recall that, in addition to North Kern, the Committee includes representatives from five neighboring water agencies (reference Figure 2 for their relative locations). The Kern County Water Agency and the California Department of Water Resources are interested parties and participate in
Committee activities from time to time. Both of these agencies have groundwater monitoring programs, and data from these agencies is also included in the Committee’s interpretive work.

6.1.1 Well Locations

Well locations are the point of beginning for any monitoring network that principally depends on existing supply wells. Accordingly, in 2008, North Kern staff conducted a field survey of all well sites within the District. At the time of this survey, 300 well sites were identified, with 84 being District-owned wells, and the remaining 216 well sites being privately-owned, on-farm wells. About two-thirds of the on-farm wells were connected to a power source and ready for use for irrigation purposes. Since 2008, the District has constructed additional wells, bringing its total to 96 wells.

6.1.2 Water Levels

Groundwater level data relate directly or indirectly to more than one of the basin management objectives. Water level data are used to evaluate groundwater movement, storage conditions, and pumping costs. Maps showing contours of equal water-level elevation indicate the direction of groundwater movement and also can be used (in conjunction with knowledge of the aquifer transmissivity) to estimate groundwater underflow entering and leaving the Management Area. Maps of depth to groundwater can provide insight into the distribution of pumping lifts. Maps showing changes in groundwater levels (when used in conjunction with data on specific yield) can be used to estimate changes in groundwater storage. In addition to these water level maps, hydrographs of water-level fluctuations in selected wells provide information on seasonal and long-term fluctuations of water levels. Using a relatively consistent set of wells for monitoring over a long-term period (to the extent practical) will facilitate the preparation of meaningful water-level change maps and hydrographs.

**Network:** District-owned wells and selected privately-owned supply wells have been routinely measured since commencement of District operations in the mid-1950s; however, the total number of wells measured in any given year has varied as a result of individual site conditions, which include access and whether the well is being pumped at the time of the field visit. In recent years, about 200 wells have been measured in a given year. While the monitoring network has consisted almost exclusively of supply wells, four monitor wells were constructed toward the end of 2011 with the aid of a Local Groundwater Assistance Grant administered by DWR. These monitor wells are located in North Kern’s spreading ponds and are intended to provide...
a better understanding of the recharge mound build up and dissipation in the areas of these extensive spreading activities. In addition to these dedicated monitor wells, the U.S. Bureau of Reclamation has two multiple-completion monitor well sites within North Kern; one located near the Highway 46 crossing of the Friant-Kern Canal, and one located about 2.5 miles north of Seventh Standard Road and adjacent to the Friant-Kern Canal. Though not located within the boundaries of North Kern, Semitropic Water Storage District has five monitor well sites located within one mile of North Kern’s northwest boundary. These latter wells are included in the previously mentioned work of the Semitropic Groundwater Monitoring Committee, in which North Kern is a participant. The network will be reviewed periodically in order to provide sufficient areal coverage to prepare representative water-level elevation and depth contour maps.

State legislation passed in 2009 resulted in the development and implementation of the California Statewide Groundwater Elevation Monitoring Program (CASGEM) by the Department of Water Resources. The Program is intended to annually collect and house sufficient water level data to identify seasonal and long-term trends in water levels throughout the State’s groundwater basins, and make that data readily available to the public. North Kern responded to DWR’s solicitation for participating Monitoring Entities by preparing and submitting a monitoring plan, and has since been confirmed as a Monitoring Entity. The District’s supply wells are included in the program and their locations are shown on Figure 4. The District’s CASGEM monitoring plan is included as Appendix B. Several of North Kern’s immediate neighbors are also Monitoring Entities; Semitropic Water Storage District, Rosedale-Rio Bravo Water Storage District, and Shafter-Wasco Irrigation District.

**Frequency:** Historically, water levels in supply wells have been measured twice a year, in both the “spring” and “fall”, with the timing of these measurements intended to coincide with the annual water level high and low, respectively. Measurement of water levels will continue to be performed in both spring and fall in order to show seasonal variations in water levels throughout the District. These data have been made available to the Kern County Water Agency and the Department of Water Resources for the District-owned wells. Most recently, with construction of four monitor wells, water level sensors were installed to provide a “continuous” record of measurements in these four wells. In addition, “continuous” water-level monitoring at five District supply wells was recently implemented. The “continuous” measurements will provide better definition of seasonal fluctuations in water levels and will assist in timing the collection of the spring and fall measurements in the larger network of wells. The network of wells which is monitored continuously or monthly is illustrated on Figure 14 and listed in Table 7.

**Protocol:** While different methods have been used in the past, acoustic sounders are presently used for all manual water-level measurements; however, these are periodically checked against electric sounder measurements to confirm their accuracy. When a measurement is taken at a given well, it is compared to the last measurement for the same well. If the implied change in water level appears to be significantly larger or smaller than
observations at other wells in the area, or the direction of the change is not consistent with observations at other wells in the area, then the measurement is repeated. Accordingly, it is important that the implied water-level changes be determined and reviewed in a timely manner, so as to allow potentially errant measurements to be repeated before too much time has passed.

Continuous water-level sensors have only recently been deployed in North Kern. It is planned that each site be visited at least once each quarter and the data downloaded to a portable storage device. During the site visit, a manual measurement will be taken, recorded, and compared with the data logger.

Additional detail is provided in the Sampling Plan found in Appendix A.

6.1.3 Water Quality

Water quality monitoring will identify the suitability of groundwater for various uses, and will provide a baseline from which to identify changes and trends. If trends indicating degradation are suggested, the District would be in a position to identify the likely source(s) and significance of the degradation, and to make an assessment of whether arrest or correction of the degradation is within the District’s control. Significance would be a function of the constituent, the magnitude of the degradation, then current standards, and the areal extent of the degradation. Historically, water quality data has suffered from a lack of regular sampling and consistent sampling protocol, which makes the interpretation of water quality trends difficult.

As noted above at Sections 4.7 and 4.8, the District is also involved in water quality programs of the Regional Board through Coalitions; however, owing to anticipated program changes, the extent to which the District will continue to be involved is presently unknown.
Network: Similar to the water-level network, the monitoring network for water quality primarily consists of District-owned supply wells and private wells which discharge into the District’s distribution system; however, the recently-constructed monitor wells will also be added. In addition to sampling water from individual District wells, North Kern has initiated a program of regular sampling and testing of water in the District’s canals. Locations include the points where the main conveyance canals enter the District, which primarily represent the quality of the Kern River water which is diverted from the River. Other selected points are located throughout the District’s distribution system. Accordingly, during dry years, these locations reflect a blend of surface water and District-pumped groundwater, or a blend of District-pumped groundwater.

Frequency and Analyses: Under the District’s current program, water samples are collected from District wells during years when their use is required to meet the District’s irrigation water delivery obligations (about one out of two years on average). Historically, water quality testing has been (typically) limited to standard agricultural-type analyses; however, in more recent years, additional testing has been included for a few wells which can discharge into the Friant-Kern Canal. For these wells, drinking water-type analyses are conducted on water samples every four years. The sampling of water in the District’s canals is done monthly, and testing consists of a typical irrigation water analysis. Following is a listing of the items typically included in such an analysis.

Table 8: Typical Irrigation Water Quality Analysis

<table>
<thead>
<tr>
<th>pH</th>
<th>Cation/Anion Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>Sodium</td>
<td>Magnesium</td>
</tr>
<tr>
<td>Alkalinity as:</td>
<td>Potassium</td>
</tr>
<tr>
<td>Hydroxide</td>
<td></td>
</tr>
<tr>
<td>Carbonate</td>
<td></td>
</tr>
<tr>
<td>Bicarbonate</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Sulfate</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Boron</td>
</tr>
<tr>
<td>Total Dissolved Solids, (Gravimetric)</td>
<td>Calculated Hardness, CaCO3</td>
</tr>
<tr>
<td>Sodium Adsorption Ratio</td>
<td>Exchangeable Sodium Percentage</td>
</tr>
<tr>
<td>Langlier Scale Index</td>
<td>Sodium, Na (Calculated)</td>
</tr>
</tbody>
</table>

Protocol: The sampling protocol is detailed in the Sampling Plan found in Appendix A.
6.1.4 Recharge and Pumpage

Data are collected annually that allow for quantification of the various elements of the hydrologic inventory, and support further analysis of the potential impact of management actions through the use of tools such as groundwater modeling. Principal components of the inventory include the amount of water recharged, and the quantity of groundwater pumped. The recharge is principally comprised of the diversion and delivery of surface water, both of which are measured. On the contrary, most of the groundwater pumping is not measured, with the exception of pumping by District-owned wells, which are equipped with hour meters and are periodically checked with a portable flow meter. In the absence of hour meters or permanent flow meters, data respecting crop acreages and crop evapotranspiration are collected annually to support a reasonable estimate of on-farm pumping.

Diversions from the Kern River are measured at the diversion structures and again where the canals cross North Kern’s southern boundary at Seventh Standard Road. Flow measurements at the points of diversion from the River and the measurements at Seventh Standard Road are all based on weir flow and continuous stage measurement. Periodically, stream gage measurements are conducted as a check on the discharge ratings at these locations. Diversions to and from adjoining districts are all measured with flow meters.

6.1.5 Land Subsidence

Historically, the District has not measured land surface subsidence; rather, it relied on infrequent studies by state and federal agencies, some of which are briefly described in Section 4. In 2007, a draft of a Groundwater Monitoring Program was prepared by a consultant to the District, which proposed that a network of benchmarks be established for the purpose of establishing a baseline from which to monitor subsidence going forward. With the help of a Local Groundwater Assistance grant, North Kern completed installation of the necessary monuments and elevation survey in spring 2012. In addition, North Kern will annually download available data for the Continuously Operating Reference Stations (CORS) in the region, which are managed by the National Geodetic Survey (NGS).

Network: Monuments have been established at 11 locations, as shown on Figure 15.

Frequency: This is a new program for the District; however, it is proposed to survey the monuments following each significant pumping season. On average over the long term, such years have occurred in about one out of two years.
Protocol: The initial or baseline survey was performed by a licensed land surveyor and included establishment of vertical and horizontal locations for each of 11 monuments, with NAD 83 for horizontal coordinates and NAVD 88 for vertical. The survey relied on geodetic surveying methods using high-precision GPS surveying equipment. Each of the monuments was observed twice and at different times of the day, for a minimum time of one hour. The primary control was provided by NGS CORS stations located outside of the target area to ensure a stable and repeatable survey. In particular, the following CORS stations were used to verify and constrain both the horizontal and vertical control: ARM2, BKR2, P545, P563, P564, P565, and P567. The methods were designed to provide accuracy of +/-0.05 feet at 95 percent relative to the primary control. It is intended that future surveys would employ the same methods.
Following the 1976-1977 drought, water levels trended upward for about ten years, which was a period of above-average rainfall. Heavy withdrawals occurred during the 1987 to 1992 drought, with a corresponding decline in water levels; however, after 1995, water levels again trended upward for about five years. Prior to implementation of the District’s Project in the 1950s, groundwater levels evidenced a persistent decline. In general, since 1977, water levels have increased during “wet” periods and decreased during “dry” periods. While groundwater levels have fluctuated in response to wet and dry periods, groundwater levels have been relatively “stable” since 1978, i.e., without clear evidence of a long-term decline. The average depth to groundwater in 1986, at the end of a “wet” period, was about 200 feet. In 1993, at the end of a “dry” period, the average depth was about 270 feet. Over the last 20 years, the annual (average) spring water levels have fluctuated within a band of about 50 feet.

Seasonal fluctuations can be significant and are a function of the amount of groundwater pumping in a given year and the location within the District. In general, seasonal fluctuations are greater in the north portion of the District and tend to become less pronounced from north to south.

**Monitoring Plan**

District-owned wells and selected privately-owned supply wells have been routinely measured since commencement of District operations in the mid-1950s; however, the total number of wells measured in any given year has varied as a result of individual site conditions, which include access and whether the well is being pumped at the time of the field visit. In recent years, about 200 wells have been measured in a given year. While the monitoring network has consisted almost exclusively of supply wells, four monitor wells were constructed toward the end of 2011 with the aid of a Local Groundwater Assistance Grant administered by DWR. These monitor wells are located in North Kern’s spreading ponds and are intended to provide a better understanding of the recharge mound build up and dissipation in the areas of these extensive spreading activities.
**Monitoring Schedule**

Historically, water levels in supply wells have been measured twice a year, in both the “spring” and “fall”, with the timing of these measurements intended to coincide with the annual water level high and low, respectively. Measurement of water levels will continue to be performed in both spring and fall in order to show seasonal variations in water levels throughout the District. These data have been made available to the Kern County Water Agency and the Department of Water Resources for the District-owned wells. Most recently, with construction of four monitor wells, water level sensors were installed to provide a “continuous” record of measurements in these four wells. In addition, “continuous” water-level monitoring at five District supply wells was recently implemented. The “continuous” measurements will provide better definition of seasonal fluctuations in water levels and because of the large fluctuations that can occur during banking operations, water levels will be measured monthly. The network of wells which is monitored continuously or monthly is illustrated on Figure 7 and listed in Table 1.

**Description of Methods**

While different methods have been used in the past, acoustic sounders are presently used for all manual water-level measurements. The District uses the Dual Range XL acoustic water meter by Well Depth Finders Pro LLC for manual water level measurements. Measurements are always taken using a sounding tube in the well casing. If for some reason the sounding tube is not accessible or damaged, an in line air vent on the discharge is used. The acoustic sounder sends a sound wave that bounces off the water at the bottom of the well and measures the time it takes for the sound wave to bounce back. This will help determine the depth of ground water. It is made sure that the sounder gives a good solid reading at least for a minute. Then the acoustic sounder is shut and we wait for the echo in the pipe to subside. Then the same procedure is repeated three times to make sure that the sounder readings are consistent. When a measurement is taken at a given well, it is compared to the last measurement for the same well. If the implied change in water level appears to be significantly larger or smaller than observations at other wells in the area, or the direction of the change is not consistent with observations at other wells in the area, then the measurement is repeated. Accordingly, it is important that the implied water-level changes be determined and reviewed in a timely manner, so as to allow potentially errant measurements to be repeated before too much time has passed.
Continuous water-level sensors have only recently been deployed in North Kern. It is planned that each site be visited at least once each quarter and the data downloaded to a portable storage device. During the site visit, a manual measurement will be taken, recorded, and compared with the data logger.
Table 1: Summary of Wells

<table>
<thead>
<tr>
<th>Well No.</th>
<th>Location Lat/Long</th>
<th>Location T-R-S</th>
<th>Concrete Pad Monument Reference Elevation NAVD 88</th>
<th>Ground Elevation</th>
<th>Method of Determining elevation/ Accuracy</th>
<th>Well Type/ Status</th>
<th>Perforated Interval (ft bgs)</th>
<th>Bottom of Well (ft bgs)</th>
<th>Water Level Measurement Frequency</th>
<th>Sampling Pump/tap</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-1 -Poso</td>
<td>35.63456993, -119.268020700</td>
<td>26S-25E-27L</td>
<td>363.69</td>
<td>363.45</td>
<td>Trimble GPS/ ± 2mm</td>
<td>M/A</td>
<td>70-240</td>
<td>270</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>MW-2 - Switchfield</td>
<td>35.613815680, -119.231600600</td>
<td>27S-25E-01B</td>
<td>400.69</td>
<td>400.34</td>
<td>Trimble GPS/ ± 2mm</td>
<td>M/A</td>
<td>70-240</td>
<td>270</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>MW-3 - Minterfield</td>
<td>35.52485981, -119.211625800</td>
<td>28S-26E-06B</td>
<td>419.49</td>
<td>419.19</td>
<td>Trimble GPS/ ± 2mm</td>
<td>M/A</td>
<td>70-240</td>
<td>270</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>MW-4 - Rosedale</td>
<td>35.462735500, -119.162650700</td>
<td>28S-26E-27G</td>
<td>374.27</td>
<td>373.87</td>
<td>Trimble GPS/ ± 2mm</td>
<td>M/A</td>
<td>70-240</td>
<td>270</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>88-1-13</td>
<td>35.456275126, -119.128337442</td>
<td>28S-26E-25P</td>
<td>393.71</td>
<td>393.52</td>
<td>Trimble GPS/ ± 2mm</td>
<td>S/A</td>
<td>440-1000</td>
<td>1000</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>88-7-04</td>
<td>35.529191730, -119.215289600</td>
<td>28S-26E-6C</td>
<td>418.03</td>
<td>418.03</td>
<td>Trimble GPS/ ± 2mm</td>
<td>S/A</td>
<td>442-944</td>
<td>944</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>88-29-12</td>
<td>35.618105608, -119.229370430</td>
<td>26S-25E-36R</td>
<td>400.07</td>
<td>399.25</td>
<td>Trimble GPS/ ± 2mm</td>
<td>S/A</td>
<td>437-1001</td>
<td>1001</td>
<td>C</td>
<td>✓</td>
</tr>
<tr>
<td>27S-25E-35A</td>
<td>35.543298952, -119.24598783</td>
<td>27S-25E-35A</td>
<td>394.83</td>
<td>393.73</td>
<td>Trimble GPS/ ± 2mm</td>
<td>S/A</td>
<td>250-684</td>
<td>684</td>
<td>C</td>
<td>✓</td>
</tr>
</tbody>
</table>

(1) **Well Type:** M = Monitor; S = Supply; Status: A = Active; I = Inactive

(2) **Water Level Measurement Frequency:** C = "Continuous"; Number = Number of times per year (e.g., "12" implies monthly)
Figure 3
Location of Wells in Water-Level Network

Legend
- Monitor Wells
- Well Locations
- BVWSD
- NWIWD
- RWRWSD
- SJWUUD
- SWD
- SWD
- Water Agencies
- Canals
<table>
<thead>
<tr>
<th>TWP</th>
<th>Range</th>
<th>Sec.</th>
<th>Tr</th>
<th>No</th>
<th>BM</th>
<th>Tape Reading</th>
<th>Date</th>
<th>NQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>26S</td>
<td>24E</td>
<td>32</td>
<td>J</td>
<td>5</td>
<td>M</td>
<td>199</td>
<td>01/22/07</td>
<td></td>
</tr>
<tr>
<td>26S</td>
<td>24E</td>
<td>34</td>
<td>R</td>
<td>1</td>
<td>M</td>
<td>216</td>
<td>01/22/07</td>
<td></td>
</tr>
<tr>
<td>26S</td>
<td>24E</td>
<td>36</td>
<td>M</td>
<td>3</td>
<td>M</td>
<td>217</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>26S</td>
<td>24E</td>
<td>36</td>
<td>P</td>
<td>2</td>
<td>M</td>
<td>217</td>
<td>01/22/07</td>
<td></td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>3</td>
<td>H</td>
<td>2</td>
<td>M</td>
<td>211</td>
<td>01/22/07</td>
<td></td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>3</td>
<td>M</td>
<td>2</td>
<td>M</td>
<td>202</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>4</td>
<td>G</td>
<td>2</td>
<td>M</td>
<td>219</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>10</td>
<td>G</td>
<td>1</td>
<td>M</td>
<td>222</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>13</td>
<td>N</td>
<td>1</td>
<td>M</td>
<td>232</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>14</td>
<td>F</td>
<td>1</td>
<td>M</td>
<td>231</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>24</td>
<td>E</td>
<td>2</td>
<td>M</td>
<td>229</td>
<td>01/22/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>24</td>
<td>M</td>
<td>3</td>
<td>M</td>
<td>237</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>26</td>
<td>H</td>
<td>2</td>
<td>M</td>
<td>241</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>27</td>
<td>F</td>
<td>2</td>
<td>M</td>
<td>234</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>28</td>
<td>R</td>
<td>2</td>
<td>M</td>
<td>233</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>34</td>
<td>J</td>
<td>2</td>
<td>M</td>
<td>239</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>35</td>
<td>J</td>
<td>1</td>
<td>M</td>
<td>241</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>36</td>
<td>A</td>
<td>1</td>
<td>M</td>
<td>247</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>7</td>
<td>R</td>
<td>1</td>
<td>M</td>
<td>249</td>
<td>01/23/07</td>
<td>0</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>18</td>
<td>F</td>
<td>1</td>
<td>M</td>
<td>251</td>
<td>01/23/07</td>
<td>0</td>
</tr>
</tbody>
</table>

**TABLE 6-1**

<table>
<thead>
<tr>
<th>AGENCY NO.</th>
<th>5614</th>
<th>AGENCY</th>
<th>Shafter-Wasco I.D</th>
</tr>
</thead>
</table>

**NO MEASUREMENT**

- Measurement Disc.
- Caved or other Obs.
- M.P. change

**Questionable Measurement**

- Pumping
- Special
- Nearby Pumping
- Oil in casing

- Tape hung up
- Temporarily inaccessible
- Pumped recently
- Acoustical sounding

- Can't get tape in casing
- Air gauge measurement
### TABLE 6-1

**GROUND-WATER MEASUREMENTS**

<table>
<thead>
<tr>
<th>AGENCY NO.</th>
<th>5614</th>
<th>AGENCY</th>
<th>Shafter-Wasco I.D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USBR WELL NUMBER</strong></td>
<td><strong>Tape Reading at M.P.</strong></td>
<td><strong>at W.S.</strong></td>
<td><strong>Date mm-dd-yy</strong></td>
</tr>
<tr>
<td>TWP</td>
<td>Range</td>
<td>Sec.</td>
<td>Tr</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>19</td>
<td>C</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>19</td>
<td>N</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>19</td>
<td>P</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>28</td>
<td>F</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>29</td>
<td>H</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>30</td>
<td>J</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>31</td>
<td>D</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>32</td>
<td>A</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>33</td>
<td>J</td>
</tr>
<tr>
<td>27S</td>
<td>25E</td>
<td>34</td>
<td>E</td>
</tr>
<tr>
<td>27S</td>
<td>24E</td>
<td>34</td>
<td>P</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>1L</td>
<td>1</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>2A</td>
<td>1</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>3R</td>
<td>1</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>10</td>
<td>R</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>11</td>
<td>F</td>
</tr>
<tr>
<td>28S</td>
<td>24E</td>
<td>12</td>
<td>J</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>12</td>
<td>M</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>2N</td>
<td>1</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>3J</td>
<td>2</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>4L</td>
<td>2</td>
</tr>
<tr>
<td>28S</td>
<td>25E</td>
<td>5F</td>
<td>1</td>
</tr>
</tbody>
</table>

### NO MEASUREMENT

<table>
<thead>
<tr>
<th>Questionable Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Measurement Disc.</td>
</tr>
<tr>
<td>0. Well destroyed</td>
</tr>
<tr>
<td>0. Caved or other Obs.</td>
</tr>
<tr>
<td>0. M.P change</td>
</tr>
<tr>
<td>1. Pumping</td>
</tr>
<tr>
<td>1. Pumping</td>
</tr>
<tr>
<td>1. Recharge</td>
</tr>
<tr>
<td>2. Pump House locked</td>
</tr>
<tr>
<td>2. Nearby Pumping</td>
</tr>
<tr>
<td>2. Oil in casing</td>
</tr>
<tr>
<td>3. Tape hung up</td>
</tr>
<tr>
<td>3. Temporarily inaccessible</td>
</tr>
<tr>
<td>3. Casing leaking</td>
</tr>
<tr>
<td>3. Acoustical</td>
</tr>
<tr>
<td>4. Can't get tape in casing</td>
</tr>
<tr>
<td>4. Pumped recently</td>
</tr>
<tr>
<td>4. Sounding</td>
</tr>
<tr>
<td>5. Unable to locate well</td>
</tr>
<tr>
<td>5. Air gauge mea.</td>
</tr>
<tr>
<td>TWP</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
<tr>
<td>28S</td>
</tr>
</tbody>
</table>

**Table 6-1**

**GROUND-WATER MEASUREMENTS**

<table>
<thead>
<tr>
<th>AGENCY NO.</th>
<th>5614</th>
<th>AGENCY</th>
<th>Shafter-Wasco I.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>USBR WELL NUMBER</td>
<td>Tape Reading</td>
<td>Date (mm-dd-yy)</td>
<td>Remarks</td>
</tr>
<tr>
<td>TWP</td>
<td>Range</td>
<td>Sec.</td>
<td>Tr No</td>
</tr>
<tr>
<td>NO MEASUREMENT</td>
<td>Questionable Measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0. Measurement Disc.</td>
<td>6. Well destroyed</td>
<td>0. Caved or other Obs.</td>
<td>6. M.P change</td>
</tr>
<tr>
<td>1. Pumping</td>
<td>7. Special</td>
<td>1. Pumping</td>
<td>7. Recharge</td>
</tr>
<tr>
<td>5. Unable to locate well</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6-5
Figure 14
Location of Land Subsidence Monitoring Stations
Friant-Kern Canal Subsidence Monitoring Points
Kern Subbasin Boundary
NK District Monitoring Stations 2012 - 2017 (in.)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 to 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
CGPS UNAVCO
Possible Error
Subsidence May 2015 to Sept. 2016 (in.)
InSAR (Farr et al, 2016)
-1.5 - 0 (Uplift)
0 - 1.5
1.5 - 3
3 - 4.5
4.5 - 6
6 - 7.5
> 7.5
North Kern Water Storage District
Shafer-Wasco Irrigation District

LANDOWNER WORKSHOP
Sustainable Groundwater Management Act

Tuesday, March 19, 2019
North Kern Water Storage District
Shafer-Wasco Irrigation District

LANDOWNER WORKSHOP
Sustainable Groundwater Management Act

Tuesday, March 19, 2019
Hydrogeologic Zone 01-2
(Average Spring Measurements)
No Municipal Well Data Available
HZ 02-3 Well Impact Analysis

No Municipal Well Data Available
Hydrogeologic Zone 05 - 1
(Average Spring Measurements)
HZ 05-1 Well Impact Analysis

(Agricultural Wells - 92)

(Domestic Wells - 22)

(Municipal Wells - 2)

Estimated Percentages

<table>
<thead>
<tr>
<th>HZ 05-1</th>
<th>Top of Screen</th>
<th>Bottom of Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Domestic)</td>
<td>(Domestic)</td>
</tr>
<tr>
<td></td>
<td>(Agricultural)</td>
<td>(Agricultural)</td>
</tr>
<tr>
<td>2020</td>
<td>30%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>71%</td>
<td>0%</td>
</tr>
<tr>
<td>2030</td>
<td>88%</td>
<td>0%</td>
</tr>
<tr>
<td>2035</td>
<td>97%</td>
<td>2%</td>
</tr>
<tr>
<td>2040</td>
<td>97%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Estimated Percentages

<table>
<thead>
<tr>
<th>HZ 05-1</th>
<th>Top of Screen</th>
<th>Bottom of Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Domestic)</td>
<td>(Domestic)</td>
</tr>
<tr>
<td></td>
<td>(Municipal)</td>
<td>(Municipal)</td>
</tr>
<tr>
<td>2020</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>82%</td>
<td>5%</td>
</tr>
<tr>
<td>2030</td>
<td>95%</td>
<td>14%</td>
</tr>
<tr>
<td>2035</td>
<td>100%</td>
<td>55%</td>
</tr>
<tr>
<td>2040</td>
<td>100%</td>
<td>59%</td>
</tr>
</tbody>
</table>
Hydrogeologic Zone 05 - 2
(Average Spring Measurements)

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg</th>
<th>Upper (110% of Average)</th>
<th>Lower (90% of Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>365</td>
<td>401</td>
<td>328</td>
</tr>
<tr>
<td>2025</td>
<td>406</td>
<td>447</td>
<td>366</td>
</tr>
<tr>
<td>2030</td>
<td>448</td>
<td>493</td>
<td>403</td>
</tr>
<tr>
<td>2035</td>
<td>490</td>
<td>539</td>
<td>441</td>
</tr>
<tr>
<td>2040</td>
<td>532</td>
<td>585</td>
<td>479</td>
</tr>
</tbody>
</table>

HZ05-2: Slope per year 8 ft. per year
No Municipal Well Data Available
Hydrogeologic Zone 05 - 3
(Average Spring Measurements)

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg</th>
<th>Upper (110% of Average)</th>
<th>Lower (90% of Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>319</td>
<td>351</td>
<td>287</td>
</tr>
<tr>
<td>2025</td>
<td>358</td>
<td>394</td>
<td>322</td>
</tr>
<tr>
<td>2030</td>
<td>397</td>
<td>437</td>
<td>357</td>
</tr>
<tr>
<td>2035</td>
<td>436</td>
<td>480</td>
<td>392</td>
</tr>
<tr>
<td>2040</td>
<td>475</td>
<td>522</td>
<td>427</td>
</tr>
</tbody>
</table>

HZ05-3: Slope per year 8 ft per year
HZ 05-3 Well Impact Analysis

(Agricultural Wells - 70)

(Domestic Wells - 31)

(Municipal Wells - 5)
Sustainable Groundwater Management Act

North Kern Water Storage District
Shafter-Wasco Irrigation District
Sustainable Groundwater Management Act

• State Legislation passed in September 2014, effective January 2015
• Provides tools and authorities to Groundwater Sustainability Agencies to manage groundwater (NKWSD & SWID are in the Kern Groundwater Authority GSA)
• Requires a Groundwater Sustainability Plan in January 2020
• Requires groundwater basins to be managed “sustainably” by 2040
Who is Doing What in Kern Basin
Who is Doing What in Kern Basin
Who is Doing What in Kern Basin

• Kern Groundwater Authority
  • Developing Umbrella GSP for all members
  • Developing guidance for development of “Chapter GSPs”
  • Ensuring Coordination between KGA members and other GSAs (Kern River GSA)
  • Point of Contact to DWR for GSP submittal, updates and annual reporting.
Shafter-Wasco / North Kern GSP Development

- Communication & Engagement
  - Reaching out to local landowners and stakeholders
- Sustainable Management Criteria
  - Establishing target groundwater levels
- Project and Management Actions
  - How the GSA can mitigate reduced groundwater pumping
- Prepare a GSP
  - Consistent with KGA Umbrella GSP
Communication and Engagement

- Identify stakeholders
  - Anyone affected/impacted by groundwater in and around basin
  - Beneficial uses and users
  - Interested parties within and around basin
  - Keep landowners/stakeholders informed
  - Seek input on key SGMA elements:
    - Minimum Thresholds and Measurable Objectives
    - Projects and Management Actions

- Stakeholder Communication & Engagement
  - Regular District Board Meetings
  - Landowner Meetings
  - KGA Meetings
Communication and Engagement

Welcome to the Kern Groundwater Authority

In response to California’s recent drought conditions and increased reliance upon groundwater, in November 2014, the state legislature passed the Sustainable Groundwater Management Act (“SGMA”) collectively contained in Senate Bills (SB) 1158 and SB 1319, and Assembly Bill (AB) 179. The SGMA mandates that groundwater basins designated by Department of Water Resources as high or medium priority develop groundwater sustainability plans (“GSP”) to become sustainable. The Kern Sub-basin of the Tulare Lake Basin, overlies the valley portion of Kern County, is designated as high priority. The development of the GSP is to occur through one or more local public agencies that has water supply, water management or land use responsibilities within a groundwater basin.

Prior to enactment of the SGMA, the Kern Groundwater Authority (“Groundwater Authority”) was established to provide a framework for the active, comprehensive management of the groundwater basin underlying the valley portion of Kern County, to preserve and maintain local control (“self-determination”) of groundwater resources and provide long-term security for all basin users.

With passage of the SGMA, the Groundwater Authority seeks to coordinate local groundwater management efforts and is working with its members to determine the most cost effective and efficient way of meeting the new requirements of the SGMA.

Important Notices & Upcoming Events

Board of Director Meetings: Kern Groundwater Authority’s board meetings are held at 8 a.m. on the fourth Wednesday of every month, location to be determined, but will be posted prior to each meeting. Board agendas are posted monthly on the Board of Directors page.
• Identify which of the six Sustainability Indicators apply within the Basin and the NKWSD-SWID Management Area, now or in the future.

• Define preliminary definitions for:
  • *Undesirable Results*  
    Conditions you don’t want to see in the groundwater basin
  • *Minimum Thresholds*  
    The level that you never want to go below or exceed
  • *Measurable Objectives*  
    Where you want to be operating most of the time
Sustainable Management Criteria

• Undesirable Results
  • These have been defined at the Sub-Basin level and adopted at by the KGA.
  • The occurrence of an Undesirable Result indicates that the sub-basin is not being managed sustainably
  • Triggered by the violation of Minimum Thresholds in a significant portion of the sub-basin

Chronic Lowering of Water Levels
Groundwater Storage
Degraded Groundwater Quality Trends
Land Subsidence Trends
Surface Water Depletion
Seawater Intrusion
Chronic Lowering of Water Levels

The point at which significant and unreasonable impacts over the planning and implementation horizon, as determined by depth/elevation of water, affect the reasonable and beneficial use of, and access to, groundwater by overlying users

This is determined when the minimum threshold for groundwater levels are exceeded in at least three (3) adjacent Management Areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by each Management Area).
Sustainable Management Criteria

**Groundwater Storage**

The point at which significant and unreasonable impacts, as determined by the amount of groundwater in the basin, affect the reasonable and beneficial use of, and access to, groundwater by overlying users over an extended drought period. (10-years?).

This is determined when the volume of storage (above the groundwater level minimum thresholds) is depleted to an elevation lower than the groundwater level minimum threshold in at least three (3) adjacent Management Areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by each Management Area).
Degraded Groundwater Quality Trends

The point at which significant and unreasonable impacts over the planning and implementation horizon, as caused by water management actions, that affect the reasonable and beneficial use of, and access to, groundwater by overlying users.

This is determined when the minimum threshold for a groundwater quality constituent of concern is exceeded in at least three (3) adjacent management areas that represent at least 15% of the subbasin or greater than 30% of the designated monitoring points within the basin.
Sustainable Management Criteria

Land Subsidence Trends

The point at which significant and unreasonable impacts, as determined by a subsidence rate and extent in the basin, that affects the surface land uses or critical infrastructure.

This is determined when subsidence results in significant and unreasonable impacts to critical infrastructure as indicated by monitoring points established by a basin wide coordinated GSP subsidence monitoring plan.
Sustainable Management Criteria

Management Areas
Sustainable Management Criteria

NKWSD-SWID Management Areas
• Identify which of the six Sustainability Indicators apply within the Basin and NKWSD-SWID Management Area, now or in the future.

• Define preliminary definitions for:
  • Undesirable Results
    Conditions you don’t want to see in the groundwater basin

  Chronic Lowering of Water Levels  ---  YES
  Groundwater Storage  ---  YES
  Degraded Groundwater Quality Trends  ---  NO
  Land Subsidence Trends  ---  Maybe, need more data
Identify which of the six Sustainability Indicators apply within the Basin and NKWSD-SWID Management Area, now or in the future.

Define preliminary definitions for:
- **Minimum Thresholds**
  The level that you never want to go below or exceed
- **Measurable Objectives**
  Where you want to be operating most of the time
Sustainable Management Criteria
Minimum Threshold
- The level that you never want to go below or exceed
- Violation of Minimum Threshold is an indication that a Management Area is not being managed sustainably
- Local call to action

Starting Point:
- Project 2006 – 2016 groundwater conditions to 2040
- Period represents a “worse case” scenario (hydrology and regulatory)

Adjust the Starting Point (if needed)
- Assess impacts to beneficial uses
  - Wells (Ag, domestic and municipal)
  - Water quality
  - Subsidence
  - Storage
Sustainable Management Criteria
Sustainable Management Criteria

Hydrogeologic Zone 05 - 1
(Average Spring Measurements)

Depth to Water (ft)

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg</th>
<th>Upper (110% of Average)</th>
<th>Lower (90% of Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>378</td>
<td>415</td>
<td>340</td>
</tr>
<tr>
<td>2025</td>
<td>428</td>
<td>470</td>
<td>380</td>
</tr>
<tr>
<td>2030</td>
<td>478</td>
<td>526</td>
<td>430</td>
</tr>
<tr>
<td>2035</td>
<td>528</td>
<td>581</td>
<td>475</td>
</tr>
<tr>
<td>2040</td>
<td>578</td>
<td>636</td>
<td>521</td>
</tr>
</tbody>
</table>

HZ05-1: Slope per year 10 ft. per year

Depth to Water (ft)
Sustainable Management Criteria
Sustainable Management Criteria

(Domestic Wells - 22)

Estimated Percentages

<table>
<thead>
<tr>
<th>H205-1</th>
<th>Top of Screen Dewatered (Domestic)</th>
<th>Bottom of Screen Dewatered (Domestic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>82%</td>
<td>5%</td>
</tr>
<tr>
<td>2030</td>
<td>95%</td>
<td>14%</td>
</tr>
<tr>
<td>2035</td>
<td>100%</td>
<td>55%</td>
</tr>
<tr>
<td>2040</td>
<td>100%</td>
<td>59%</td>
</tr>
</tbody>
</table>

Depth (ft)

- Blank Casing
- Perforations
- Avg Water Level

2016 Avg Water Level

WL

2020
2025
2030
2035
2040
**Sustainable Management Criteria**

**Measurable Objectives**
- Where you want to be operating most of the time
- Represents a long-term average, not annual values

**Starting Point:**
- Provide a Margin of Operational Flexibility to protect against prolonged droughts – 10 years?

**Adjust the Starting Point (if needed)**
- Assess impacts to beneficial uses
  - Wells (Ag, domestic and municipal)
  - Water quality
  - Subsidence
  - Storage
Sustainable Management Criteria

Measurable Objective

Minimum Threshold

10 Year of Drought Protection
• Determine deficiency, if any, in groundwater supply (sustainable yield) basinwide

• Formulate, investigate, and implement desired projects and management actions to eliminate the deficiency in groundwater supply and achieve the sustainability goals

• Iterate as necessary to reach ensure the correct mix of projects and management actions

• Update projects and management actions every 5-years for GSP required update
Projects & Management Actions

Water Supply and Demand Management

- Pumping Reduction
- Fees
- Market
- Buy Back Programs
- Other Projects
- Surface Water Capture
- Recharge
- Import Supply
Projects & Management Actions

Adaptive Management to Difference Between Supply and Demand

Water Supply Projects

REDUCED GW PUMPING!

Management Actions

Water Supply and Demand Management

Demand Reduction $$$

Water Supply Projects $$
Projects & Management Actions

Cost of Sustainability

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs</td>
<td>Domestic wells – replacement</td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>M&amp;I Pumping cost increases</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>Subsidence</td>
</tr>
<tr>
<td>Well repair and replacement</td>
<td>Water quality</td>
</tr>
</tbody>
</table>
### Projects & Management Actions

#### Cost of Sustainability

- **Landowner Impacts**
  - Energy costs
  - Decreasing yield
  - O&M costs
  - Well repair/replacement

- **Third Party Impacts**
  - Domestic wells – replacement
  - M&I pumping cost increases
  - Subsidence
  - Water quality

<table>
<thead>
<tr>
<th>Year</th>
<th>Depth to Water (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>325</td>
</tr>
<tr>
<td>2040</td>
<td>300</td>
</tr>
</tbody>
</table>

**Cost:** $
Projects & Management Actions

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs</td>
<td>Domestic wells – replacement</td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>$</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>--</td>
</tr>
<tr>
<td>Well repair/replacement</td>
<td>--</td>
</tr>
</tbody>
</table>

Cost: $$$$
### Projects & Management Actions

#### Cost of Sustainability

<table>
<thead>
<tr>
<th>Year</th>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Energy costs $$</td>
<td>Domestic wells – replacement $$</td>
</tr>
<tr>
<td></td>
<td>Decreasing yield $</td>
<td>M&amp;I pumping cost increases $</td>
</tr>
<tr>
<td></td>
<td>O&amp;M costs $</td>
<td>Subsidence $$</td>
</tr>
<tr>
<td></td>
<td>Well repair/replacement $</td>
<td>Water quality --</td>
</tr>
</tbody>
</table>

**Cost:** $$$$$$
Projects & Management Actions

- Cost of Sustainability
- Projects & Management Actions

<table>
<thead>
<tr>
<th>Year</th>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>Energy costs $$ $$</td>
<td>Domestic wells – replacement $$$</td>
</tr>
<tr>
<td></td>
<td>Decreasing yield $</td>
<td>M&amp;I pumping cost increases $</td>
</tr>
<tr>
<td></td>
<td>O&amp;M costs $</td>
<td>Subsidence $$$</td>
</tr>
<tr>
<td></td>
<td>Well repair/replacement $$$</td>
<td>Water quality $</td>
</tr>
</tbody>
</table>

Cost: $$$$$$$$$$$$$$$$$$
### Projects & Management Actions

#### Cost of Sustainability

<table>
<thead>
<tr>
<th>Projects &amp; Management Actions</th>
<th>2030</th>
<th>2040</th>
<th>Measurable Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landowner Impacts</td>
<td>$$$</td>
<td>$$$</td>
<td></td>
</tr>
<tr>
<td>Energy costs</td>
<td>$$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well repair/replacement</td>
<td>$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic wells – replacement</td>
<td>$$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M&amp;I pumping cost increases</td>
<td>$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidence</td>
<td>$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water quality</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase Water Supply</td>
<td>$$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand Reduction</td>
<td>$$$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cost:** $$$$$$$$$$$$$$$$$$$$$$$

**Basis:** Setting
Next Steps for Setting Minimum Thresholds
• Work with landowners/stakeholders within discrete areas to review 2040 projections and impacts to wells and groundwater production costs
• Based on input revise Minimum Thresholds as appropriate
• REMINDER: This is the Point of Avoidance!

Next Steps for Setting Measurable Objective
• Work with landowners/stakeholders within discrete areas to set the normal operating groundwater elevations
• Based on input revise Measurable Objective.
• REMINDER: This is the Point of Management!

Coordination with Kern Sub-Basin neighbors
Sustainable Management Criteria

Hydrologic Zone Landowner/Stakeholder Meetings

March 21, 2019
1:00 to 2:00pm – HZ01-2 and HZ05-1
2:00 to 3:00pm – HZ02-3 and HZ02-2
3:00 to 4:00pm – HZ05-2 and HZ05-3
4:00 to 5:00pm – HZ02-4, HZ02-5, and HZ04-3

Location: Shafter-Wasco Irrigation District
16294 Central Valley Hwy. Wasco CA 93280
Communication and Engagement

Stay Involved!

- District Board Meetings – GSP development update each month
- Public Workshops
  - Stakeholder and Landowner Meetings
  - KGA Board meetings
  - KGA sponsored workshops and meetings
Questions
Sustainable Groundwater Management Act

North Kern Water Storage District
Shafter-Wasco Irrigation District
Sustainable Groundwater Management Act

• State Legislation passed in September 2014, effective January 2015
• Provides tools and authorities to Groundwater Sustainability Agencies to manage groundwater (NKWSD & SWID are in the Kern Groundwater Authority GSA)
• Requires a Groundwater Sustainability Plan in January 2020
• Requires groundwater basins to be managed “sustainably” by 2040
Who is Doing What in Kern Basin
Who is Doing What in Kern Basin
Who is Doing What in Kern Basin

• Kern Groundwater Authority
  • Developing Umbrella GSP for all members
  • Developing guidance for development of “Chapter GSPs”
  • Ensuring Coordination between KGA members and other GSAs (Kern River GSA)
  • Point of Contact to DWR for GSP submittal, updates and annual reporting.
Shafter-Wasco / North Kern GSP Development

- Communication & Engagement
  - Reaching out to local landowners and stakeholders
- Sustainable Management Criteria
  - Establishing target groundwater levels
- Project and Management Actions
  - How the GSA can mitigate reduced groundwater pumping
- Prepare a GSP
  - Consistent with KGA Umbrella GSP
• Identify stakeholders
  • Anyone affected/impacted by groundwater in and around basin
  • Beneficial uses and users
  • Interested parties within and around basin
  • Keep landowners/stakeholders informed
  • Seek input on key SGMA elements:
    • Minimum Thresholds and Measurable Objectives
    • Projects and Management Actions

• Stakeholder Communication & Engagement
  • Regular District Board Meetings
  • Landowner Meetings
  • KGA Meetings
Communication and Engagement

Welcome to the Kern Groundwater Authority

In response to California’s recent drought conditions and increased reliance upon groundwater, in November 2014, the state legislature passed the Sustainable Groundwater Management Act (“SGMA”) collectively contained in Senate Bills (SB) 1156 and SB 1319 and Assembly Bill (AB) 1793. The SGMA mandates that groundwater basins designated by Department of Water Resources as high or medium priority develop groundwater sustainability plans (“GSP”) to become sustainable. The Kern Sub-basin of the Tulare Lake Basin, covering the valley portion of Kern County, is designated as high priority. The development of the GSP is to occur through one or more local public agencies that has water supply, water management or land use responsibilities within a groundwater basin.

Prior to enactment of the SGMA, the Kern Groundwater Authority (“Groundwater Authority”) was established to provide a framework for the active, comprehensive management of the groundwater basin underlying the valley portion of Kern County, to preserve and maintain local control (“determination”) of groundwater resources and provide long term supply for all basin users.

With passage of the SGMA, the Groundwater Authority seeks to coordinate local groundwater management efforts and is working with its members to determine the most cost effective and efficient way of meeting the new requirements of the SGMA.

Important Notices & Upcoming Events

Board of Director Meetings: Kern Groundwater Authority’s board meetings are held at 8 a.m. on the fourth Wednesday of every month, location to be determined, but will be posted prior to each meeting. Board agendas are posted monthly on the Board of Directors page.
• Identify which of the six Sustainability Indicators apply within the Basin and the NKWSD-SWID Management Area, now or in the future.

• Define preliminary definitions for:
  • Undesirable Results
    Conditions you don’t want to see in the groundwater basin
  • Minimum Thresholds
    The level that you never want to go below or exceed
  • Measurable Objectives
    Where you want to be operating most of the time
Sustainable Management Criteria

• Undesirable Results
  • These have been defined at the Sub-Basin level and adopted at by the KGA.
  • The occurrence of an Undesirable Result indicates that the sub-basin is not being managed sustainably
  • Triggered by the violation of Minimum Thresholds in a significant portion of the sub-basin

Chronic Lowering of Water Levels
Groundwater Storage
Degraded Groundwater Quality Trends
Land Subsidence Trends
Surface Water Depletion
Seawater Intrusion
Chronic Lowering of Water Levels

The point at which significant and unreasonable impacts over the planning and implementation horizon, as determined by depth/elevation of water, affect the reasonable and beneficial use of, and access to, groundwater by overlying users

This is determined when the minimum threshold for groundwater levels are exceeded in at least three (3) adjacent Management Areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by each Management Area).
Groundwater Storage

The point at which significant and unreasonable impacts, as determined by the amount of groundwater in the basin, affect the reasonable and beneficial use of, and access to, groundwater by overlying users over an extended drought period. (10-years?).

This is determined when the volume of storage (above the groundwater level minimum thresholds) is depleted to an elevation lower than the groundwater level minimum threshold in at least three (3) adjacent Management Areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by each Management Area).
Degraded Groundwater Quality Trends

The point at which significant and unreasonable impacts over the planning and implementation horizon, as caused by water management actions, that affect the reasonable and beneficial use of, and access to, groundwater by overlying users.

This is determined when the minimum threshold for a groundwater quality constituent of concern is exceeded in at least three (3) adjacent management areas that represent at least 15% of the subbasin or greater than 30% of the designated monitoring points within the basin.

Sustainable Management Criteria
Land Subsidence Trends

The point at which significant and unreasonable impacts, as determined by a subsidence rate and extent in the basin, that affects the surface land uses or critical infrastructure.

This is determined when subsidence results in significant and unreasonable impacts to critical infrastructure as indicated by monitoring points established by a basin wide coordinated GSP subsidence monitoring plan.
Sustainable Management Criteria

Management Areas
Sustainable Management Criteria

NKWSD-SWID Management Areas
Sustainable Management Criteria

- Identify which of the six Sustainability Indicators apply within the Basin and NKWSD-SWID Management Area, now or in the future.
- Define preliminary definitions for:
  - Undesirable Results
    Conditions you don’t want to see in the groundwater basin

**Chronic Lowering of Water Levels --- YES**
**Groundwater Storage --- YES**
**Degraded Groundwater Quality Trends --- NO**
**Land Subsidence Trends --- Maybe, need more data**
Sustainable Management Criteria

- Identify which of the six Sustainability Indicators apply within the Basin and NKWSD-SWID Management Area, now or in the future.

- Define preliminary definitions for:
  - *Minimum Thresholds*
    The level that you never want to go below or exceed
  - *Measurable Objectives*
    Where you want to be operating most of the time
Sustainable Management Criteria
Minimum Threshold
• The level that you never want to go below or exceed
• Violation of Minimum Threshold is an indication that a Management Area is not being managed sustainably
• Local call to action

Starting Point:
• Project 2006 – 2016 groundwater conditions to 2040
• Period represents a “worse case” scenario (hydrology and regulatory)

Adjust the Starting Point (if needed)
• Assess impacts to beneficial uses
  • Wells (Ag, domestic and municipal)
  • Water quality
  • Subsidence
  • Storage
Sustainable Management Criteria
Sustainable Management Criteria

(Agricultural Wells - 92)

Estimated Percentages

- H205-1
- Top of Screen Dewatered (AG)
- Bottom of Screen Dewatered (AG)

<table>
<thead>
<tr>
<th>Year</th>
<th>Top of Screen</th>
<th>Bottom of Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>30%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>71%</td>
<td>0%</td>
</tr>
<tr>
<td>2030</td>
<td>88%</td>
<td>0%</td>
</tr>
<tr>
<td>2035</td>
<td>97%</td>
<td>2%</td>
</tr>
<tr>
<td>2040</td>
<td>97%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Depth (ft): Blank Casing, Perforations, Avg. Water Level

2016 Avg. Water Level
Sustainable Management Criteria

(Domestic Wells - 22)

Estimated Percentages

<table>
<thead>
<tr>
<th>H295-1</th>
<th>Top of Screen</th>
<th>Bottom of Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dewatered</td>
<td>Dewatered</td>
</tr>
<tr>
<td></td>
<td>(Domestic)</td>
<td>(Domestic)</td>
</tr>
<tr>
<td>2020</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>2025</td>
<td>82%</td>
<td>5%</td>
</tr>
<tr>
<td>2030</td>
<td>95%</td>
<td>14%</td>
</tr>
<tr>
<td>2035</td>
<td>100%</td>
<td>55%</td>
</tr>
<tr>
<td>2040</td>
<td>100%</td>
<td>59%</td>
</tr>
</tbody>
</table>

Depth (ft)

- Blank Casing
- Perforations
- Avg Water Level
Sustainable Management Criteria
Sustainable Management Criteria

**Measurable Objectives**
- Where you want to be operating most of the time
- Represents a long-term average, not annual values

**Starting Point:**
- Provide a Margin of Operational Flexibility to protect against prolonged droughts – 10 years?

**Adjust the Starting Point (if needed)**
- Assess impacts to beneficial uses
  - Wells (Ag, domestic and municipal)
  - Water quality
  - Subsidence
  - Storage
Sustainable Management Criteria

Measurable Objective

Minimum Threshold

10 Year of Drought Protection
Sustainable Management Criteria
Projects & Management Actions

• Determine deficiency, if any, in groundwater supply (sustainable yield) basinwide
• Formulate, investigate, and implement desired projects and management actions to eliminate the deficiency in groundwater supply and achieve the sustainability goals
• Iterate as necessary to reach ensure the correct mix of projects and management actions
• Update projects and management actions every 5-years for GSP required update
Projects & Management Actions

Water Supply and Demand Management

Water Supply

- Import Supply
- Recharge
- Surface Water Capture
- Other Projects
- Buy Back Programs
- Market
- Fees
- Pumping Reduction

Water Demand

Projects & Management Actions

- Sustainability Goal
- Governmental Communication & Engagement
- Data Management System
- Project & Management Action

Basic Setting
Projects & Management Actions

Adaptive Management to Difference Between Supply and Demand

Water Supply Projects

- Reduced GW Pumping

Water Supply and Demand Management

- Demand Reduction $$$
- Water Supply Projects $$

Management Actions

Projects
## Cost of Sustainability

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs</td>
<td>Domestic wells – replacement</td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>M&amp;I Pumping cost increases</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>Subsidence</td>
</tr>
<tr>
<td>Well repair and replacement</td>
<td>Water quality</td>
</tr>
</tbody>
</table>
Projects & Management Actions

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs</td>
<td>Domestic wells – replacement</td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>M&amp;I pumping cost increases</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>Subsidence</td>
</tr>
<tr>
<td>Well repair/replacement</td>
<td>Water quality</td>
</tr>
</tbody>
</table>

Cost: $
Projects & Management Actions

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs $§§</td>
<td>Domestic wells – replacement $</td>
</tr>
<tr>
<td>Decreasing yield $</td>
<td>M&amp;I pumping cost increases --</td>
</tr>
<tr>
<td>O&amp;M costs --</td>
<td>Subsidence --</td>
</tr>
<tr>
<td>Well repair/replacement --</td>
<td>Water quality --</td>
</tr>
</tbody>
</table>

Cost: $$$$$
Projects & Management Actions

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs</td>
<td>Domestic wells – replacement</td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>M&amp;I pumping cost increases</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>Subsidence</td>
</tr>
<tr>
<td>Well repair/replacement</td>
<td>Water quality</td>
</tr>
</tbody>
</table>

Cost: $$$$$$$$$$$
Projects & Management Actions

Cost of Sustainability

Projects & Management Actions

<table>
<thead>
<tr>
<th>Landowner Impacts</th>
<th>Third Party Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy costs</td>
<td>Domestic wells – replacement</td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>M&amp;I pumping cost increases</td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>Subsidence</td>
</tr>
<tr>
<td>Well repair/replacement</td>
<td>Water quality</td>
</tr>
</tbody>
</table>

Cost: $$$$$$$$$$$$$$$$$$$
## Projects & Management Actions

### Cost of Sustainability

<table>
<thead>
<tr>
<th>Projects &amp; Management Actions</th>
<th>2030</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landowner Impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy costs</td>
<td>$$$</td>
<td></td>
</tr>
<tr>
<td>Decreasing yield</td>
<td>$$</td>
<td></td>
</tr>
<tr>
<td>O&amp;M costs</td>
<td>$$</td>
<td></td>
</tr>
<tr>
<td>Well repair/replacement</td>
<td>$$</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Party Impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic wells – replacement</td>
<td>$$$</td>
<td></td>
</tr>
<tr>
<td>M&amp;I pumping cost increases</td>
<td>$$</td>
<td></td>
</tr>
<tr>
<td>Subsidence</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Water quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Water Supply and Demand Management

- Increase Water Supply: $$
- Demand Reduction: $$$

### Measurable Objective

- 2030: Depth to Water (ft): 350
- 2040: Depth to Water (ft): 250

### Cost: $\text{-------------------------}$
Next Steps for Setting Minimum Thresholds
• Work with landowners/stakeholders within discrete areas to review 2040 projections and impacts to wells and groundwater production costs
• Based on input revise Minimum Thresholds as appropriate
• REMINDER: This is the Point of Avoidance!

Next Steps for Setting Measurable Objective
• Work with landowners/stakeholders within discrete areas to set the normal operating groundwater elevations
• Based on input revise Measurable Objective.
• REMINDER: This is the Point of Management!

Coordination with Kern Sub-Basin neighbors
Sustainable Management Criteria

Hydrologic Zone Landowner/Stakeholder Meetings

March 21, 2019
1:00 to 2:00pm – HZ01-2 and HZ05-1
2:00 to 3:00pm – HZ02-3 and HZ02-2
3:00 to 4:00pm – HZ05-2 and HZ05-3
4:00 to 5:00pm – HZ02-4, HZ02-5, and HZ04-3

Location: Shafter-Wasco Irrigation District
16294 Central Valley Hwy. Wasco CA 93280
Communication and Engagement

Stay Involved!

- District Board Meetings – GSP development update each month
- Public Workshops
  - Stakeholder and Landowner Meetings
  - KGA Board meetings
  - KGA sponsored workshops and meetings
Questions
GSP DEVELOPMENT PROCESS

GEI Method and Approach

July 24, 2018

Presented by:
Michelle Ricker
Larry Rodriguez

GEI Consultants

ITERATIVE PROCESS

• GSP development is not a linear process
• Steps may be taken in parallel
• Steps may iterate until conclusion is reached
• Process is continuous
• GSAs work toward increased sustainability, adaptively managing and responding to changes over time
• GSPs submitted to DWR will not all be equal
The Kern Groundwater Authority (KGA) is preparing an “Umbrella GSP” for all of its members.

- North Kern WSD and Shafter-Wasco Irrigation District are members of the KGA
- The KGA is also developing guidance for each of its members to develop “Chapter GSPs”

The KGA is also ensuring coordination between its members and other GSAs within the basin (e.g. Kern River GSA)

The KGA is the point of contact to DWR for GSP submittal, updates, and annual reporting
GSP Participants

- **GSA Leadership**
  - Local water managers and leaders with decision-making responsibilities

- **Technical Experts**
  - Local water managers, subject matter experts (local staff), consultants

- **Stakeholders**
  - Beneficial users of groundwater, interested parties, impacted parties within and adjacent to the basin

---

BASIN SETTING

- Develop basin description and state of the basin
- Develop hydrogeologic conceptual model (HCM)
- Outline what impacts are already happening
- Develop basin numerical model
- Identify structures and costs (i.e. important structures/wells/types of wells/current and future pumping costs, etc.)
- Identify gaps in knowledge
- Develop plan to eliminate data gaps when necessary
- Identify areas where there is disagreement about the basin setting
GOVERNANCE AND COMMUNICATION & ENGAGEMENT

- Identify stakeholders
  - Anyone affected/impacted by groundwater in and around basin
  - Beneficial uses and users
  - Interested parties within and around basin

- Identify technical experts
  - GSA leadership
  - Consultants
  - Technical leads

- Define governance structure
  - Who makes the decisions for the basin
  - How conflicts will be resolved
  - How GSA will interact with adjacent basins

- Develop Stakeholder Communication & Engagement Plan

SUSTAINABLE MANAGEMENT CRITERIA

- Identify which of the six Sustainability Indicators (SI) are possible in the basin, now or in the future.

- Define impacts those SIs are having, and potential future impacts.

- Define a basin level Undesirable Results for each SI.

- Define Minimum Thresholds, Measurable Objectives and Interim Milestones for each SI (could be more than one per SI)

- Begin outreach communications in your basin.

- Identify Representative Monitoring Sites (RMS)
DATA MANAGEMENT SYSTEM

- Establish monitoring program
- Develop DMS – data will be reported to DWR
- Use DMS to track which RMS is monitoring which SI

PROJECTS AND MANAGEMENT ACTIONS

- Determine deficiency, if any, in groundwater supply (sustainable yield) basinwide (§354.18(b)(7)).
- Iterate as necessary to adjust sustainable management criteria
- Formulate, investigate, and implement desired projects and management actions to eliminate the deficiency in groundwater supply and achieve the GSAs goals
- Iterate as necessary to ensure the correct mix of projects and management actions to work toward sustainability
- Update projects and management actions every 5 years for required GSP updates
SUMMARY

- Iteration required
- Record gaps or disputed data/decisions so can be addressed in GSP
- GSAs will work through these activities differently – some may make many iterations before the first GSP, others may not
- GSPs submitted to DWR will not all be equal or at the same level of sustainability or completeness of information

SUSTAINABILITY

- Managing and using groundwater in a way that can be sustained over a long period of time
- Sustainable yield is the amount of groundwater that can be withdrawn without causing undesirable results
HOW TO BECOME INVOLVED

• SSJMUD Board Meetings – GSP Development Update Each Month

• Public Workshops
  – KGA Board Meetings
  – KGA-sponsored Workshops and Meetings
**GSP DEVELOPMENT PROCESS**

**GEI Method and Approach**

July 12, 2018

Presented by:
Michelle Ricker
Larry Rodriguez

GEI Consultants

**ITERATIVE PROCESS**

- GSP development is not a linear process
- Steps may be taken in parallel
- Steps may iterate until conclusion is reached
- Process is continuous
- GSAs work toward increased sustainability, adaptively managing and responding to changes over time
- GSPs submitted to DWR will not all be equal
The Kern Groundwater Authority (KGA) is preparing an “Umbrella GSP” for all of its members.

- North Kern WSD and Shafter-Wasco Irrigation District are members of the KGA
- The KGA is also developing guidance for each of its members to develop “Chapter GSPs”

The KGA is also ensuring coordination between its members and other GSAs within the basin (e.g. Kern River GSA)

The KGA is the point of contact to DWR for GSP submittal, updates, and annual reporting
BASIN SETTING

- Develop basin description and state of the basin
- Develop hydrogeologic conceptual model (HCM)
- Outline what impacts are already happening
- Develop basin numerical model
- Identify structures and costs (i.e. important structures/wells/types of wells/current and future pumping costs, etc.)
- Identify gaps in knowledge
- Develop plan to eliminate data gaps when necessary
- Identify areas where there is disagreement about the basin setting

GOVERNANCE AND COMMUNICATION & ENGAGEMENT

- Identify stakeholders
  - Anyone affected/impacted by groundwater in and around basin
  - Beneficial uses and users
  - Interested parties within and around basin
- Identify technical experts
  - GSA leadership
  - Consultants
  - Technical leads
- Define governance structure
  - Who makes the decisions for the basin
  - How conflicts will be resolved
  - How GSA will interact with adjacent basins
- Develop Stakeholder Communication & Engagement Plan
SUSTAINABLE MANAGEMENT CRITERIA

- Identify which of the six Sustainability Indicators (SI) are possible in the basin, now or in the future.
- Define impacts those SIs are having, and potential future impacts.
- Define a basin level Undesirable Results for each SI.
- Define Minimum Thresholds, Measurable Objectives and Interim Milestones for each SI (could be more than one per SI)
- Begin outreach communications in your basin.
- Identify Representative Monitoring Sites

DATA MANAGEMENT SYSTEM

- Establish monitoring program
- Develop DMS – data will be reported to DWR
- Use DMS to track which RMS is monitoring which SI
PROJECTS AND MANAGEMENT ACTIONS

- Determine deficiency, if any, in groundwater supply (sustainable yield) basinwide (§354.18(b)(7).
- Iterate as necessary to adjust sustainable management criteria
- Formulate, investigate, and implement desired projects and management actions to eliminate the deficiency in groundwater supply and achieve the GSAs goals

SUMMARY

- Iteration required
- Record gaps or disputed data/decisions so can be addressed in GSP
- GSAs will work through these activities differently – some may make many iterations before the first GSP, others may not
- GSPs submitted to DWR will not all be equal or at the same level of sustainability or completeness of information
SUSTAINABLE MANAGEMENT CRITERIA

**Set Basinwide**
- Undesirable Results
- Sustainability Goals

**Set by Management Area**
- Minimum Thresholds
- Measurable Objectives
- Interim Milestones

SUSTAINABILITY GOALS

**Chronic Lowering of Groundwater Levels**
Maintain groundwater levels that continue to support agricultural viability and sustainable communities

**Reduction of Groundwater Storage**
Maintain groundwater volumes in storage to sustain agriculture and communities during prolonged drought conditions

**Degraded Water Quality**
Avoid degradation of groundwater quality that would impact sustainable agriculture and communities

**Land Subsidence**
Reduce or prevent land subsidence that causes impacts to critical infrastructure

**Depletions of Interconnected Surface Water**
Prevent impacts to groundwater dependent ecosystems

**Seawater Intrusion**
Not applicable
SUSTAINABILITY GOALS

• Undesirable Results:
  • *High level definition, applicable to the entire sub-basin*

• Example Definitions:
  • Water Levels
    • GW levels that impact >10% of domestic and municipal wells
    • Violation of Minimum Thresholds in >10% of the sub-basin (by area)
  • Storage – Storage Amounts Equivalent to Double the Volume Needed for Operational Flexibility
  • Seawater Intrusion – Not Applicable
  • Water Quality – No Migration of Identified Plumes Resulting in new MCL Exceedances
  • Subsidence – No Subsidence to Critical Infrastructure Resulting in 2% Loss in Performance
  • Depletion of Interconnected Streams – Streamflow Depletion Limited to Less than 1% or Less than 2% Impact to Area of Riparian Impacts

SUSTAINABILITY GOALS

• Minimum Thresholds:
  • Quantitative value that, when exceeded, can cause Undesirable Results
  • Measurable Objective is goal that represents the normal or average groundwater condition

• Measurable Objectives:
  • Quantitative goals that reflect the desired groundwater condition of the management area while maintaining a volume of operational flexibility
  • A Measurable Objective is a goal that represents the average or normal groundwater condition (GW elevations based on trends, WQ based on discrete values)

• Interim Milestones:
  • Trend line values that represent the projected changes in groundwater conditions based on implementation of projects and management actions
SUSTAINABLE MANAGEMENT CRITERIA

Other Projects
Surface Water Capture
Recharge
Import Supply

Pumping Reduction
Fees
Market
Buy Back Programs

Project and Management Actions

Adaptive Management to Difference Between Supply and Demand

Water Demand
Management Actions
Adaptive Management

Water Supply
SUSTAINABLE MANAGEMENT CRITERIA

Project and Management Actions

Adaptive Management

REDUCED GW PUMPING!

SUSTAINABLE MANAGEMENT CRITERIA

5%

Pumping Reduction

15%

Pumping Reduction

40%

Pumping Reduction

50%

Pumping Reduction

GDP Adaptation Date

SOMS Sustainability Date

Historical Measurement Data

Minimum Threshold

Measurable Objective

Margin of Operational Feasibility
SUSTAINABLE MANAGEMENT CRITERIA

Developing Minimum Thresholds

Groundwater Elevation Declines

- No
- Yes

- Dry Wells
- Pumping Cost
- Well Deepening

Minimum Threshold
Lowest historic GW elevation

Minimum Threshold
Set minimum GW elevation at elevation of avoid impacts

Historical Measurement Data

GW Adoption Date

SMART Sustainability Date

Margin of Operational Reliability

MT
Developing Minimum Thresholds

Presence of Subsidence

No

Yes

Is subsidence significant

No

Yes

Minimum Threshold
Do not exceed historic minimum GW elevation

Minimum Threshold
Set minimum GW elevation at elevation of avoid impacts

Significance determined at the Management Area. Metrics for subsidence include:
• Impacts to infrastructure
• Cost of mitigation

Determine GW elevation that avoids impacts of subsidence plus an appropriate buffer.
• Determine level of acceptable subsidence or mitigation (if any) and corresponding GW elevation
• Consider presence of clay layers and avoidance of dewatering

NEXT STEPS

• Sub-Basin Level (July)
  • Set Undesirable Results at the Sub-Basin level
  • Develop basic guidance for development of Minimum Thresholds, Measurable Objectives and Interim Milestones

• GSA Level (Late July - September)
  • Preliminary cut at Minimum Thresholds, Measurable Objectives and Interim Milestones
Proposed SGMA Outreach Schedule

- SGMA Progress Report to Cities’ Public Works staff
  - Quarterly (starting in September)
    - Next KGA Urban Water Users Meeting on 9/17/18
  - In-person meeting or conference call
  - Topics:
    - Discussion of Sustainable Management Criteria (Where the Cities fall in the Management Areas, How SMCs are established, etc.)
    - Potential for Partnership on Projects and Management Actions

- Coordination of SMCs with North Kern WSD, Semitropic WSD, and SSJMUD
  - Ongoing via the North of River HCM Group
  - Next NOR HCM Group meeting is on 9/11/18
  - As-needed until SMCs are established

- Meetings with 7th Standard Annex Landowners and EKI
  - Monthly (starting in October)
  - Topics:
    - Coordination of SMCs and Monitoring within the Management Area shared by SWID and 7th Standard Annex
    - Discussion of Projects and Management Actions for their GSP

- Landowner/Stakeholder Workshops
  - Quarterly (starting in October)
  - Topics:
    - GSP Development Process (KGA and District activities)
    - Sustainable Management Criteria
    - Projects and Management Actions for District
Shafter-Wasco Irrigation District and North Kern Water Storage District  
Sustainable Groundwater Management Act  
Stakeholder Workshop  

Topic: SGMA – Sustainable Management Criteria and Minimum Thresholds  

When: Tuesday, March 19, 2019 @ 2:00 pm – 4:00 pm  
Where: Wasco-Shafter Elks Lodge, 16694 Wasco Ave, CA 93280  

You are invited by the Shafter-Wasco Irrigation District (SWID) and North Kern Water Storage District (NKWSD) to attend a SGMA workshop at the Wasco-Shafter Elks Lodge (16694 Wasco Ave, CA 93280) on Tuesday, March 19th, 2019 from 2:00 pm to 4:00 pm.  

We will provide an update on the district’s development of a Groundwater Sustainability Plan and the development of Sustainability Management Criteria, including Minimum Thresholds for groundwater conditions.  

If you are planning to attend this workshop, please RSVP to Grace Martin (GEI Consultants) at 661.716.3010 or gemartin@geiconsultants.com by Friday, March 15th, 2019 so we can get a head count to ensure adequate seating.  

Thank you and we look forward to seeing you at the workshop.  

Regards,  

Dana Munn        Richard Diamond  
Shafter-Wasco Irrigation District        North Kern Water Storage District