4. MONITORING NETWORKS [23 CCR § 354.32]

4.1. Introduction [23 CCR § 354.34(a)]

This section describes the Tule Subbasin Monitoring Plan (TSMP), as established in Section 5 the 2024 Coordination Agreement (Attachment 1), and includes monitoring objectives, protocols, and data reporting requirements in accordance with GSP regulations. The TSMP was developed as a coordinated effort and is adopted by the PID GSA. The monitoring plan describes the monitoring network designed to collect data such as surface water flow, surface water quality, groundwater levels, groundwater quality, and land surface elevation.

Individual GSAs may include additional monitoring features that are not specified in the TSMP. All additional monitoring features in this GSP meet the minimum design and construction requirements as agreed upon in the 2024 Coordination Agreement.

4.2. Monitoring Network Objectives [23 CCR § 354.34 (b)]

The monitoring network objective is to ensure that data collected is in sufficient quantities, distribution, frequency, and accuracy to provide meaningful results for demonstrating progress toward achieving the Subbasin's sustainability goal. The following objectives are identified in Section 1.1 of the TSMP:

- To monitor impacts on the beneficial uses and users of groundwater.
- To monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
- Enable the quantification of annual changes in water budget components.
- To identify data gaps and monitoring features to address the data gaps.
- To provide a standard methodology for the collection of surface water, groundwater, and land surface subsidence data within the Tule Subbasin.
- To provide for a central, secure monitoring database available to the GSAs for their use in preparing their respective groundwater sustainability plans and annual reports.

The TSMP is both iterative and adaptable, allowing for modifications to the network which can accommodate changes in the frequency of monitoring or changes in methodologies.

4.2.1. Progress Toward Achieving Measurable Objectives [23 CCR § 354.34(b)(1)]

Each year during Plan implementation, the PID GSA, in coordination with the Subbasin, will prepare an Annual Report to document Subbasin conditions and monitoring activities from the previous water year.

Data collected from the monitoring network is evaluated to determine current conditions and progress towards measurable objectives and achieving sustainability goals. Progress toward achieving measurable objectives for each sustainability indicator is quantified by comparing current conditions against interim milestones and minimum thresholds (**Section 3**).

If monitoring results indicate any of the sustainability indicators are not meeting interim milestones, the GSA may need to adjust Projects and Management Actions (PMA), as described in **Section 5** of this GSP. Additionally, GSP Periodic Evaluations are conducted every five years, in compliance with CCR regulations (23 CCR § 356.4), providing an opportunity to amend the plan and provide a written assessment on whether it is meeting the sustainability goals established by the agency.

4.3. Chronic Lowering of Groundwater Levels Monitoring Network [23 CCR § 354.34; 354.36]

4.3.1. Monitoring Network Design

The groundwater level monitoring network must demonstrate occurrence, flow direction, and hydraulic gradients between principal aquifers and surface water features. Groundwater level monitoring networks were developed for the Upper Aquifer, Lower Aquifer, and Santa Margarita Formation. As described in the Hydrogeologic Conceptual Model (**Section 2.2)**, the Upper Aquifer depth varies from approximately 400 feet below ground surface (feet bgs) in the western portion of the Subbasin to, as shallow as, 100 feet in the northwest. The Lower Aquifer, which is below the Corcoran Clay west of highway 99, ranges in depth from 2,200 feet in the west to approximately 400 feet in the eastern portions of the Subbasin where the Corcoran Clay is not present. The Santa Margarita Formation, located in the southeast part of the Subbasin ranges in depth from 700 feet to 2,000 feet bgs. A monitoring network was not developed for the Pliocene deposits which is considered to be an aquitard. Monitoring for the Pliocene Formation is discussed in the PMA section to address the issues of critical head.

The entire Tule Subbasin groundwater level monitoring network is presented in **Figure 4-1** and **Table 4-1.** This includes aquifer specific monitoring wells for each principal aquifer and composite wells. Composite wells are only utilized where there are no other aquifer specific wells for monitoring in the area. The following describes the full groundwater level monitoring network for each principal aquifer along with the representative monitoring sites (RMS).

Hopkins (1984) suggests a monitoring well density of four wells per 100 square miles for basins that pump more than 10,000 acre-feet annually per 100 square miles. For the Tule Subbasin, which is roughly 745 square miles, this equates to approximately 30 monitoring wells. The PID GSA is approximately 16,900 acres and historically has pumped more than 10,000 AFY (on average 23,600 AFY). Based on Hopkins 1984, PID would need to have 1-2 monitoring wells in its network

4.3.2. RMS Selection

RMS wells were strategically selected from the monitoring network to assess progress towards achieving groundwater level sustainability in the Subbasin. Groundwater level RMS must have documented construction, be located within a designated management area to ensure adequate spatial coverage and ideally have perforations exclusively in a single hydrogeologic unit. Additionally, these wells must meet the specific historical record criteria and be equipped with pressure transducers to record automated daily water level measurements.

4.3.3. Upper Aquifer Monitoring Network

A total of 121[1] monitoring wells included in **Figure 4-1** were identified in the Upper Aquifer. The entire Upper Aquifer monitoring network is used to create groundwater level contours for seasonal high and seasonal low conditions. The Subbasin GSAs selected a subset (30) of these wells as Representative Monitoring Sites (RMSs) for the Upper Aquifer. Upper Aquifer RMS well locations are shown in **Figure 4-2** and summarized in **Table 4-2**. Within the PID GSA, there are 4 Upper Aquifer RMS wells. Upper Aquifer monitoring wells with PID are presented below in **Table 4-3** and include composite wells.

Table 4-3 – PID Upper Aquifer Monitoring Wells

Master Well ID	Short State Well Number	RMS	Ref. Point Elev (ft amsl)	Ground Elev (ft amsl)	Borehole Depth (ft bgs)	Casing Depth (ft bgs)	Top of Perfs (ft bgs)	Bottom of Perfs (ft bgs)
Tule_E0026_RMS	21S/27E-18M01	No	395	395	N/A	N/A	150	300
21S27E20Q001M	21S/27E-20Q01	No	410	410	180	174	150	168
Tule_E0081_ILP	21S/26E-24	No	384	382	N/A	N/A	N/A	N/A
21S26E24R001M	21S/26E-24R01	No	396	394	218	N/A	N/A	N/A
R-11	21S/27E-30	Yes	403	400	216	216	N/A	216
Tule_E0082_ILP	21S/26E-36	No	395	394	N/A	N/A	N/A	N/A

[1] 108 Upper Aquifer well used for Upper Aquifer contouring in the Water Year 2025 Annual Report.

Table 4-3 – PID Upper Aquifer Monitoring Wells								
Master Well ID	Short State Well Number	RMS	Ref. Point Elev (ft amsl)	Ground Elev (ft amsl)	Borehole Depth (ft bgs)	Casing Depth (ft bgs)	Top of Perfs (ft bgs)	Bottom of Perfs (ft bgs)
21S27E32N001M	21S/27E-32N01	No	412	411	95	N/A	N/A	N/A
PID Composite Monitoring Wells								
Tule_L0080_ILP	21S/26E-16	No	345	344	N/A	N/A	N/A	N/A

4.3.4. Lower Aquifer and Santa Margarita Monitoring Network

The Lower Aquifer monitoring network consists of 144[2] monitoring wells were identified for the Lower Aquifer, with an additional 49 composite and Santa Margarita Aquifer wells (**Figure 4-1**) and (**Table 4-4**). The Lower Aquifer monitoring network is presented in **Figure 4-3**. This network consists of 34 RMS wells[3]. The three RMS monitoring sites within the Santa Margarita formation are included in **Figure 4-4**. Within the PID GSA, there are no monitoring or RMS wells available. The lack of aquifer specific monitoring wells for the Lower and Santa Margarita aquifers is identified as a data gap, discussed further in Section 4.8 of this GSP.

4.3.5. Groundwater Level Monitoring Network – Monitoring Protocols, Reporting Standards, and Frequency [23 CCR §354.34 (f)(g)(2)(i)]

Data collection procedures and reporting standards are established so data collected throughout the Subbasin is consistent and comparable. Monitoring protocols are as follows within the PID GSA, in accordance with the Coordination Agreement:

- Groundwater level measurements shall be collected from each well using either a steel tape, a calibrated well sounder, or a pressure transducer. Where possible, groundwater level measurements shall be collected with steel tape or electrical groundwater level sounder calibrated to the nearest 0.01 ft. For pre-existing wells with limited access, a calibrated steel tape and chalk or acoustic sounder may be used.

- All equipment must be in good working condition.

[2] 87 Lower Aquifer wells and 62 composite wells were used for contouring in Water Year 2025 Annual Report.
[3] 22 RMS wells are identified for the Lower Aquifer in the Water Year 2025 Annual Report.

- All new monitoring wells shall be equipped with calibrated pressure transducers and corrected for barometric pressure with a vented cable or separate barometric pressure transducer.

- Groundwater level measurements must be representative of static (i.e. non-pumping) groundwater level conditions. To ensure measurement of static groundwater levels in active pumping wells, the field technician collecting the data must verify that the pump has been off for at least 24 hours prior to collecting data.

4.3.5.1 Manual Groundwater Level Measurements

The following describes the procedures for collecting manual groundwater level measurements and is quoted directly from Section 2.1.2.1 of the TSMP. The procedure for collecting manual groundwater level measurements in the field is the following:

1. Upon arrival at each site, the field technician shall note the well name, time of day, and date on the standard groundwater level data form (see Appendix F of Attachment 1).

2. For groundwater level measurements taken with chalk and steel tape, the field technician shall use the groundwater level data form provided in Appendix G of Attachment 1.

3. The field technician shall document the duration since last pumping of the well occurred and document if any nearby pumping is known.

4. All monitoring equipment shall be cleaned prior to lowering it into the well(s) using the following decontamination procedure:

    a. Wash equipment with an Alconox solution which is followed by a deionized water rinse.

    b. Triple rinse equipment with deionized water.

    c. Place equipment on clean surface such as teflon or polyethylene sheet to air dry.

5. To measure the depth to groundwater with a steel tape or an electrical sounder or meter, slowly lower the steel tape or water level electrical tape into the designated sounding port for production wells and into the main well for monitoring wells. Steel tapes and electrical tapes are lowered to the water surface, as determined by the audio signal, meter, or technician. Depths to groundwater are measured relative to the dedicated reference point at the top of the casing or sounding tube. Depth to groundwater shall be immediately recorded on the standard groundwater level data form (see Appendix F [of the monitoring plan]). Depths to groundwater shall be

compared to previous measurements in the field and re-measured if significantly different.

6. For wells with limited access (such as agricultural wells or domestic wells equipped with a pump), a steel tape and chalk may be used. For this method, chalk is applied to a 1- to 3-foot section of the steel tape prior to lowering in the well. The steel tape is lowered to a depth at least 1-ft below the static groundwater level and a whole number on the calibrated tape is matched to the reference point at the surface. Both the foot mark held at the reference point and the groundwater level observed on the chalk shall be recorded on the standard field forms (see Appendix G of Attachment 1). The difference between the two is the depth to groundwater.

7. When finished sounding the groundwater level, all downhole equipment shall be removed, and where existing, the well cap shall be replaced, and the riser locked.

8. Prior to leaving the monitoring well site, the field technician shall note any physical changes in the concrete well pad and riser pipe, such as erosion, cracks or damage. All changes shall be recorded on the standard field forms provided in Appendices F and G [Attachment 1].

4.3.5.2 Automatic Groundwater Level Measurements Using Transducers

- All RMS well shall be equipped with transducers at a depth below the groundwater level that will accommodate anticipated changes in groundwater levels. The following descriptions for utilizing transducers for measuring groundwater levels is quoted directly from Section 2.1.2.2 of the TSMP. Transducers shall be corrected for barometric pressure with a vented cable or separate barometric pressure transducer.

- Desiccants in transducers with a vented cable shall be replaced in accordance with the manufacturer's specifications.

- Before removing a transducer that will be reinstalled at the same depth, place an identifying mark on the cable (colored electrical tape or other identifying mark) to ensure that pressure transducers are installed to the same depth during reinstallation.

4.3.5.3 Frequency of Measurement

The frequency of measurements for the groundwater level monitoring network is as specified in Section 2.1.3 of the Coordination Agreement and described herein. Groundwater level measurements will be collected from existing domestic and irrigation wells with sufficient temporal frequency such that short-term, seasonal, and long-term groundwater level trends can be determined. Groundwater levels will be collected semi-annually in the Spring (primarily February but also March or April) and in the Fall (primarily October but also September and November). Groundwater level measurements from new monitoring wells and RMS will be collected using pressure transducers, which will be downloaded on a semi-annual basis.

4.4. Decrease in Groundwater Storage Monitoring Network [23 CCR § 354.34 (c)(2)]

The monitoring network established for groundwater levels is adopted as a proxy to monitor changes in groundwater storage, as discussed previously in **Section 3** of this GSP. As such, all wells selected for monitoring changes in groundwater storage will be the same as those used for groundwater level monitoring (**Section 4.3**).

4.5. Degraded Groundwater Quality [23 CCR § 354.34 (c) (4)]

4.5.1. Monitoring Network Design

The existing groundwater quality monitoring program is described in the TSMP (Attachment 1 to the 2024 Tule Subbasin Coordination Agreement). The program is designed to support beneficial users and uses within the Subbasin for the Upper and Lower Aquifers. The Upper Aquifer and Lower Aquifer monitoring networks are presented in **Figure 4-5** and **Figure 4-6,** respectively. The full groundwater quality monitoring network with the expanded list of constitutes to be analyzed is presented in **Figure 4-7**.

GSAs utilize a unified dataset to streamline monitoring within the Subbasin. By aligning their efforts, they collectively satisfy the requirements of the Irrigated Lands Program, the CV-SALTS Nitrate Control Program, and SGMA. This coordination ensures a consistent approach to both immediate and long-term groundwater management solutions at the local level.

The groundwater quality monitoring network described in the Subbasin GSPs focused on monitoring features included in the Tule Basin Water Quality Coalition's (TBWQC) groundwater quality trend monitoring program. The ILRP General Order R5-2013-0120-09 specifies the monitoring network and schedule requirements. Additionally, SDWIS datasets inform the GSAs regarding the public water systems' characterization and monitoring groundwater quality.

4.5.2. RMS Selection

RMS sites were derived from existing monitoring programs in the Tule Subbasin and based on an analysis of beneficial use and users. The RMS wells consist of privately owned domestic and agricultural wells within the subbasin. The following criteria were used to select specific wells as RMS:

1. Located near (preferably up-gradient of) drinking water wells
2. Located in regions with known historical COC exceedances or contamination plumes
3. Representative of groundwater quality in a single aquifer

4. Can be accessed and are capable of collecting representative samples at semi-annual intervals or better.

The Tule Subbasin Coordination Agreement proposed that water quality RMS wells be designated for agricultural or domestic use, depending on the dominant surrounding land use. However, modifications to the approach are being implemented by the GSAs such that both existing and future RMS locations will be monitored for all regulatory drinking water standard constituents of concern (COCs). Data gaps in the existing RMS well network have been identified for the development of future well additions to the network.

In accordance with the Draft Tule Basin Water Quality Surface Water and Groundwater Monitoring Plan, as well as the Quality Assurance Program Plan (Appendix 4-3), groundwater samples shall be collected and analyzed each summer on an annual basis.

According to the Tule Subbasin Coordination Agreement (see Attachment 1), the groundwater sampling protocols described herein will ensure the following:

- Groundwater quality data are collected from the correct location
- Groundwater quality data are accurate and reproducible
- Groundwater quality data represent conditions that inform appropriate basin management decisions
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity

4.5.3. Upper Aquifer Monitoring Network

The RMS network for the Upper Aquifer consists of 25 wells[4] across the Subbasin (**Figure 4-5** and **Table 4-5**). Within PID, there are three wells designated to monitor groundwater quality in the Upper Aquifer, which are presented in **Table 4-6**.

Table 4-6 PID Upper Aquifer Water Quality RMS Network

Master Well ID	Reference Point Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Borehole Depth (ft bgs)	Casing Depth (ft bgs)	Top of Perfs (ft bgs)	Bottom of Perfs (ft bgs)	Aquifer	X-Coordinate (ft)	Y-Coordinate (ft)
Tule_E0026_RMS	395	395	N/A	N/A	150	300	U	6535440	1919750
Tule_E0081_ILP	384	382	N/A	N/A	N/A	N/A	U	6527930	1916670
Tule_E0082_ILP	395	394	N/A	N/A	N/A	N/A	U	6529860	1905060

[4] 43 Upper Aquifer water quality wells were identified in the WY 2025 Annual Report.

4.5.4. Lower Aquifer Monitoring Network

For the Lower Aquifer, the RMS network is comprised of 22 wells[5] throughout the Subbasin (**Figure 4-6** and **Table 4-7**). Within PID, there are no wells designated to monitor groundwater quality in the Lower Aquifer. This is identified as a data gap, discussed further in section 4.8 of this GSP.

4.5.5. Groundwater Quality Constituents to be Analyzed

Annual water quality monitoring of wells within the Subbasin, as represented in **Figures 4-4** and **4-6,** will include laboratory analyses for nitrate as N only. Measurements of the following parameters will be collected from well discharge prior to sampling: temperature, pH, dissolved oxygen (DO), and electrical conductivity (EC) (**Table 4-8**). Additional details for this process are described below and in Section 2.4.2 of the TSMP.

Table 4-8. Groundwater Quality Monitoring Constituents Field Analysis	
Constituent	**Units**
Electrical Conductivity (EC)	µmhos/cm[1] (at 25˚C)
pH	Standard Unit
Dissolved Oxygen (DO)	mg/L
Temperature	˚C[2]

[1] µmhos/cm = micromhos per centimeter
[2] ˚C = Degrees Celsius

Groundwater samples from wells within the Groundwater Quality Monitoring Network, depicted in **Figure 4-7,** will be analyzed for an expanded list of analysts in addition to nitrate as N every five years, rather than on an annual basis. The additional analytes will include total dissolved solids (TDS), as well as major cations and anions outlined in **Table 4-9**.

Table 4-9. Groundwater Quality Monitoring Constituents Laboratory Analysis		
Type	**Constituent**	**Units**
Elemental	Arsenic	mg/L
	Uranium	mg/L

[5] 40 Lower Aquifer water quality wells were identified in the WY2025 Annual Report.

Table 4-9. Groundwater Quality Monitoring Constituents Laboratory Analysis		
Type	**Constituent**	**Units**
	Hexavalent Chromium	mg/L
Cations	Calcium	mg/L[2]
	Magnesium	mg/L
	Potassium	mg/L
	Sodium	mg/L
Anions	Sulfate	mg/L
	Chloride	mg/L
	Perchlorate	mg/L
	Carbonate/Bicarbonate	mg/L
	Nitrate as N	mg/L
Nitrogen Cycle	Nitrite as N	mg/L
	Total Kjeldahl Nitrogen (TKN)	mg/L
	Ammonia	mg/L
Additional Considerations	Total Dissolved Solids	mg/L
	Tetrachloroethene (PCE)	mg/L
	Dibromo-3-chloropropane(DBCP)	mg/L
	1,2,3-Trichloropropane (TCP)	ng/L[3]
	Per-and polyfluoroalkyl Substances (PFAS)	ng/L

[1] µg/L = Micrograms per liter; equivalent to parts per billion (ppb)
[2] mg/L = milligrams per liter; equivalent to parts per million (ppm)
[3] ng/L = nanograms per liter; equivalent to parts per trillion (ppt)

4.5.6. Groundwater Quality Samples from Existing Domestic Water Supply of Irrigation Wells

Per the 2024 Tule Subbasin Coordination Agreement (see Attachment 5), the following procedures shall be followed to remain in accordance with the Tule Subbasin GSAs as it pertains to groundwater quality samples from existing domestic water supply of irrigation wells:

> *The field technician shall document all groundwater sampling activities on the standard groundwater sampling form (see Appendix I). Domestic water supply and irrigation wells that are active (i.e. that have pumped in the last 24 hours) shall be pumped for a minimum of 10 minutes and shall meet the field parameter requirements below before sampling. Domestic and irrigation wells that are inactive (i.e. have not pumped in the last 24 hours) shall be sampled after purging the well for a period of time adequate to remove at least three well volumes removed prior to sampling and shall meet the field parameter requirements below (see Appendix I).*
>
> *During pumping and prior to sample collection, the field technician shall obtain field measurements of temperature, pH, DO and EC from water collected from the sample port. Meters for measuring pH, DO and EC shall be field calibrated in accordance with manufacturer's specifications at the beginning of each sampling day. Samples will be collected when: (1) a minimum of four sets of parameter readings have been obtained; and (2) the temperature, pH, and EC reach relatively constant values.*
>
> *All samples shall be collected from the discharge point nearest the well head and placed in laboratory-prepared sample containers. The technician collecting the sample shall wear new latex or neoprene gloves while collecting the sample. Sample containers shall be labeled before or immediately after sampling with self-adhesive tags having the following information written in waterproof ink:*
>
> - *Project number*
> - *Sample I.D. number*
> - *Sample location*
> - *Date and time sample was collected*
> - *Initials of sample collector*

4.5.7. Groundwater Quality Samples from Monitoring Wells

According to the 2024 Tule Subbasin Coordination Agreement (see Attachment 5), groundwater quality samples from monitoring wells shall follow the procedures described below:

> *All groundwater samples from monitoring wells will be collected consistent with procedures described in the United States Environmental Protection Agency's (USEPA's) Low-flow (Minimal Drawdown) Groundwater Sampling Procedures.*[6] *Low-flow purging can be conducted using either portable or dedicated (leave in well) pump systems. A submersible pump, diaphragm pump, or positive displacement pump, which may contain a bladder, may be used for evacuating (purging) the monitoring well casing and collecting the samples. The pump-intake should be set in the middle or slightly above the middle of the screened interval in the well and documented in the field notes.*

Other equipment necessary for collecting groundwater samples using the low-flow sampling method include:

- *A water level measurement device, or water level sounder*
- *In-line flow through cell to monitor water quality parameters*
- *Field forms for documenting water quality parameters measured at each monitoring well*
- *Chain of custody forms*
- *Laboratory prepared sample containers from a State-certified laboratory with the appropriate labels for the analytes being measured*
- *Gloves*
- *Cleaning supplies for decontaminating*
- *Tubing for the pump*

All samples shall be collected from a discharge port at the wellhead and placed in laboratory-prepared sample containers. For dissolved trace metal analyses, samples will be collected in unpreserved bottles, then filtered through a 0.45-micron filter and acidified prior to analysis in accordance with the laboratory's instructions. The technician collecting the sample shall wear new latex or neoprene gloves while collecting the sample. Sample containers shall be labeled before or immediately after sampling with self-adhesive tags having the following information written in waterproof ink:

- *Project number*
- *Sample I.D. number*
- *Sample location*
- *Date and time sample was collected*
- *Initials of sample collector*

4.5.8. Well Sampling Records

According to the 2024 Tule Subbasin Coordination Agreement (see Attachment 5), groundwater quality samples from monitoring wells shall follow the procedures described below:

Data collected during groundwater sampling will be recorded on the standard forms provided in Appendix I. Information and data to be recorded shall include:

- *Sample I.D.*
- *Duplicate I.D., if applicable*
- *Date and time sampled*
- *Name of sample collector*
- *Well designation (State well numbering system for water supply wells)*
- *Owner's name, or other common designation*
- *Well diameter*
- *Depth to water on day sampled*
- *Casing volume on day sampled*
- *Method of purging (bailing, pumping, etc.)*
- *Extraordinary circumstances (if any)*

- *Field measurements temperature (0º C), pH, specific electrical conductivity (at 25ºC µs/cm), and dissolved oxygen (mg/l)*
- *Number and type of sample container(s)*
- *Times corresponding to water quality measurements*
- *Pumping rate at time of sampling*
- *In addition to the standard forms for collecting data, the field technician shall keep a daily field record for each day of fieldwork. Following review by the project manager, the original records*
- *shall be kept in the project file.*

4.5.9. Handling, Storage and Transportation of Samples

Per the 2024 Tule Subbasin Coordination Agreement (see Attachment 5), the following procedures shall be followed as it pertains to handling, storage, and transportation of groundwater quality samples:

> *Upon collection and labeling, all samples shall be placed immediately into a clean chest/cooler with ice in order to keep samples cool. Exposure to dust, direct sunlight, high temperature, adverse weather conditions, and possible contamination shall be avoided.*
>
> *All samples will be transported to a State-certified analytical laboratory within 24 hours of collection. Samples shall be transported under chain-of-custody procedures, which document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis shall be recorded on a Chain-of-Custody Record, which includes instructions to the laboratory for analytical services.*
>
> *Information contained on the triplicate Chain-of-Custody Record shall include:*
>
> - *Project number*
> - *Signature of sampler(s)*
> - *Date and time sampled*
> - *Sample I.D.*
> - *Number of sample containers*
> - *Sample matrix (water)*
> - *Analyses required*
> - *Remarks, including preservatives, special conditions, or specific quality control measures*
> - *Turnaround time and person to receive laboratory report*
> - *Method of shipment to the laboratory*
> - *Release signature of sampler(s), and signatures of all people assuming custody*
> - *Condition of samples when received by laboratory*
>
> *Blank spaces on the Chain-of-Custody Record will be crossed out between the last sample listed and the signatures at the bottom of the sheet.*
>
> *The field sampler shall sign the Chain-of-Custody Record and record the time and date at the time of transfer to the laboratory or to an intermediate person. A set of signatures is required for each relinquished/reserved transfer, including intermediate transfers. The original imprint of the*

Chain-of-Custody Record will accompany the sample containers. A duplicate copy shall be placed in the project file.

If the samples are to be shipped to the laboratory, the original Chain-of-Custody will be sealed inside a plastic bag within the ice chest, and the chest shall be sealed with custody tape which has been signed and dated by the last person listed on the Chain-of-Custody. U. S. Department of Transportation shipping requirements shall be followed and the sample shipping receipt retained in the project file as part of the permanent chain-of-custody document. The shipping company (e.g. Federal Express, UPS, DHL) will not sign the chain-of-custody forms as a receiver, instead the laboratory shall sign as a receiver when the samples are received.

4.5.10. Quality Control Samples

According to the 2024 Tule Subbasin Coordination Agreement (see Attachment 5), the following procedures shall be followed as it pertains to quality control samples for the monitoring of groundwater quality:

Quality control samples shall consist of duplicates and blanks. At least one duplicate sample shall be collected during each day of sampling. The duplicate sample shall be collected from the same well as the original and immediately after the original sample. At least one blank sample shall be included with each batch of samples delivered to the laboratory. Blank samples shall consist of laboratory prepared deionized water that is containerized at the laboratory and delivered with the sample containers. Duplicate and blank samples will be analyzed by the laboratory, as specified in the project Quality Assurance Project Plan (QAPP)[7] or by the project manager (see Appendix H).

4.5.11. Frequency of Measurements

Groundwater quality samples will be collected from the wells shown on **Figures 4-5** and **4-6** on an annual basis each summer and analyzed as described in **Section 4.5.5** of this GSP (see Section 2.4.1 of Attachment 1).

4.6. Land Subsidence [23 CCR § 354.34(c)(5)]

4.6.1. Monitoring Network Design

Land subsidence has been monitored throughout the Tule Subbasin based on InSAR, survey benchmark, GPS station, and extensometer data. A combination of these sources have provided data that have allowed for an analysis of historical and current subsidence, which can be compared and correlated to groundwater pumping and groundwater levels. The U.S. Geological Survey (USGS) collected and analyzed land subsidence measurements in the 1950s and 1960s (Lofgren and Klausing, 1969), which was used to conclude that lowered groundwater levels caused by groundwater pumping in areas where significant amounts of clay and silt are present in the subsurface.

4.6.2. RMS Selection

The RMS for land subsidence consists of a combination of benchmarks sites supplemented by InSAR data. A single extensometer is located near the Friant-Kern Canal, in a region of the subbasin where subsidence is of most concern.

4.6.3. Monitoring Features

Changes in land surface elevation associated with groundwater withdrawal will be monitored by collecting data from survey benchmarks, extensometers, and satellite (InSAR) data. Each data source is discussed in the following sections.

4.6.3.1 Surveyed Benchmarks

Ninety-nine benchmarks have been established throughout the Tule Subbasin that will allow for changes in land surface elevation to be monitored using GPS measurements. Each benchmark indicates a survey station, which is labeled with a station identification number, as shown in **Figure 4-8** and **Table 4-10**. The 99 benchmarks in the Subbasin that make up the land subsidence monitoring network are categorized by the following: 1) 61 RMS benchmark stations, 2) 33 benchmark stations established by the Friant Water Authority (FWA), and 3) 38 benchmark stations established by the ETGSA Land Subsidence Monitoring Plan. Additional benchmarks may be established in the Tule Subbasin in the future. One benchmark (PD0050_B_RMS) is present within PID GSA (**Table 4-11**).

Table 4-11 – PID Land Subsidence RMS Monitoring Network

RMS Data Source	RMS ID	Status
Benchmark	PD0050_B_RMS	Active

4.6.3.2 Satellite Data (InSAR)

Changes in land surface elevation over time can be observed on a regional scale using satellite data, which is generated using interferometric synthetic aperture radar (InSAR). Eighty-four InSAR monitoring points based on InSAR data points are shown between benchmark stations to represent land subsidence changes since 2015. To be consistent with the Tule Subbasin Coordination Agreement, the PID GSA will be obtained from the CDWR quarterly. InSAR locations as part of the RMS network, along with their identification numbers, are shown in **Figure 4-7** and **Table 4-10.**

4.6.3.3 Extensometers

The USGS uses an extensometer to collect data on aquifer system compaction, which causes land subsidence. The extensometer station (22S/27E-30D2) is located near the FKC on the northeastern side of the SID GSA, within 4 miles of the southern boundary of the PID GSA, and approximately one mile north of the Deer Creek crossing (**Figure 4-8**). The extensometer collects data on the aquifer compaction of sediments between the land surface to a depth of 1,180 ft. The data is accessible to the public on the

USGS website. There is the potential for additional extensometers to be established in the Tule Subbasin in the future.

4.6.4. Monitoring Procedure

4.6.4.1 Surveyed Benchmarks

According to the Tule Subbasin Coordination Agreement (see Attachment 1), the benchmark station network will be established in accordance with the National Geodetic Survey (NGS) Guidelines for Establishing GPS-Derived Ellipsoid Heights (National Oceanographic and Atmospheric Administration [NOAA], 1997). Elevation data collected using a GPS will be constrained to an established NGS benchmark location on Lake Success Dam (KT 200), and land surface elevations readings will be recorded to an accuracy of 0.1 ft relative to NAVD88.

4.6.4.2 Extensometers

The USGS extensometer (22S/27E-30D2) records aquifer system compaction with its equipped continuous monitoring device. Aquifer system compaction data collected from the extensometer is accessible on the USGS website, and data updates can be downloaded for analysis.

4.6.4.3 Satellite Data (InSAR)

InSAR data will be obtained from the USGS, Jet Propulsion Laboratory, or European Space Agency. The data will be processed, analyzed, and interpreted by an outside professional, such as the Neva Ridge Technologies, Inc. or an approved equal. The InSAR data will ultimately be used to develop maps representing regional land surface elevation changes.

4.6.5. Frequency of Measurement

4.6.5.1 Global Positioning Surveys

GPS surveys of the stations throughout the Subbasin will be conducted annually and will be correlated to groundwater quality sampling events. GPS stations located within the Friant-Kern Canal Monitoring Zone, however, will be surveyed quarterly.

4.6.5.2 Extensometers

Continuous aquifer system compaction measurements are collected at the USGS extensometer (22S/27E-30D2). The resulting data can be accessed on the USGS website, which can be downloaded for analysis as updates are available.

4.6.5.3 Satellite Data (InSAR)

InSAR data will be obtained and analyzed quarterly.

4.7. Interconnected Surface Water [23 CCR § 354.34(c)(6)]

4.7.1. Monitoring Network Design

The ISW monitoring network for the Subbasin is as described in Section 2.6 and 4.1 of the TSMP. The Tule River Association (TRA) monitors surface water flow in the Tule River and beyond the Tule Subbasin, and Deer Creek and White River surface water are monitored by the USGS and USBR, respectively. Current monitoring features, procedures, and frequency for surface water in the Tule Subbasin follows those in place by the corresponding monitoring agency. Monitoring features are comprised of monitoring stations in primary rivers and streams, including the Tule River, Deer Creek, and White River. Stream flows at gaging stations and diversion points are measured continuously and transmitted electronically. Locations without stream gages are measured at least once every two weeks or when major changes in stream flow occur.

Within the PID GSA, the only major natural surface water feature is the Tule River, which flows from east to west. The ISW monitoring network is presented in **Figure 4-9.** Within PID, the monitoring network is comprised of wells R-11, MW-4, and MW-101, as well as an instream gage at Rockford Station. A numerical groundwater-surface water model will incorporate data from the existing shallow monitoring wells, and future monitoring wells discussed in **Section 4.8.4** below to quantify the degree of interconnection.

4.8. Data Gaps [23 CCR § 354.38(b); § 354.38(c)(1); § 354.38(d)]

Section 4.1 of the TSMP identifies data gaps for each sustainability indicator across the Subbasin. This section summarizes those subbasin wide findings while focusing on the data requirements specific to PID GSA.

4.8.1. Groundwater Level Monitoring Data Gaps

There is a high density of wells across the Subbasin, but many of them are composite and do not provide aquifer specific data. More aquifer specific monitoring data will enhance the ability to monitor groundwater level changes and flow patterns for both the Upper and Lower Aquifers. Areas are selected to provide the spatial coverage necessary to prepare complete groundwater level contour maps in both the Upper and Lower Aquifers.

Additionally, the Subbasin is lacking in pumping test data that is used to estimate aquifer parameters. The majority of pumping test that used to derive aquifer parameters were single well, short-term term test less than 24 hours. Also, there is a lack of pumping tests that measure groundwater level interference from nearby monitoring wells. This is necessary to estimate aquifer storage. Moving forward, it is recommended that when constructing new monitoring wells, GSAs conduct long-term pumping tests longer than 24 hours to better estimate transmissivity. It is also recommended that pumping test as be conducted on high-capacity production wells. Future pumping test for PID to improve estimates of aquifer parameters are described in the *Projects and Management Actions*.

General recommendations for aquifer specific monitoring locations are presented in **Figure 4-10**. This includes Upper Aquifer, Lower Aquifer, and nested monitoring well locations. Most of the proposed locations nested wells consisting of monitoring zones in both the Upper and Lower Aquifer. The depth of these wells will vary depending on their location. Upper Aquifer wells will typically be in the upper 400 feet, while Lower Aquifer wells may be as shallow as 250 feet and as deep as 100 feet. All wells are recommended to have 5-inch casing diameter to allow for groundwater sampling.

For PID, plans to fill data gaps include aquifer specific monitoring within the Lower Aquifer, including the Santa Margarita Formation. Specifics for these monitoring wells are discussed further in **Section 5** of the GSP.

4.8.2. Groundwater Quality Monitoring Data Gaps

The current groundwater quality RMS network was derived from existing monitoring programs in the Tule Subbasin. Therefore, the requirements of these programs, including monitoring features and frequency, were used to develop and implement the Tule Subbasin SGMA groundwater quality monitoring network. Data gaps and limitations within existing monitoring programs is discussed below, and the Tule Subbasin GSAs have identified a plan to address such data gaps in order to improve the groundwater quality monitoring program.

Many of the current RMS network wells are privately owned domestic or agricultural wells; therefore, the GSAs are not responsible for maintenance and upkeep of wells. As such, sample collection during monitoring events cannot be guaranteed. Limitations may be encountered for a variety of reasons. For example, in the case that agricultural wells are not in operation or are actively pumping water to the measuring point, groundwater quality samples would not be able to be collected from those wells. Similarly, for an accurate analysis of groundwater quality, monitoring wells must also be purged prior to sampling; however, agricultural wells do not typically run when surface water supplies are available to meet crop demands during wet years or in winter or spring seasons. In such cases, these limitations would hinder current RMS network from being monitored on a semi-annual or quarterly basis to capture short-term seasonal trends. Additionally, static groundwater levels cannot be collected from wells if the pump has not been shut-off for at least 24 hours for collecting accurate groundwater level measurements. Groundwater levels are measured in the Spring and Fall when groundwater pumps are not running, which poses a challenge while attempting to correlate elevation with groundwater quality data.

The Tule Subbasin GSAs are working to refine and improve groundwater quality RMS well network, such as proposing to incorporate additional dedicated monitoring sites that are representative of groundwater conditions and beneficial users. Such additions and improvements would allow for adequate monitoring frequency to detect short-term and seasonal trends in the Subbasin.

In order to provide adequate coverage of groundwater quality characterization, the GSAs will adaptively refine the groundwater network in the case that conditions change and new information and data becomes available. Areas in the Tule Subbasin are being identified as designated data gaps, which will be prioritized for future groundwater quality RMS locations. Initial efforts will include reevaluation of monitoring sites from existing groundwater quality programs (**Table 4-12**) for adequacy to be utilized as a groundwater quality RMS wells. In the case that an existing monitoring feature is deemed inadequate, the Tule Subbasin GSAs will coordinate with landowners to obtain permission to utilize domestic wells as dedicated monitoring sites.

4.8.3. Land Surface Elevation and Subsidence Monitoring Data Gaps

InSAR data that provides coverage throughout the Tule Subbasin have been historically available and indicate areas where land subsidence has occurred. More conventional methods for land surface elevation surveying, such as GPS monitoring, are ongoing in order to verify the accuracy of InSAR data. The USGS has refurbished one extensometer that is included in this monitoring plan, which is located approximately one mile north of Deer Creek along the Friant-Kern Canal. However, a data gap has been identified in that the characteristics of aquifer system compaction in the northwestern portion of the Subbasin is unknown, which is hydrogeologically different than the area where the existing extensometer is located. Therefore, at least one new extensometer is recommended for the vicinity of the Homeland Canal at Highway 43 in the northwest portion of the subbasin. The additional extensometer would provide a more accurate assessment of aquifer system compaction in an area of the subbasin that has experienced relatively high level of subsidence.

4.8.4. Interconnected Surface Water Data Gaps

Currently, the Subbasin faces a data gap regarding the depletions of ISW. To address this, the existing network of stream games and interim monitoring wells (**Section 4.3.7**) will be supplemented by the 16 preliminary new monitoring well sites (**Figure 4-11**). These locations- comprising eight sites along the Tule River, six along Deerk Creek, and two along White River, are designed to track groundwater levels and clarify surface water interactions.

Additionally, SID GSA will incorporate DWR's best management practices for estimating ISW depletions Caused by groundwater use. To estimate interconnected surface water (ISW) depletion using a numerical model, the document outlines a high-level three-step process: first, run the model with pumping at the wells of interest and record the net stream gain; second, rerun the model without pumping from those same wells and record the new net stream gain; and finally, subtract the results of the first step from the second to determine the net change in flow, which represents the depletion caused by groundwater pumping. This process allows managers to quantify the location, quantity, and timing of depletion, which can then be analyzed across different seasons and water-year types to understand how pumping impacts surface water over time (DWR, 2024). This approach will be further clarified as SID works with the other Subbasin GSAs to estimate ISW depletions.

4.9. Reporting Monitoring Data to the Department [§ 354.40]

Reporting monitoring data to the department will occur using the Tule Subbasin Data Management System. A detailed description and a guide for this system is provided in Attachment 1, Section 5.0 of this GSP, as well as Attachment 1 of the 2024 Tule Subbasin Coordination Agreement.