4 SUSTAINABLE MANAGEMENT CRITERIA AND MONITORING NETWORKS

This chapter of the GSP describes the Sustainable Management Criteria (SMC) for the FWD GSA. Other areas of the Subbasin are covered by Appendix A and the five other individual GSPs prepared for the Subbasin. The purpose of establishing SMC is to create standards that allow a subbasin or GSP area to reach sustainable conditions. Each GSP is required to create a sustainability goal which defines the absence of undesirable results related to groundwater conditions. Undesirable results are defined by the GSA and occur when conditions for any six sustainability indicators become significant and unreasonable. The six sustainability indicators (SI) are listed below:

- Chronic Lowering of Groundwater Elevation
- Reduction of Groundwater Storage
- Seawater Intrusion
- Degraded Groundwater Quality
- Land Subsidence
- Depletions of Interconnected Surface Waters

All SI apply to FWD with the exception of seawater intrusion because the Subbasin is not a coastal basin. A monitoring network has been established for each of these sustainability indicators to serve as a basis for setting Minimum Thresholds (MT) and Measurable Objectives (MO) in order to avoid Undesirable Results and achieve sustainability. This chapter provides a discussion on the development of all SMC components for the FWD GSA area.

The SMC were established by the following process:

- Hydrogeologic Analysis
- Coordination with adjacent GSAs
- Input from local stakeholders and interested parties

The information obtained from this process was used to define what is considered significant and unreasonable conditions, and what conditions are considered sustainable for the five applicable SI. Significant and unreasonable conditions are quantified by MTs. Significant and unreasonable conditions occur when multiple MT exceedances occur for consecutive years. Analysis of historic and projected hydrogeologic conditions provided insight into what these conditions were and what they are likely to be in the future. The projected conditions and legislative requirements were used to determine MOs. Coordination with adjacent GSAs also occurred to ensure established MTs and MOs were not significantly different. Finally, input from stakeholders was utilized to ensure that established MTs and MOs would not significantly impact planned groundwater management. The following discussion provides further description of the processes used to develop each of the components that make up the SMC.

4.1 Sustainability Goal (Reg. § 354.24)

Description of the Goal: FWD will manage groundwater resources in a manner that results in the absence of undesirable results for the Upper Aquifer by the year 2040. FWD is not expected to extract groundwater of a significant amount from the Lower Aquifer during the projected water budget period. Lower Aquifer conditions will be monitored and managed in coordination with other entities that utilize the Lower Aquifer as a source of groundwater to a much greater degree than FWD. Sustainability will be accomplished by continuing existing monitoring and data collection and intra-basin and inter-basin coordination to improve our understanding of regional influences on Lower Aquifer conditions. Coordination and communication with surrounding GSAs will be conducted to implement management actions that will prevent over extraction of groundwater and maintain stable conditions for each of the sustainability indicators in the Upper and Lower Aquifers.

The historic period showed that, under normal hydrologic conditions, the FWD plan area operates sustainably when the average change in storage is slightly positive and groundwater levels are generally stable. Extended dry periods, similar to those from 2012 through 2016, results in conditions that are not sustainable due to significant reductions in groundwater storage. Using the current understanding of groundwater conditions in FWD as they relate to variable hydrologic conditions, the FWD plan area will be managed and monitored to ensure the sustainability goal is met by 2040. This will be completed through further investigation of existing data gap areas and development of future projects and management actions to ensure sustainable conditions are maintained through the planning and implementation horizon (2040 through 2070).

4.2 Measurable Objectives and Interim Milestones (Reg. § 354.30)

MOs quantify groundwater conditions that are representative of sustainable conditions for each sustainability indicator. The interim milestones represent the trend of groundwater conditions, in 5-year increments, required to reach sustainable conditions over the 20-year implementation period. In addition, the GSP includes descriptions of each objective and how each objective is intended to achieve the sustainability goal for the Subbasin for the long-term beneficial uses. The GSP regulations define measurable objectives as specific, quantifiable goals for the maintenance or improvement of specific groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the plan area.

Per GSP Regulations (§354.30):

1. Each Agency shall establish measurable objectives, including interim milestones, in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

2. Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metric and monitoring sites as are used to define the minimum thresholds.
3. Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
4. An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence. Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years.

The measurable objectives developed for each applicable sustainability indicator in this GSP are based on the current understanding of the Plan area and basin setting as discussed in Chapter 3.

4.2.1 Measurable Objectives for Chronic Lowering of Water Levels

4.2.1.1 Description of Measurable Objective

Groundwater elevation SMC were developed based on historic measurements and the sustainability goal of preventing a long-term trend of declining groundwater levels. MOs were set at the two representative sites (**Figure 4-1**). As described in *Groundwater Conditions* (Section 3.2.1), groundwater levels are measured in terms of elevation above sea level in NAVD 88. One site (R-8) monitors groundwater conditions in the Upper Aquifer, and the other (USGS-31J6) monitors conditions in the Lower Aquifer. A Lower Aquifer monitoring well is planned to be constructed within FWD as part of DWR Technical Support Service grant funds. This new well will replace USGS 31J6 within the monitoring network once it is constructed by 2020. Given the small area of FWD, only a single site is needed to monitor conditions in each of the principal aquifers. Data from other monitoring programs located in adjacent GSAs will be utilized as well to evaluate whether trends observed in FWD in the future may be a result of groundwater management in adjacent GSAs. For both the Upper and Lower Aquifer, MOs were set based on seasonal high conditions observed in 2015. Under SGMA, undesirable results prior to 2015 do not have to be addressed. Interim milestones were set as a linear projection between recent groundwater elevations and MO levels that represent2040. The methodology used to establish MTs will be discussed in the following section. FWD management actions will not impact Lower Aquifer sustainability because all future pumping will occur in the Upper Aquifer. Representative wells and their associated MOs are shown in **Table 4-1**.

4.2.1.2 Reasonable Margin of Safety for Operational Flexibility

The established MOs for chronic lowering of groundwater elevation allow a reasonable margin of safety for operational flexibility under adverse conditions, as these water levels are based on 2015 water levels which are near historic lows. Recent (post 2016) and historic water levels have generally remained above these levels. Based on the information described in the *Current and Historic Groundwater Conditions* section, dry periods have resulted in decline of groundwater elevation followed by a recovery during wet and normal years.

4.2.1.3 Path to Achieve and Maintain the Sustainability Goal

Historic trends and planned groundwater extraction and management actions provide a reasonable path to maintain the sustainability goal of a stable groundwater elevation. Recent water levels remain above the MO and interim milestones. Therefore, since recent groundwater levels are higher than the MO due to recent wet hydrologic conditions, a recovery of groundwater elevation is not needed to reach the sustainability goal. The sustainability goal for groundwater elevation is to prevent a trend of declining water levels in a manner that results in groundwater elevations lower than the MO. Planned management actions, in conjunction with coordination of SMC with adjacent GSAs, will ensure the MOs for groundwater elevations are met.

Table 4-1: Groundwater Elevation Measurable Objectives and Interim Milestones

Well Name	Aquifer	Interim Milestone 5 Years (ft NAVD88)	Interim Milestone 10 Years (ft NAVD88)	Interim Milestone 15 Years (ft NAVD88)	Measurable Objective (ft NAVD88)
R-8	Upper	111	109	107	105
31J6	Lower	0	-9	-18	-27

4.2.2 Measurable Objectives for Reduction in Groundwater Storage

4.2.2.1 Description of Measurable Objective

MO values for reduction in groundwater storage are based on the difference between the recent water levels and MO values (**Table 4-2**). The MO for decline in groundwater storage is the estimated cumulative decline in storage over the next 20 years that the GSP area is able to experience while maintaining sustainable groundwater conditions. This value is subject to change as it is based on the most recent groundwater elevations. With increasing groundwater levels, more loss of storage will be allowed over the SGMA implementation period. Interim milestones for groundwater storage, similar to those set for groundwater elevation, are the projection between recent levels and the MO. The interim milestones are the decline in storage based on the recent groundwater elevation and the interim milestones for groundwater elevation at each five-year interval.

4.2.2.2 Reasonable Margin of Safety for Operational Flexibility

As described above, groundwater storage MOs are based on current water levels and the MOs for groundwater elevation. For the reasons stated in Section 4.2.1.2, the MOs for groundwater storage provide a reasonable margin of safety.

4.2.2.3 Path to achieve and Maintain the Sustainability Goal

Groundwater elevations and storage are currently above sustainable levels due to recent wet hydrologic conditions that resulted in an increase in groundwater levels and storage above 2015 levels. Based on the planned groundwater management and projected groundwater conditions, it is expected that sustainable conditions will be reached over the next 20 years. For the Upper Aquifer, data from the *Basin Setting* showed that the average change in storage over the historic and current water budget period would not exceed the MO. Results from the projected water budgets also shows that groundwater storage change does not exceed the MO. For the Lower Aquifer, historic conditions projected over the next 20-years result in sustainable change in storage. However, the projected water budget shows groundwater changes in storage exceeding the established MO in the Lower Aquifer. This is likely the result of groundwater pumping projections in the Lower Aquifer occurring in neighboring GSAs.

Table 4-2: Reduction in Groundwater Storage Measurable Objectives and Interim Milestones

Aquifer	Interim Milestone 5 Years (AF)	Interim Milestone 10 Years (AF)	Interim Milestone 15 Years (AF)	Measurable Objective (AF)
Upper	-900	-1900	-2800	-3700
Lower	-100	-200	-250	-300

4.2.3 Measurable Objectives for Subsidence

4.2.3.1 Description of Measurable Objective

MO and interim milestone values for subsidence and compaction are based on the rate observed during historic conditions prior to the most recent drought for the Yearout extensometer and P304 (**Figure 4-2**). The primary focus of management for subsidence in the FWD area will be on Upper Aquifer compaction. Subsidence that occurs in FWD would not have a significant effect on existing infrastructure within the FWD GSA, and FWD will not extract groundwater from the Lower Aquifer over the GSP implementation. Therefore, any subsidence that occurs from compaction of the Lower Aquifer is caused by Lower Aquifer pumping from adjacent GSAs. As described in the *Historic and Current Groundwater Conditions* section, Upper Aquifer compaction is only a small fraction of total land subsidence. Interim milestones were set to the same rate as the MO. MO and Interim milestones for FWD can be seen in **Table 4-3**.

4.2.3.2 Reasonable Margin of Safety for Operational Flexibility

The MO for subsidence allows for a reasonable margin of safety, as the MO value is based on historic and current conditions. During this time, there were generally average groundwater conditions for wet and dry periods. Using a subsidence rate consistent with this time period allows a rate of subsidence, as a result of groundwater extraction, to be consistent with the sustainability goal of the Subbasin and not impact the operations of any infrastructure to a significant and unreasonable degree.

4.2.3.3 Path to achieve and Maintain the Sustainability Goal

Managing groundwater elevations to MO levels will result in the stabilization of groundwater conditions. Inelastic subsidence is the result of continual groundwater decline, and long-term stable groundwater elevations should prevent additional inelastic subsidence.

Table 4-3: Measurable Objectives and Interim Milestones for Subsidence

Monitoring Site	Interim Milestone 5 Years (ft/year)	Interim Milestone 10 Years (ft/year)	Interim Milestone 15 Years (ft/year)	Measurable Objective (ft/year)
Yearout	0.009	0.009	0.009	0.009
P304	0.036	0.036	0.036	0.036

4.2.4 Measurable Objectives for Degraded Water Quality.

4.2.4.1 Description of Measurable Objective

The primary groundwater quality concern in FWD is related to the migration of the Steffens Plume that has migrated northward from the Fresno County Management Area A GSA. Specific wells were selected for the monitoring network based on the migration of the plume constituents (primarily TDS), and SMC values were based on past TDS concentrations. All wells in the groundwater quality network are screened in the Upper Aquifer. The wells provide coverage over the FWD GSA area and delineate the areas of concern for water quality (**Figure 4-3**). MO values were developed based on an evaluation of historic TDS concentrations and input with local stakeholders. Interim milestones were set based on a linear interpretation between the MO and MT. MOs and interim milestones for each well are displayed in **Table 4-4.** The MO and MT may change once remediation of the Steffens Plume is approved by the Regional Board and implemented to reduce TDS concentrations of affected groundwater to background concentrations.

4.2.4.2 Reasonable Margin of Safety for Operational Flexibility

MO values allow for a reasonable margin of safety, as values are based on the maximum observed TDS concentrations. All but one of the representative sites are below the MO value, and, with CAO requirements, should result in TDS concentrations that either decrease or stabilize.

4.2.4.3 Path to achieve and Maintain the Sustainability Goal

Groundwater quality conditions are currently at sustainable levels. With remediation of the Steffens Plume expected to occur by 2040 and targeted redistribution of pumping in FWD to minimize migration of high salinity groundwater, sustainable conditions will be maintained.

4.2.4.4 Management Area Status

Due to the increasing levels of TDS concentration as a result of conditions outside of FWD, a management area was created for groundwater quality in FWD. The rationale for setting MOs at current levels was to maintain existing conditions because such levels are not harmful to the beneficial uses of groundwater. The purpose of designating FWD as a management area for water quality was not to establish significantly different MO values from other areas in the Subbasin, but to indicate that management and cleanup efforts are outside the control of FWD. MO values are not likely to cause undesirable results, as values are based on current levels and water quality in FWD is of higher quality than other areas in the region.

Table 4-4: Degraded Water Quality Measurable Objectives and Interim Milestones

Well Name	Interim Milestone 5 Years (TDS)	Interim Milestone 10 Years (TDS)	Interim Milestone 15 Years (TDS)	Measurable Objective (TDS)
R-1	1,130 mg/L	1,060 mg/L	990 mg/L	920 mg/L
R-3	1,130 mg/L	1,060 mg/L	990 mg/L	920 mg/L
R-8	1,130 mg/L	1,060 mg/L	990 mg/L	920 mg/L
R-11	1,130 mg/L	1,060 mg/L	990 mg/L	920 mg/L
PCF-1	1,130 mg/L	1,060 mg/L	990 mg/L	920 mg/L

4.2.5 Measurable Objectives for Interconnected Surface Waters

4.2.5.1 Description of Measurable Objective

The MO for interconnected surface waters was established based on the historic vertical gradient at two Shallow Zone wells in the Upper Aquifer along the SJR (Figure 4-4). Data for groundwater levels in the Shallow Zone along the SJR have only been collected since 2009. During this time, management of the SJR has changed due to the SJRRP. As described in the Historic and Current Groundwater Conditions, there has always been a vertical downward gradient along the SJR near FWD (Figure 3-35). The magnitude of the downward gradient is strongly influenced by flow in the SJR which is controlled by the releases from Millerton Reservoir. Given the available data for interconnected surface waters and uncertainty regarding releases from Millerton Reservoir, the MO was set as the minimum observed value during 2015, the baseline year of SGMA. Interim milestones were set as the projection over the GSP implementation period from recent measurements to the MO in 2040 (**Table 4-5**).

4.2.5.2 Reasonable Margin of Safety for Operational Flexibility

A reasonable margin of safety was accounted for by using the gradient from 2015 which is below current levels and near historic lows. Future data collection and implementation of SJRRP flows and management of the SJR will involve future evaluation of interconnected surface water conditions which may result in revisions to the MO and MT. Recent values of vertical gradients are currently above the established MO.

4.2.5.3 Path to achieve and Maintain the Sustainability

FWD does not control the management of the SJR but will monitor conditions of interconnected surface waters along the SJR as part of the GSP implementation. FWD will manage groundwater resources around the established MO for groundwater elevations.

4.2.5.4 Management Area Status

FWD has been established as a management area for interconnected surface waters, as levels in the SJR are controlled by USBR. FWD will manage the groundwater elevation to sustainable levels, but the gradient of interconnected surface waters is strongly influenced by the releases to the SJR and interception of stream flows upstream of FWD. MO values were selected to be consistent with MO for groundwater elevation.

Table 4-5: Interconnected Surface Waters Measurable Objectives and Interim Milestones

Monitoring Site	Interim Milestone 5 Years (ft/ft)	Interim Milestone 10 Years (ft/ft)	Interim Milestone 15 Years (ft/ft)	Measurable Objective (ft/ft)
SJRRP 09-55, 55b	-0.44	-0.49	-0.54	-0.60

4.3 Minimum Thresholds (Reg. § 354.28)

Minimum thresholds refer to a numeric value for each sustainability indicator used to define undesirable results. A GSP must establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site. The numeric value used to define the minimum threshold shall represent a point in the Subbasin that, if exceeded, may cause significant and unreasonable undesirable results. A GSA may establish a representative minimum threshold, such as groundwater elevation (GWE) to serve as the value for multiple sustainability indicators if the GSA can demonstrate the representative value is a reasonable proxy for multiple individual minimum thresholds, as supported by adequate evidence. Minimum thresholds are not required for sustainability indicators that are not present and not likely to occur in the plan area.

The description of minimum thresholds shall include the following (§354.28):

1. The information and criteria relied upon to establish and justify the minimum threshold for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate and qualified by uncertainty in the understanding of basin setting.
2. The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results from each sustainability indicator.
3. How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting adjacent basins ability to achieve sustainability goals.
4. How minimum thresholds may affect the interests of beneficial users and users of groundwater or land uses and property interests.
5. How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
6. How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements.

4.3.1 Minimum Thresholds for Chronic Lowering of Groundwater Levels

4.3.1.1 Description of Minimum Threshold

MTs for chronic lowering of groundwater levels are those indicating a depletion of supply at a given location that may lead to undesirable results. These undesirable results are based on the local definition of significant and unreasonable water levels. Utilizing information from the *Basin Setting,* MT values were determined by evaluating historic water levels, trends of groundwater elevation, and the potential effects on other sustainability indicators. To establish MTs, the annual maximum groundwater elevation for each year was determined for the historic period of record. This was used to determine the largest decline in groundwater elevation throughout the GSA area. The magnitude of decline observed during this period was applied to the MO to establish a MT value (**Figure 4-5 and 4-6**). The likelihood of groundwater elevations dropping to MT levels were evaluated in the projected model results as shown in **Figures 4-5** and **4-6**. The MTs established for each of the representative sites are provided in **Table 4-6**.

4.3.1.2 Quantitative Measurements

Chronic lowering of groundwater elevation will be quantitatively measured by taking depth to ground water measurements from a surveyed reference point. These measurements will be collected to capture seasonal highs and lows. MTs are based on seasonal high measurements. Procedures for collection groundwater elevation measurements are discussed in section 4.6.1.

Table 4-6: Groundwater Elevation Minimum Thresholds

Well Name	Aquifer	Maximum Seasonal high 2015 GWE	Max Decline in GWE	Minimum Threshold (ft NAVD 88)
R-8	Upper	105	-16	89
31J6	Lower	-27	-71	-98

4.3.1.3 Existing local, State, or Federal Standards

No standards currently exist for groundwater elevation.

4.3.1.4 Avoidance of Undesirable Results

The established MTs were developed based on the observation of historic conditions. The criteria used for the development of MTs was consistent with other sustainability indicators. During the development of MT values, FWD met with adjacent GSAs and subbasins to ensure values did not significantly differ.

4.3.1.5 Affects to the beneficial uses and users of groundwater

For agricultural beneficial uses of groundwater, the established MT for groundwater elevation could have economic implication. When MT values are exceeded, the cost for pumping groundwater will increase due to higher lift and energy costs. This additional cost could result in a reduction of irrigated land.

For the small number of domestic beneficial users within the GSA, MTs for groundwater elevation were evaluated to ensure known domestic wells will have the ability to continue to operate. In FWD, there are four private residents. In a review of well completion reports, three potential domestic wells were identified, all of which are screened in the Upper Aquifer. Based on the construction information of these wells, the MT for groundwater elevations will likely not affect the beneficial uses of groundwater **(Table 4-7)**. All MT values for groundwater elevation are well above the perforation intervals for identified domestic wells. The seasonal variation in groundwater elevation was also considered which is described in *Historic and Current Groundwater Conditions* section 3.2.2.

Table 4-7: Identified Well Completion Reports in Farmers Water District

WCR Number	Date Completed	Aquifer	Top Perforation (ft NAVD 88)	Bottom Perforation (ft NAVD 88)
1091557	05-14-2006	Upper	-90	-95
499789	01-24-1997	Upper	-77	-121
EO73574	05-14-2008	Upper	-57	-137

The MTs for groundwater elevation will likely not affect the environmental beneficial uses and users of groundwater since the vertical hydraulic gradients near the SJR are mostly influenced by geologic conditions in the vicinity of GDEs, impacts from adjacent GSAs, and SJR flows. Groundwater elevations at or below MT levels could affect GDEs to a significant and unreasonable degree, however, since the only GDEs are located along the SJR, a coordinated outreach effort will be conducted with neighboring GSAs and the USBR to identify management actions to mitigate unreasonable impacts on environmental beneficial users.

4.3.2 Minimum Thresholds for Reduction in Groundwater Storage

4.3.2.1 Description of Minimum Thresholds

The MT for reduction of groundwater storage is the total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Reduction in groundwater storage is not a parameter that can be directly measured, rather, change in storage will be regularly estimated based on either the Subbasin water budget or monitoring results derived from an analysis of groundwater elevations and aquifer properties (monitoring protocols for data collection and monitoring).

Annual changes in storage will be estimated based on changes observed between seasonal high contours. For the initial estimation of MT values for change in storage, the most recent water level elevations were compared to the MT for groundwater elevation. The average change in groundwater elevation from current level to MT level for all representative sites was used to calculate a change in storage over the entire GSP area. **Table 4-8** shows the MT values for each Principal Aquifer. The Upper Aquifer estimate is likely more accurate than the Lower Aquifer estimate due to well coverage and available data. This value is subject to change based on current water levels. With increasing GWE, the MT for change in storage will increase.

4.3.2.2 Quantitative Measurements

Reduction in groundwater storage will be quantitatively measured by creating contour maps for seasonal high groundwater elevations and taking the difference between the current and preceding water year. Contour maps will be developed with groundwater elevation measurements collected at wells throughout the plan area.

Table 4-8: Reduction in Groundwater Storage Minimum Threshold

Aquifer	Difference Between MT and Recent GWE	GSP Area (Acres)	Specific Yield (Upper)/ Storativity (Lower – Inelastic +Elastic)	Total Storage Change (AF)
Upper	-24 ft	2,213	0.21	11,000
Lower	-98	2,213	0.0041+0.058	4,400

4.3.2.3 Existing local, State, or Federal Standards

There are currently no standards for reduction in groundwater storage.

4.3.2.4 Avoidance of Undesirable Results

Groundwater storage MTs were developed based on the groundwater elevation MT's. The established MT values for groundwater storage will avoid undesirable results for the same reasons described in the section 4.3.1.4 above.

4.3.2.5 Affects to the beneficial uses and users of groundwater

The MTs for groundwater storage will affect the beneficial uses and users of groundwater in the manner as groundwater elevation described in 4.3.1.5 above.

4.3.3 Minimum Thresholds for Subsidence

4.3.3.1 Description of Minimum Thresholds

MTs for land subsidence were based on conditions observed during the historic groundwater period. The minimum threshold was established as the maximum rate of subsidence or compaction that occurred during the historic groundwater period (**Table 4-9**). The SMC for subsidence relative to historic measurements is displayed in **Figure 4-7.**

4.3.3.2 Quantitative Measurements

FWD will utilize data collected by the USGS for the Yearout monitoring site and data collected by UNAVCO for P304.

Table 4-9: Subsidence/Compaction Minimum Thresholds

Monitoring Site	Monitoring Type	Minimum Threshold (ft/year)
Yearout	Upper Aquifer Compaction	0.017
P304	Land Subsidence	0.1

4.3.3.3 Existing local, State, or Federal Standards

There are currently no standards for subsidence.

4.3.3.4 Avoidance of Undesirable Results

Undesirable results are rates that exceed the historic maximum. By setting the subsidence MT as the rate observed during the last dry period, the established MT will prevent undesirable results that are worse than the historic conditions observed in 2015. In addition, a majority of impacts caused by subsidence are a result of Lower Aquifer compaction (**Figure 4-7**).

4.3.3.5 Affects to the Beneficial Uses and Users of Groundwater

MT levels subsidence are not likely to impact the agricultural beneficial uses and users of groundwater in FWD. Rates of subsidence in excess of the established MT for total land subsidence at P304 could result in issues outside of the GSP area.

MT levels of subsidence will not impact the domestic beneficial users and uses of groundwater in FWD. The use of domestic water does not rely on a conveyance system like agricultural users outside of FWD.

MT levels of subsidence will not affect the environmental beneficial users of groundwater in FWD.

4.3.4 Minimum Thresholds for Groundwater Quality

4.3.4.1 Description of Minimum Thresholds

MTs for degraded groundwater quality were determined by an analysis of historic data and feedback from local stakeholders (**Table 4-10**). Historically, groundwater quality in FWD has been very suitable for agricultural purposes. MT values for groundwater quality were set at a slightly higher value than the historic high TDS to maintain historic agricultural practices and prevent impacts on all beneficial uses of groundwater. Historic groundwater quality data relative to SMC can be seen in **Figure 4-8**.

4.3.4.2 Quantitative Measurements

Groundwater quality measurements will be taken by collecting groundwater samples from a purged well and analyzing samples at an accredited water quality testing facility. Procedures for collection groundwater quality samples are discussed in Section 4.6.2.

Table 4-10: Degraded Water Quality Minimum Thresholds

Well Name	Minimum Threshold (TDS)
R-1	1200 mg/L
R-3	1200 mg/L
R-8	1200 mg/L
R-11	1200 mg/L
PCF-1	1200 mg/L

4.3.4.3 Existing local, State, or Federal standards

The EPA secondary standard for TDS in drinking water is 500 mg/L (EPA, 2017). This is a non-enforceable guideline and do not apply to FWD as it is a Management Area for groundwater quality.

State standards include the allowed rate of degradation based on the Water Quality Control Plan for the Tulare Lake Basin Second Edition (RWQCB, 2015). This standard was not used to set water quality MTs, as FWD intends to prevent continual degradation.

4.3.4.4 Avoidance of Undesirable Results

FWD groundwater quality is lower than other areas in the in region and throughout the subbasin. Managing groundwater quality to the established MT values will prevent undesirable results in FWD and in adjacent GSAs.

FWD has been designated as a management area for groundwater quality because of conditions outside of the GSP area. Standards for water quality have been set, but TDS levels are dependent on the cleanup and remediation actions to the south.

4.3.4.5 Affect to beneficial uses and users of groundwater

Poor water quality could impact the irrigation of crops. Individual salt tolerance varies depending on crop type. A majority of crops within FWD have a TDS threshold of approximately 1000 mg/L or less (Maas 1993). Maintenance or improvement of existing water quality will be important for the planned operations at FWD.

Water quality levels within FWD are generally acceptable for drinking water based on EPA secondary standards with only two of the five representative sites with TDS concentrations significantly higher than 500 mg/L. Continued groundwater degradation near or exceeding MT levels could impact the domestic use of groundwater. It is unknown whether residents use their wells for drinking water or if they have filtration systems to treat raw groundwater.

The impact of a significant increase in salinity in groundwater on freshwater aquatic plants and animals is not well understood in the San Joaquin Valley (USBR and WWD, 2018). It is likely that the MT values set for groundwater quality will not significantly impact the environmental beneficial users of groundwater given the historic water quality in FWD compared to the surrounding region. Regions west of the Fresno Slough consist of beneficial users of groundwater where TDS concentrations are significantly higher than FWD as described in *Historic and Current Groundwater Conditions* Section 3.2.5. In addition, past environmental impact statements regarding activities in the Mendota Pool have established that groundwater discharged into the Mendota Pool must be below have a TDS concentration below 1,600 mg/L in order to protect the beneficial uses of groundwater outside of FWD in the Mendota Wildlife Area (USBR and WWD, 2018).

4.3.4.6 Management Area Status

As described in previous sections, FWD has been designated as a management area for water quality due to contamination issues originating outside of the FWD GSA. The MT values were set based on an analysis of historic data and feedback from local stakeholders and interested parties. The MT values set for water quality will likely not cause undesirable results for areas outside of the management area as values are only slightly higher than existing levels and are still relatively low compared to other areas in the region.

4.3.5 Minimum Thresholds for Interconnected Surface Waters.

4.3.5.1 Description of Minimum Threshold

The MT for interconnected surface waters was set based on the maximum magnitude of decline observed over the period of record applied to the established MO. MTs were established in this manner to be consistent with MTs for groundwater elevation. SMC values in relation to the historic records are displayed in **Figure 4-9**.

4.3.5.2 Quantitative Measurement

Interconnected surface waters will be quantitatively measured by evaluating the shallow groundwater elevation measurements along the SJR and calculating the magnitude of the vertical gradient.

Table 4-11: Interconnected Surface Waters Minimum Thresholds

Well Name	Minimum Threshold (ft/ft)
SJRRP-09-55, 55b	-1.17

4.3.5.3 Exiting local, State, or Federal standards

No standards exist for interconnected surface waters.

4.3.5.4 Affects to the beneficial uses and users of groundwater

MT values for interconnected surface waters will not impact the agricultural or domestic beneficial uses of groundwater. Within FWD, both agricultural and domestic beneficial users of groundwater extract water that is well below the interconnection between the surface water and groundwater.

MT values for interconnected surface waters could impact the environmental beneficial uses of groundwater if the vertical gradient is below or near MT values for an extended period of time along with declining groundwater elevations. A lower groundwater elevation, which can increase the magnitude of the downward vertical gradient, could affect existing GDEs along the SJR.

4.3.5.5 Avoidance of Undesirable Results

The MT for interconnected surface waters was established based on limited historic data. The only control FWD has on interconnected surface water is the groundwater elevation. Preventing groundwater elevation decline that exceeds the maximum value over the historic period will prevent undesirable results.

4.3.5.6 Management Area Status

As previously stated, FWD has been designated as a management area for interconnected surface water due to management of surface water levels by USBR. Interconnected surface waters are influenced by both groundwater levels and surface water flow. MT values for interconnected surface waters were developed in a consistent manner with groundwater elevations. FWD will management groundwater elevation to prevent undesirable results.

4.3.6 Relationship Between Sustainability Indicator Minimum Thresholds

The governing sustainability indicator is the chronic lowering of groundwater elevation. Lower groundwater levels will result in a reduction in storage for each the Upper and Lower Aquifers. Lower groundwater levels in the Upper Aquifer have a direct relationship to depletion of interconnected surface waters. The Upper Aquifer is unconfined, and lower groundwater levels will increase the rate of depletion for losing reaches and increase the potential disconnect of groundwater from surface water bodies. Lower groundwater levels in both the Upper and Lower Aquifer have a direct relationship with land subsidence. Lower groundwater levels and reduction of storage may cause irreversible compaction of aquifer materials. Subsidence caused by lower groundwaters and reduction in storage is more prevalent in the Lower Aquifer where compaction values are greater than two orders of magnitude.

The one sustainability indicator that is not directly impacted or caused by the others is degraded water quality. Groundwater quality can be influenced by the reduction of storage and a lower groundwater elevation but is primarily controlled by other factors. Sources of degraded groundwater quality can be from human activities or naturally occurring. Outside of FWD in the Fresno County Management Areas, groundwater quality issues are the result of management practices at the former Spreckels Sugar Company and naturally occurring conditions west of the Fresno Slough due to the Western Saline Front. The source of these groundwater quality issues is unrelated to the other sustainability indicators, but the migration of groundwater quality can be influenced by lower groundwater elevations.

4.4 Undesirable Results (Reg. § 354.26)

According to GSP Regulations, the description of undesirable results is to include the following (§354.26):

1. The cause of groundwater conditions occurring throughout the basin that would lead to or has led to the undesirable results based on information described in the basin setting, and other data or models as appropriate.
2. The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.
3. Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

Under SGMA, undesirable results occur when the effects caused by groundwater conditions throughout the basin cause significant and unreasonable impacts to any of the six sustainability indicators. A “significant and unreasonable occurrence of any of the six sustainability indicators constitutes an undesirable result.” These sustainability indicators are:

1. Chronic lowering of groundwater levels,
2. Reduction of groundwater storage,
3. Seawater intrusion,
4. Degraded water quality,
5. Land subsidence, and
6. Depletion of interconnected surface water.

4.4.1 Description of Undesirable Results

A description of undesirable results for each of the sustainability indicators is summarized below.

4.4.1.1 Groundwater Elevation

Undesirable results occur when groundwater levels exceed the MT at the Upper Aquifer representative site for two consecutive years. FWD will monitor, but is responsible for, Lower Aquifer conditions. In the event of undesirable results for the Upper Aquifer, FWD will develop project and management actions to prevent future MT exceedances.

4.4.1.2 Groundwater Storage

Groundwater storage calculations will be estimated with groundwater elevation measurements at multiple sites. Undesirable results occur when groundwater storage exceeds the MT for the Upper Aquifer for two consecutive years. Storage changes will be calculated for the Lower Aquifer, but FWD actions are not responsible for these conditions. In the event of undesirable results for the Upper Aquifer, FWD will develop project and management actions to prevent future MT exceedances.

4.4.1.3 Subsidence

Undesirable results for subsidence will occur when the rate of compaction for the Upper Aquifer exceeds MT rate for two consecutive years. Similar to groundwater level and storage, FWD will only extract groundwater from the Upper Aquifer and is not responsible for Lower Aquifer compaction. Based on the information presented in the *Current and Historic Groundwater Conditions* section 3.2.7, Upper Aquifer compaction is only responsible for a fraction of the total subsidence. In the event of undesirable results for the Upper Aquifer, FWD will develop project and management actions to prevent future MT exceedances.

4.4.1.4 Groundwater Quality

Undesirable results occur when any two wells in the representative network exceed the MT value. FWD has been designated as a management area for groundwater quality. Projects or management actions will not be implemented in the event of undesirable results for groundwater quality. FWD will work with adjacent GSAs to address water quality concerns.

4.4.1.5 Interconnected Surface Waters

Undesirable results occur when the vertical gradient exceeds the MT value for two consecutive years. FWD has been designated as a Management Area for interconnected surface water and will not implement projects or management actions in the event of interconnected surface waters undesirable results.

4.4.2 Cause of Groundwater Conditions that Lead to Undesirable Results

Over extraction of groundwater during extended dry periods will likely lead to short term undesirable results for groundwater elevation, groundwater storage, and subsidence. These three sustainability indicators are directly tied together. The MT values were set based on historic conditions when groundwater pumping, coupled with low recharge, resulted in lower groundwater levels and declines in storage over multiple dry years.

Undesirable results for interconnected surface waters occur as a result of lower groundwater elevations and reduced flow in the SJR. While FWD management actions can influence the groundwater elevation, reduced flow in the SJR is not controlled by FWD.

Undesirable results for groundwater quality are the result of continued migration of the Steffens Plume. Pumping in FWD can affect the migration of the Steffens Plume, but FWD is not responsible for the cleanup and mitigation of contaminated groundwater.

4.4.3 Criteria Used to Define Undesirable Results based on Minimum Thresholds

Groundwater levels, subsidence, and interconnected surface waters monitoring networks all consist of one monitoring site. Given the small area of FWD, the measurements made at these sites are reflective of conditions over the entire GSA. For each of these sustainability indicators, a MT exceedance for two consecutive years was defined as an undesirable result.

The groundwater quality monitoring network consists of multiple representative sites due to the variation in groundwater quality within FWD and the influence of the Steffens Plume. Groundwater quality conditions are more dynamic and require a higher density of monitoring based on the conditions described in Section 3.2.5. Undesirable results for groundwater quality were defined as two MT exceedances at two monitoring sites over a two-year period.

4.4.4 Potential Effects on the Beneficial Users of Groundwater

For the sustainability indicators that are a primary concern in FWD, the effects undesirable results could have on the beneficial users of groundwater are generally consistent with the undesirable results described in the *Minimum Threshold* section 4.3. The following is a summary of the undesirable results for the sustainability indicators that are most significant to the beneficial users of groundwater.

For agricultural beneficial users of groundwater, the most significant undesirable results are groundwater levels, groundwater storage, groundwater quality, and subsidence. The undesirable results for interconnected surface waters will not have a direct impact on agriculture. Undesirable results for any of the sustainability indicators of concern will limit the ability of agricultural users to extract groundwater and irrigate crops.

For domestic beneficial users of groundwater, the most significant undesirable results are groundwater levels, groundwater storage, and groundwater quality. Subsidence and interconnected surface waters will not have direct impact on domestic users.

For environmental beneficial uses and users of groundwater the most significant undesirable results are those determined for interconnected surface waters.

4.5 Monitoring Network (Reg. § 354.34)

4.5.1 Description of Monitoring Network

The FWD GSA monitoring network consists of 10 sites that will monitor conditions for each of the five applicable sustainability indicators across the plan area. Each of monitoring sites are considered representative sites where SMC have been established. The individual monitoring sites were selected to have an even distribution over the plan area where groundwater management practices vary. The monitoring schedule for each sustainability indicator was developed in order to utilize existing monitoring programs as much as possible and capturing the relevant seasonal, short-term, and long-term trends (**Table 4-12**). Below is a brief description on each of the individual sustainability indicator monitoring networks.

Table 4-12: Farmers Water District Monitoring Schedule

Sustainability Indicator	Monitoring Site	Monitoring Frequency	Monitoring Time Frame	Existing Monitoring Program
Groundwater Elevation	USGS 31J6	Semi Annual	Season High: (February-April) Season Low: (September-October)	USGS
	R-8			MPG
Groundwater Quality	R-1	Annual	May -August	MPG
	R-3			
	R-8			
	R-11			
	PCF-1			
Subsidence	Yearout	Annual	Annual High: (December-May)	USGS
	P304-PBO			UNAVCO
Interconnected Surface Waters	SJRRP-09-55, 55b	Semi Annual	Season High: (February-April) Season Low: (September-October)	USBR

4.5.2 Groundwater Elevation Monitoring Network

The groundwater elevation monitoring network consists of two representative monitoring sites, one in each principal aquifer (**Figure 4-1**). The Upper Aquifer monitoring site was selected based on its central location in FWD. Historic groundwater elevations at this site are consistent with the GSA (**Figure 4-10**). The Lower Aquifer monitoring site was selected as it was the closest Lower Aquifer well to the FWD area. Both of these sites are consistent with the standards described in Section 352.4 of the GSP regulations. Groundwater elevation measurements will be made at least twice a year to capture seasonal high and seasonal low levels. Historic groundwater elevation measurements have shown that seasonal highs occur in the early months of the year (February-April) and seasonal low conditions occur in the fall (September-October).

4.5.3 Groundwater Storage Monitoring Network

Groundwater storage calculations will be made by creating groundwater elevation contour maps, evaluating changes in groundwater elevations at each groundwater level monitoring site, and taking the difference in groundwater levels between the current and previous water year. These calculations will be conducted from the seasonal high groundwater elevation measurements throughout the GSA area.

4.5.4 Subsidence Monitoring Network

The subsidence monitoring network will utilize one USGS extensometer and one UNAVCO GPS monitoring site (**Figure 4-2**). The USGS extensometer (Yearout Ranch) measures the amount of compaction in the Upper Aquifer. The UANVCO GPS monitoring site (P304) measures the total amount of subsidence due to compaction in both the Upper and Lower Aquifer. Data are collected at these sites year-round, but, for SGMA, only seasonal high measurements will be reported in order to evaluate the maximum amount of inelastic subsidence on an annual basis. The purpose of monitoring subsidence is to capture the inelastic component that results in permanent subsidence. This is most accurately characterized by comparing seasonal high measurements. For the GSP annual report, the highest measurement observed during each water year will be reported. Each of these monitoring sites are consistent with the standards described in Section 352.4 regulations.

4.5.5 Groundwater Quality Monitoring Network

The groundwater quality monitoring network consists of five monitoring sites all screened in the Upper Aquifer (**Figure 4-3**). These specific sites were selected to serve as monitoring sites to provide an even coverage over the GSP area and to closely monitor the migration of contaminated groundwater. Samples are to be collected at least once a year between May and August for annual reporting purposes. Samples for each site will be analyzed at an accredited laboratory and TDS concentrations will be reported for each monitoring site. Each of the monitoring sites are consistent with the standards described in Section 352.4. No groundwater quality constituents, aside from TDS, have demonstrated to issues pertaining to beneficial uses in the FWD GSA.

4.5.6 Interconnected Surface Waters Monitoring Network

In FWD, interconnected surface waters will be monitored at SJRRP 09-55 and 55b (**Figure 4-4**). These sites were selected to monitor interconnected surface waters, as they are a set of nested wells in the Shallow Zone of the Upper Aquifer adjacent to the SJR in FWD. Groundwater elevations from these sites are measured on a weekly basis by the USBR. Seasonal high and seasonal low measurements consistent with the time periods discussed in the groundwater monitoring network will be reported for the GSP annual report. Each of these sites are consistent with the standards described in Section 352.4 of the GSP regulations and Section 4.6 Monitoring Protocols for Data Collection and Monitoring

4.6 Monitoring Protocols for Data Collection and Monitoring (Reg. § 352.2)

The monitoring protocols developed for FWD are largely based on the *Best Management Practices for the Sustainable Management of Groundwater: Monitoring Protocols, Standards, and Sites* produced by DWR. The recommended monitoring protocols were adjusted and added to in order to fit the specific monitoring needs of FWD to achieve sustainability. Monitoring protocols for seawater intrusion were not necessary, as FWD is roughly 100 miles from the coast. Monitoring protocols for measuring pumping amounts were also added. Monitoring protocols for groundwater pumping were not described in the BMP document, and accounting for groundwater pumping will be an integral part of achieving sustainability in FWD and the Delta-Mendota Subbasin. The monitoring protocols that are described in this document will provide the necessary data to track the minimum thresholds and measurable objectives for each of the sustainability indicators. The monitoring protocols established here are to be reviewed in five years as a part of periodic review of the GSP.

4.6.1 Protocols for Monitoring Sites

The following protocols will be applied to all monitoring sites:

- Long-term access agreements. Access agreements should include year-round site access to allow for increased monitoring frequency.
- A unique identifier that includes a written description of the site location, date established, access instructions, type of data to be collected, latitude, longitude, and elevation.
- A modification log is to be kept in order to track all modifications to the monitoring site.

4.6.2 Groundwater Level Elevation

There has been a groundwater level monitoring network in FWD for the past 20 years as a part of existing groundwater resources monitoring programs. Wells from the existing network, along with other wells in the area, will be used for the SGMA monitoring network. The GSA will be responsible for collecting groundwater level elevation data for under the following protocols:

4.6.2.1 Protocols for Measuring Groundwater Levels

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions.

Groundwater levels should be measured to the nearest 0.01 foot relative to the Reference Point (RP).

- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.
- The sampler should calculate the groundwater elevation as:

$$GWE = RPE - DTW$$

Where:
GWE = Groundwater Elevation
RPE = Reference Point Elevation
DTW = Depth to Water

- The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.
- The sample should replace any well caps or plugs and locks on well buildings or covers
- Groundwater Level measurements are to be made on semi-annual basis

4.6.2.2 Recording Groundwater Level Measurements

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and provide comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. Standardized field forms should be used for all data collection.
- All data should be entered into the GSA data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person.

4.6.2.3 Installing Pressure Transducers and Downloading Data

There are not currently any wells with pressure transducers in FWD. If a pressure transducer is added to a well in the SGMA network, the following procedures will be followed in the installation of a pressure transducer and during periodic data downloads:

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.

- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected accurately. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that data is being collected accurately.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.
- The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.
- The data should be downloaded as necessary to ensure no data is lost and entered into the basin's DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

4.6.3 Groundwater Quality Measurements

There has been a groundwater quality monitoring network in FWD for the past 20 years as a part of existing groundwater resources monitoring programs. Wells from the existing network, along with other wells in the area, will be used for the SGMA monitoring network. The GSA will be responsible for collecting groundwater quality samples for using the following:

- Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.

- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow the well to recover to within 90% of the original level prior to sampling.
- Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well, and the well should stabilize prior to sampling. Measurements of pH should only be measured in the field; lab pH analyses are typically unachievable due to short hold times. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.

- Instruct the laboratory to use reporting limits that are equal to or less than the regional water quality objectives/screening levels.
- Groundwater quality samples are to be collected on annual basis.
- All data will be entered into the GSA DMS as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person.

4.6.4 Groundwater Storage Measurements

Groundwater storage will be determined from groundwater elevation measurements. Groundwater elevation contours will be created for each annual report where current year conditions will be compared to the previous groundwater contours generated during the previous year. The change in groundwater elevation at each monitoring site will also be analyzed on a yearly basis to understand where the greatest decline in storage is occurring spatially. Groundwater storage for the Upper Aquifer will be calculated with the equation below

- Change in Upper Aquifer Storage = $(\Delta H) \times (S_y) \times (A)$

Where ΔH is change in head (or groundwater elevation), S_y is the specific yield of the unconfined aquifer, and A is the surface area of FWD. Groundwater storage for the Lower Aquifer will be calculated with the equation below:

Change in Lower Aquifer Storage = $(\Delta H) \times (S_s \times B) \times (A)$

Where ΔH is change in head (or groundwater elevation), S_s is the specific storage of the confined aquifer, B is the aquifer thickness, and A is the surface area of FWD.

4.6.5 Groundwater Pumping Measurement

Significant pumping occurs in the area of FWD during the irrigation season. The following protocols will be followed when recording groundwater pumping totals:

- Groundwater pumping amounts are to be reported on a monthly basis in units of Acre-Feet.
- Amounts are to be determined by a totalizer/flowmeter or calculated from electric consumption records.
- Groundwater pumping totals will be reported by the owner.

4.6.6 Subsidence Measurements

Subsidence in the Delta-Mendota Subbasin has been studied and documented in the past. Subsidence monitoring for FWD will included an extensometer monitored and maintained by the USGS and a UNAVCO GPS monitoring station. The GSA will not be responsible for collecting subsidence data.

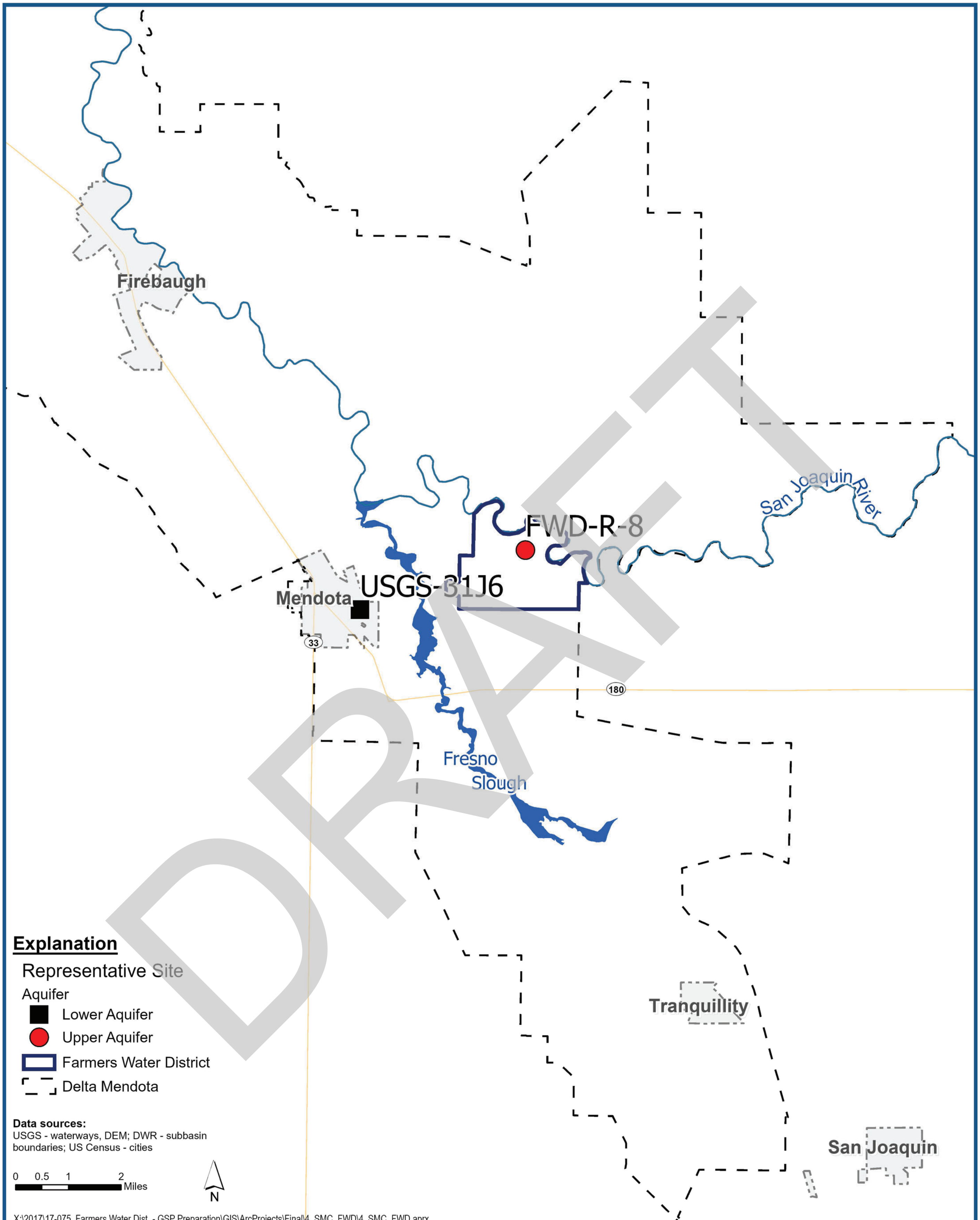
- Subsidence data will be downloaded on a monthly basis from the publicly available sources and uploaded to the DMS.

4.6.7 Interconnected Surface Water Measurements

Interconnected surface water measurements will be made by collecting groundwater elevation measurements form SJRRP-09-55 and SJRRP -09-55b and calculating the vertical gradient with the equation below:

$$\text{Vertical gradient} = (h_1 - h_2) / (m_1 - m_2)$$

Where h_1 and h_2 represent groundwater elevation in the deep well and shallow well, respectively, and m_1 and m_2 represent the mid-point of the well screen for the deep well and shallow well, respectively.



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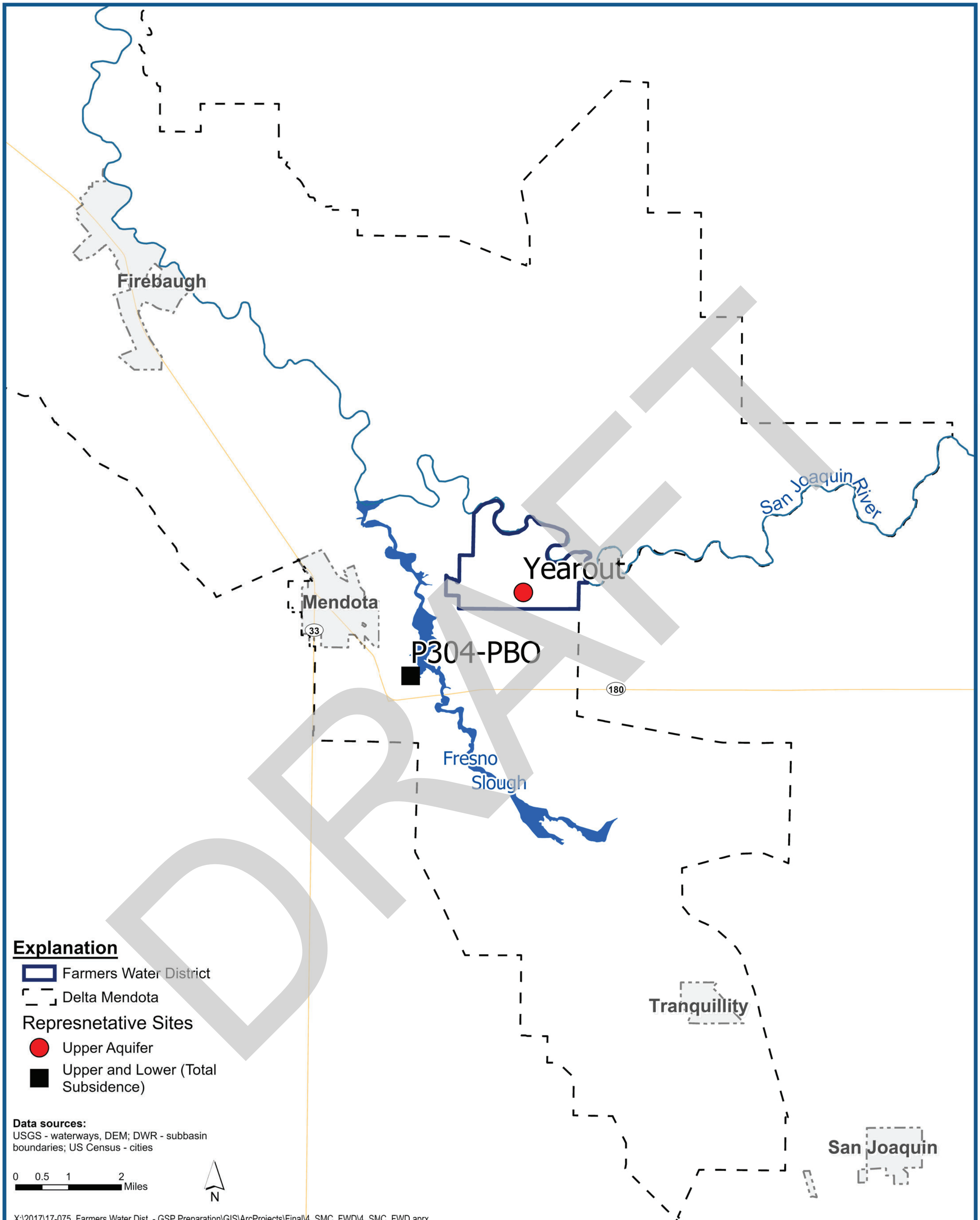
Groundwater Elevation Representative Monitoring Network

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-1



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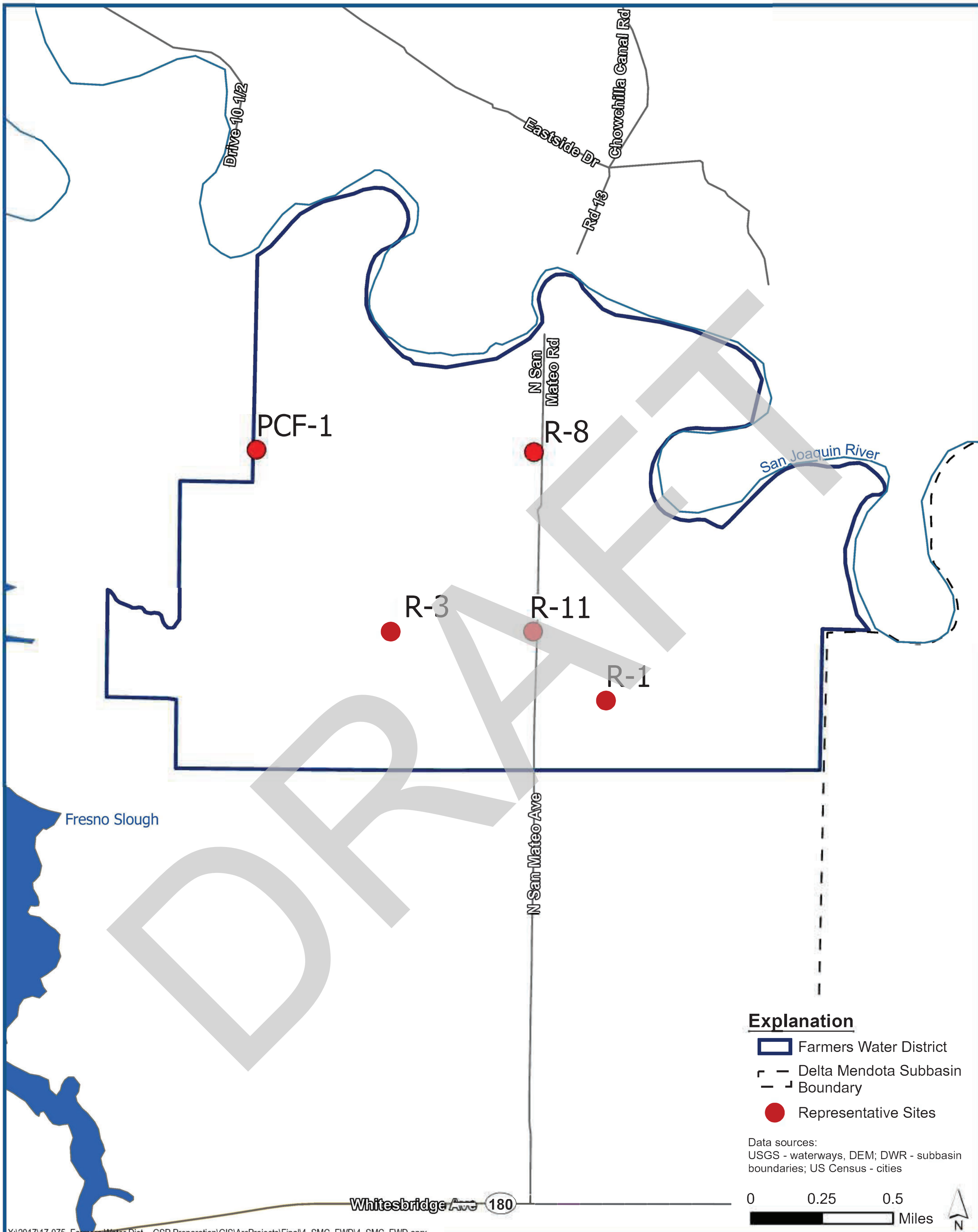
Subsidence
Representative Monitoring Network

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-2



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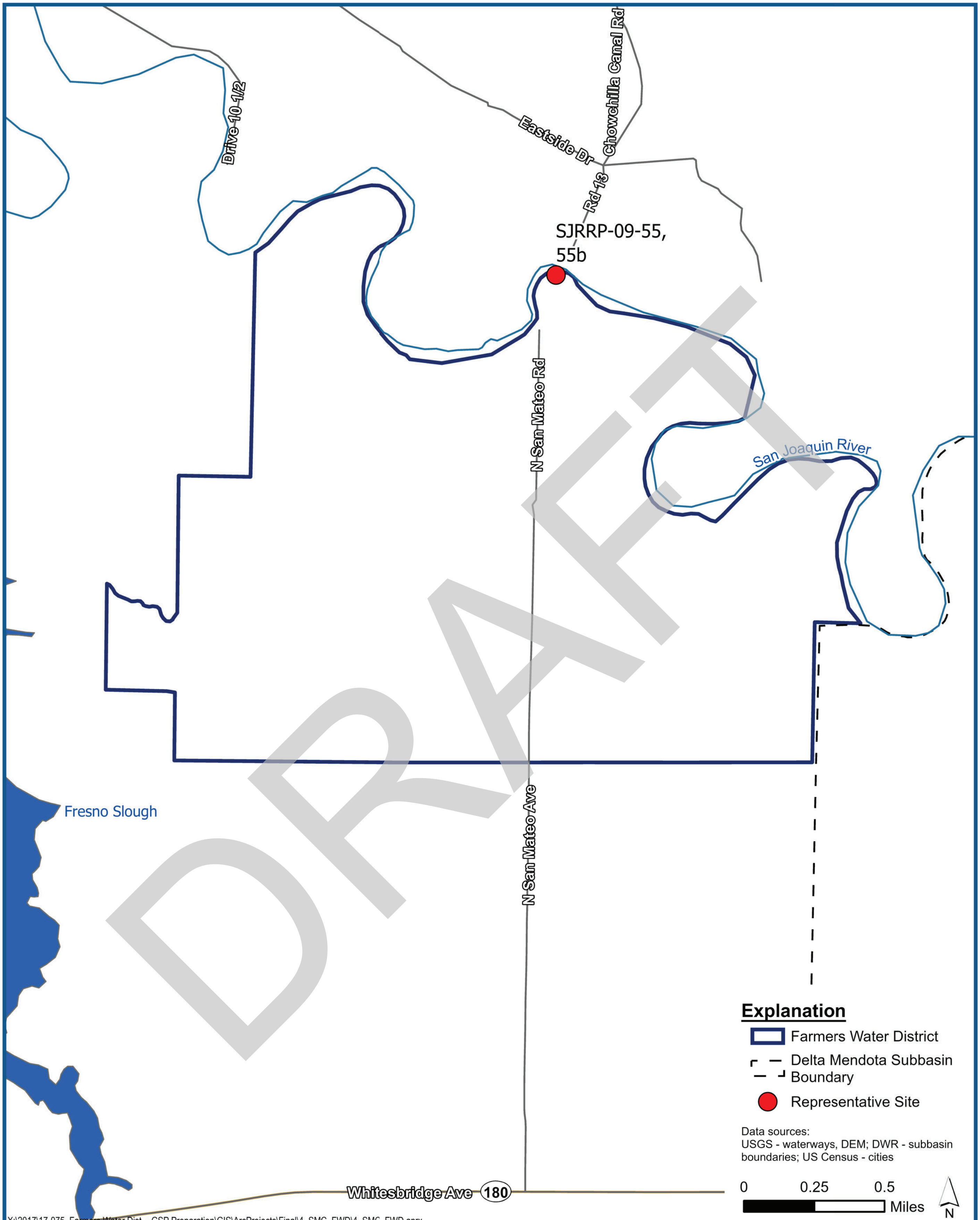
Groundwater Quality
Representative Monitoring Network

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-3



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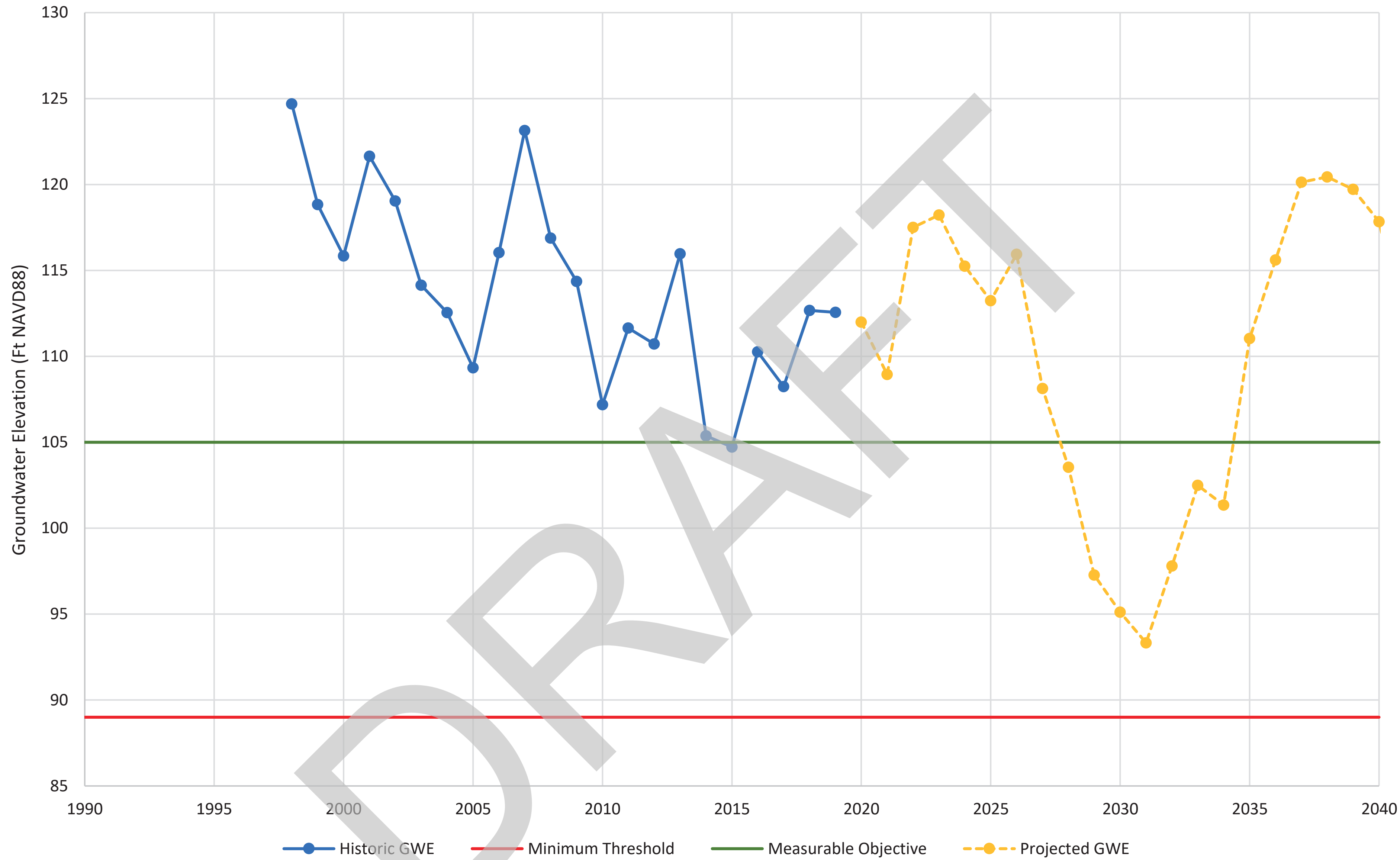
Interconnected Surface Waters Representative Monitoring Network

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-4



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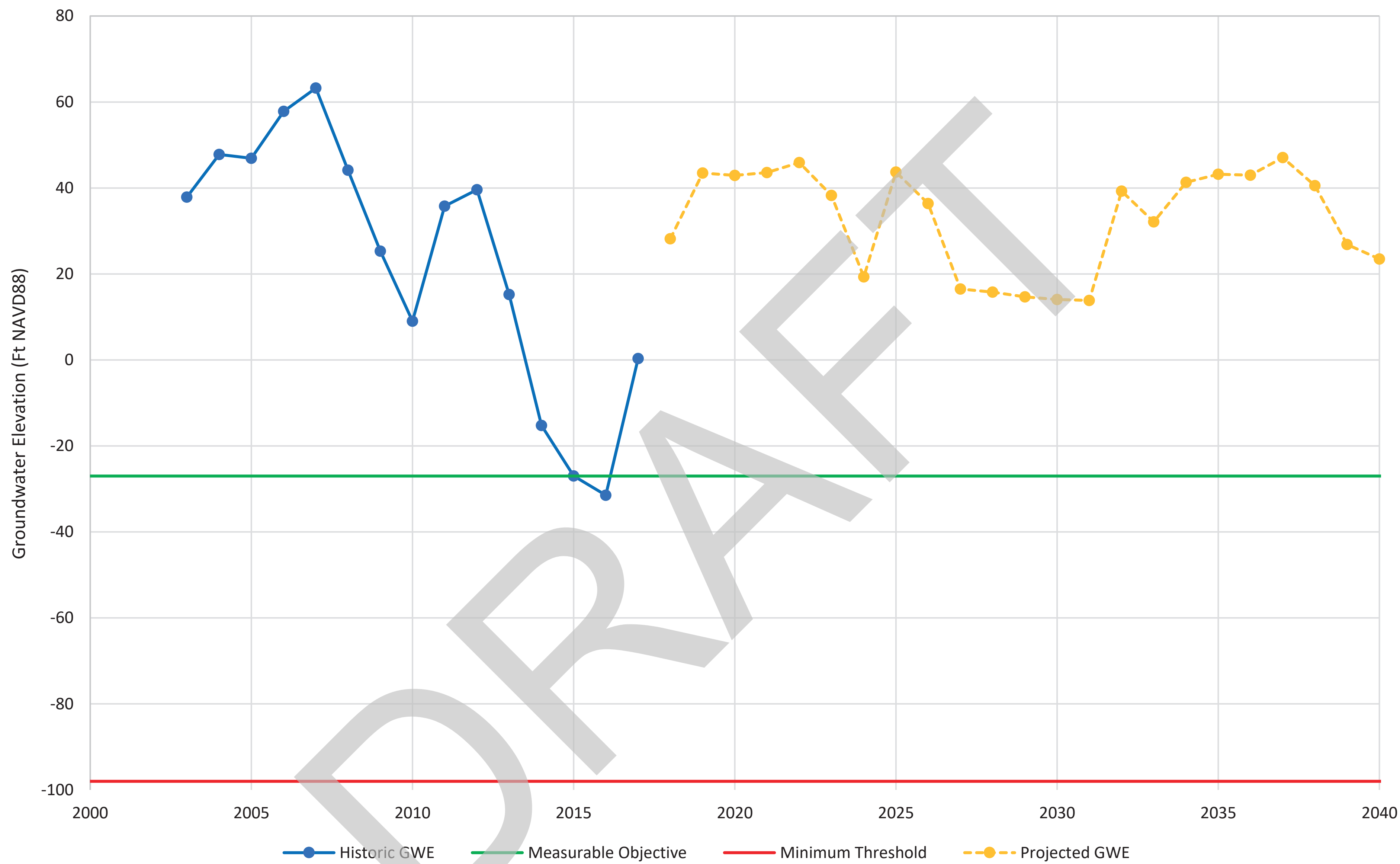
R-8 - Groundwater Elevation Representative Monitoring Site
Sustainable Management Criteria

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-5



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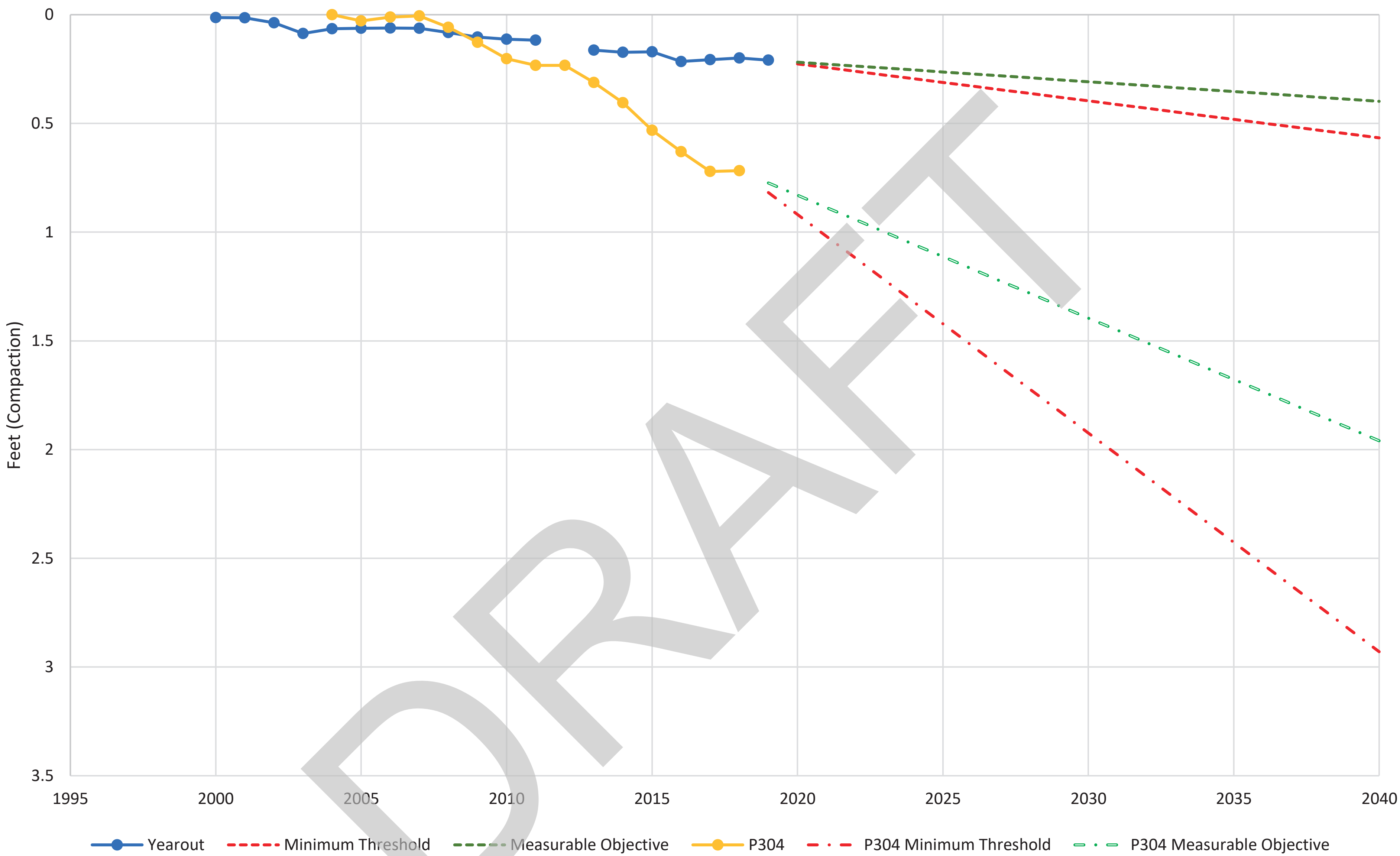
USGS 31J6 - Groundwater Elevation Representative Monitoring Site
Sustainable Management Criteria

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-6



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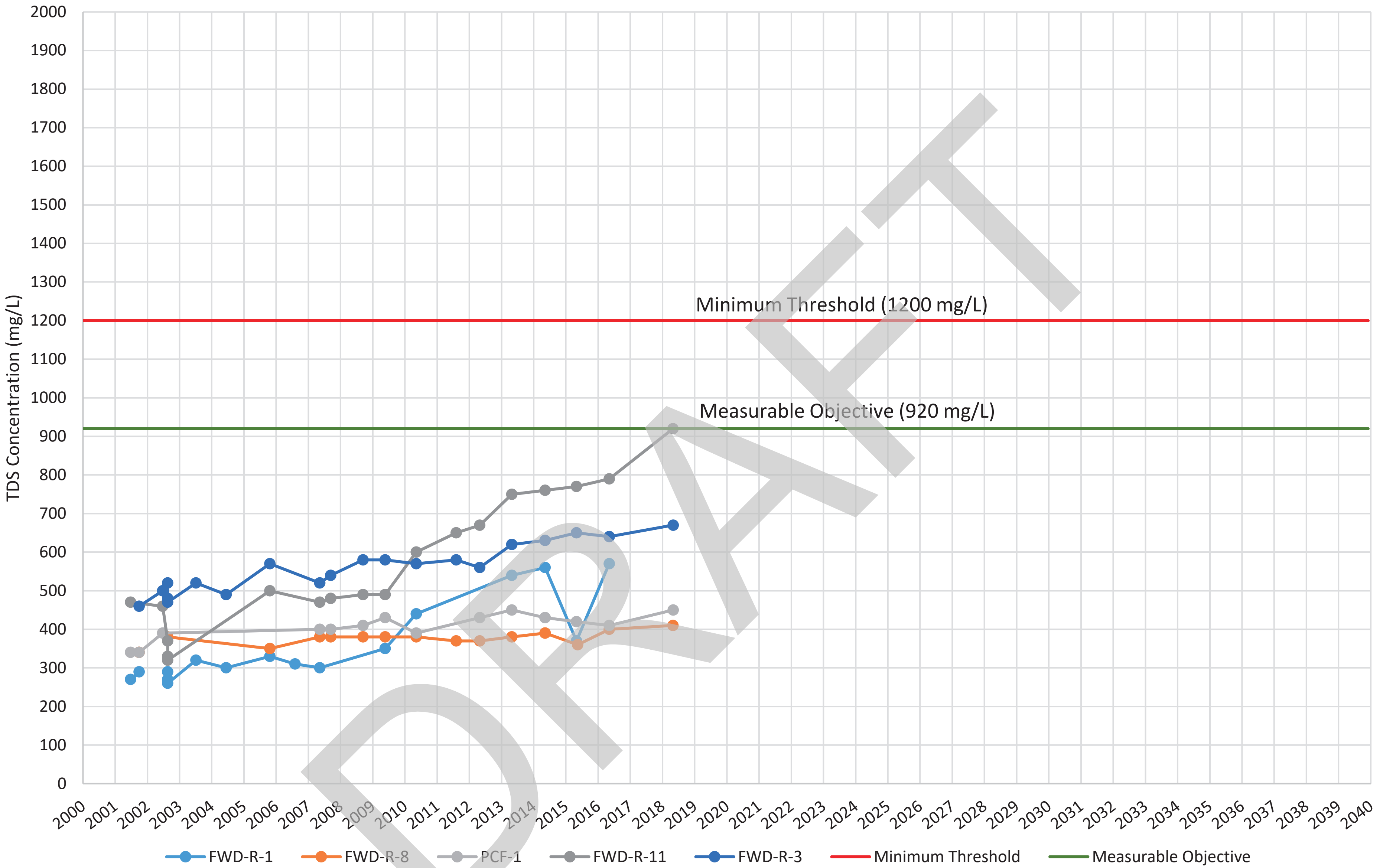
Yearout and P304 - Subsidence Sustainable Management Critiera

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-7



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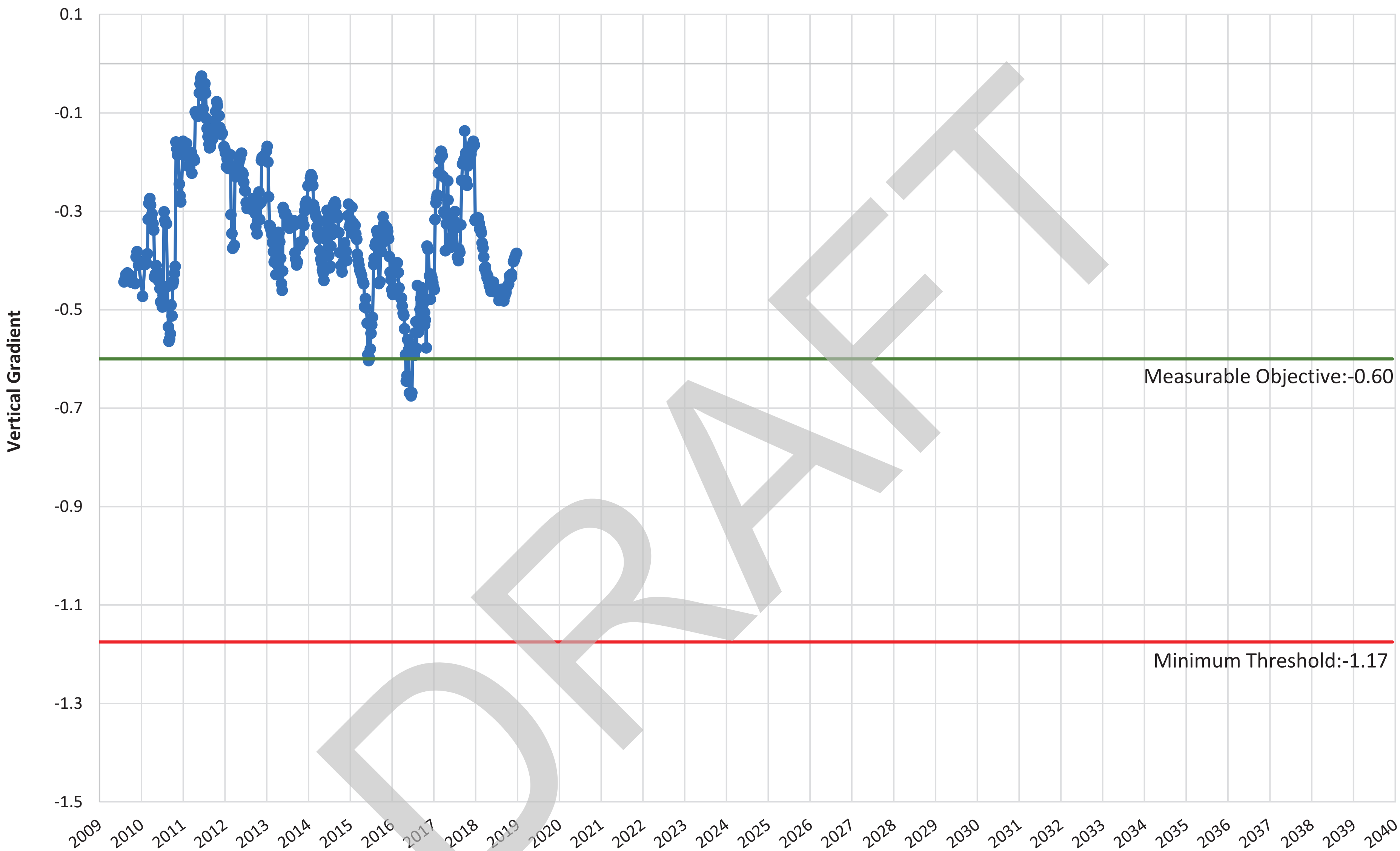
FWD Groundwater Quality
Sustainable Management Criteria

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-8



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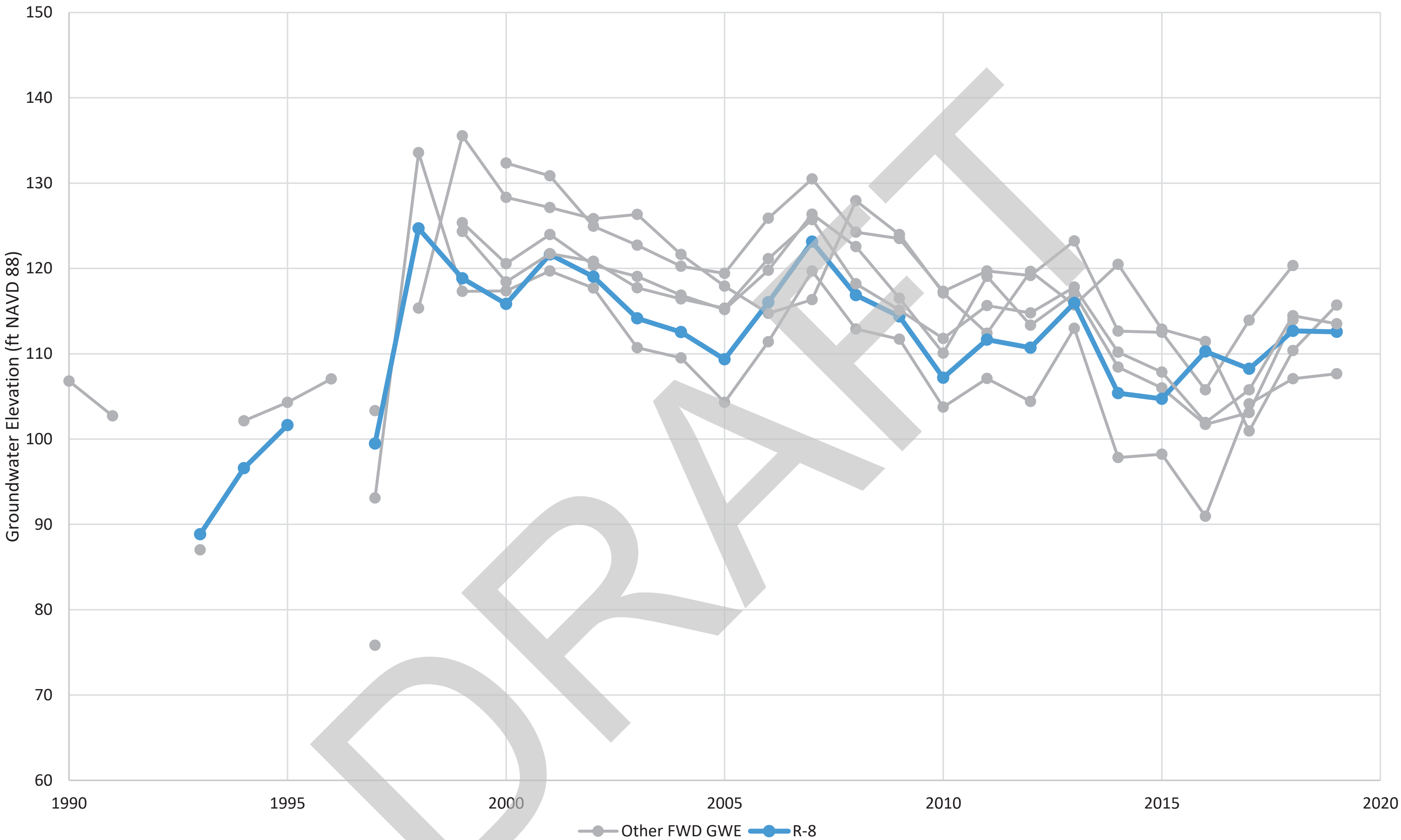
SJRRP-09-55, 55b - Interconnected Surface Waters
Sustainable Management Criteria

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-9



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Farmers Water District Water Levels
Sustainable Management Criteria

Groundwater Sustainability Plan
Farmers Water District
Delta-Mendota Subbasin

Figure 4-10