CSAB REVIEW DRAFT
Section 5 – Monitoring Network

Corning Subbasin
Groundwater Sustainability Plan

June 2021

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5 MONITORING NETWORKS

This section describes the monitoring networks in the Corning Subbasin that the GSAs intend to utilize to assess groundwater sustainability conditions and identify sustainability management criteria. This description of the monitoring network was prepared in accordance with GSP Regulation §354.32. The section includes a detailed description of the monitoring objectives, monitoring networks, monitoring protocols, and data reporting plan for assessing each applicable sustainability indicator in the Subbasin. The GSAs used DWR Monitoring Protocols Standards and Sites BMP (Monitoring Protocol BMP; DWR, 2016a) and Monitoring Networks and Identification of Data Gaps BMP (Monitoring Network BMP; DWR, 2016b) to create a monitoring plan that will provide the necessary information to assess groundwater sustainability in the Subbasin. The GSAs used existing data as much as possible for the monitoring networks, which were compiled from various sources including the Tehama County Groundwater Management Plan and Glenn County Monitoring Network Assessment Report (TCFCWCD, 2012; Davids Engineering and West Yost Associates, 2018).

5.1.1 Monitoring Objectives

SGMA requires monitoring networks that allow for the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the Subbasin and evaluate changing conditions that occur through implementation of the Plan. The monitoring network is intended to:

- Monitor changes in groundwater and related conditions relative to measurable objectives and minimum thresholds, and thereby demonstrate progress toward achieving measurable objectives
- Assess potential impacts to the beneficial uses or users of groundwater
- Quantify annual changes in water budget components

The sustainable management criteria, including descriptions of the sustainability goal, undesirable results, measurable objectives, and minimum thresholds, are described in Section 6, Sustainable Management Criteria.

5.1.2 Approach to Monitoring Networks

Monitoring networks were developed for each of the 5 sustainability indicators applicable to this GSP:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage

- Land subsidence
- Degraded groundwater quality
- Depletion of interconnected surface water

As described in the Groundwater Conditions Section 3.2.4, seawater intrusion is not an applicable sustainability indicator for the Subbasin and is therefore not discussed further in this section. The monitoring networks presented in this section consist of locations used historically by various entities to monitor groundwater, surface water, and subsidence in the Subbasin. The locations and data used for developing monitoring networks are from publicly available sources.

There are data gaps for some sustainability indicators that will need to be addressed during implementation of the GSP, as discussed in Section 8.2 on GSP Implementation. Data gaps will be filled through the expansion of the existing monitoring networks or collection of additional information. Filling these data gaps and developing more extensive and complete monitoring systems will improve the GSAs' ability to demonstrate sustainability and refine the existing conceptual and numerical hydrogeologic models.

5.2 Groundwater Level Monitoring Network

The sustainability indicator for chronic lowering of groundwater levels is routine groundwater level measurement in designated monitoring wells. The GSP regulations require a sufficient network of wells to demonstrate groundwater occurrence, flow directions, and hydraulic gradients within the principal aquifer and between the principal aquifer and surface water features.

5.2.1 CASGEM Groundwater Level Monitoring Program

In November 2009, the State amended the Water Code to mandate statewide groundwater elevation monitoring through collaboration between local agencies and DWR. In response, DWR created the California Statewide Groundwater Elevation Monitoring (CASGEM) program wherein local agencies upload available water elevation data and DWR maintains the database in a format that is readily and widely available to the public. The goal of the CASGEM program is to collect and store groundwater elevation data such that current and future groundwater management programs can draw upon the data to assess seasonal and long-term trends in local groundwater conditions.

A CASGEM monitoring program was established in both Tehama and Glenn Counties, in collaboration with DWR and other local agencies. The approved CASGEM monitoring plans for each County are provided in Appendix 5A. The CASGEM monitoring networks in both Counties include dedicated groundwater level observation wells that were installed by DWR. The Tehama County CASGEM monitoring network also includes supply wells to which owners voluntarily give access for groundwater level measurements. Access is also provided voluntarily for groundwater level measurements in Glenn County supply wells, and measurements are made public on the state CASGEM website; however, these wells are not officially part of the Glenn County CASGEM well network (Appendix 5A). The groundwater level measurements from both observation and supply wells are uploaded to the DWR CASGEM database.

The CASGEM program was intended specifically to serve the purpose that is now required of the groundwater elevation monitoring network under SGMA. As such, the CASGEM network is the foundation and basis for the GSP groundwater elevation monitoring network described herein. After incorporating the CASGEM network into the GSP groundwater elevation monitoring network, no future CASGEM reporting will be necessary, as groundwater level reporting will take place during GSP implementation for SGMA compliance. All groundwater elevation data will continue to be collected by the local agencies and DWR for consistency with previous CASGEM efforts and will be reported to DWR through the monitoring module of the SGMA GSP upload tool. An assessment of well access agreements and coordination with DWR will be developed during the early years of GSP Implementation to transition between the 2 monitoring programs as described in Section 8 – Plan Implementation.

The CASGEM well network in the Corning Subbasin included 144 total monitoring wells as of February 17, 2020. Of these wells, 50 have either been decommissioned or have not been routinely monitored in the past 12 years and therefore are assumed to no longer be accessible for monitoring in the future. 4 new wells were installed recently as part of a multi-level well cluster by Glenn County using a TSS grant. Consequently, there are 98 monitoring wells used to develop the GSP groundwater level monitoring network, as discussed below.

5.2.2 GSP Groundwater Level Monitoring Network

The GSP groundwater level monitoring network was used to assess historical groundwater level data in the Subbasin and to select representative monitoring locations for comparison to groundwater level SMC. The 98 wells in the GSP groundwater level monitoring network have been routinely monitored since 2012 and are generally gauged for groundwater levels on at least a semi-annual frequency. The GSP groundwater level monitoring wells are shown on Figure 5-1 and summarized in Table 5-1. The detailed well installation information including well name, type, depth, screen interval (if known), and surveyed location is summarized in Appendix 5B. For the purpose of this section, all well types listed in the appendix and tables are referred to herein as "monitoring wells." As DWR is working on updating their well access agreements and refining monitoring networks, the GSAs will coordinate to update well information and refine the groundwater level monitoring network over the next 5 years if needed.

Table 5-1. GSP Groundwater Level Monitoring Wells.

GSP Monitoring Well Type	Total Wells	Wells with Known Screen Interval	Average Screen Length (feet)	Minimum Screen Depth (feet bgs)	Minimum Well Depth (feet bgs)	Average Well Depth (feet bgs)	Maximum Well Depth (feet bgs)
Domestic	18	14	30	40	68	153	270
Agricultural	37	27	261	12	90	326	1,350
Observation	41	41	55	25	71	501	1,204
Industrial	2	2	20	70	100	120	140
GSP Monitoring Well Sum	**98**	**84**					

feet bgs = feet below ground surface

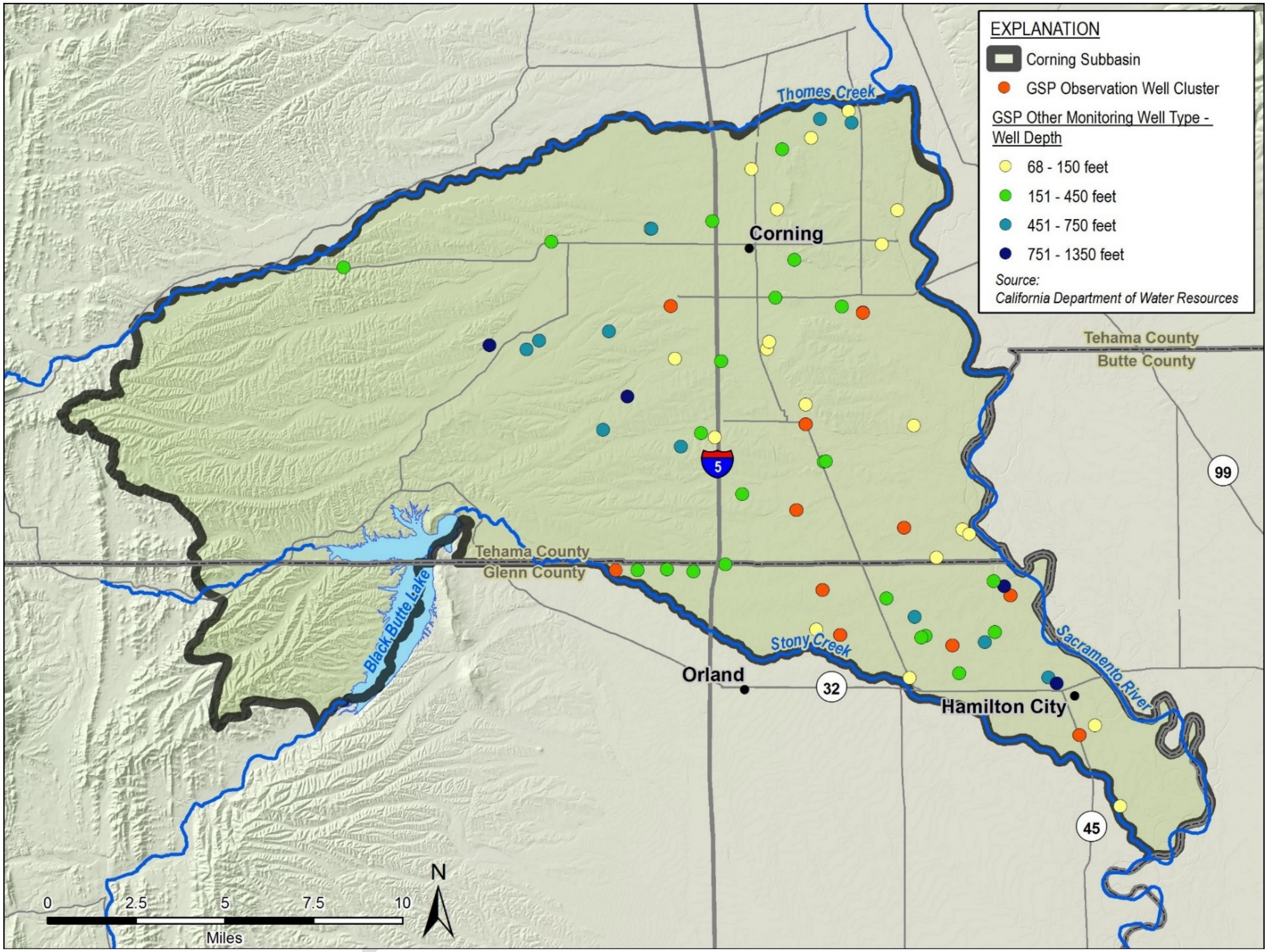

Figure 5-1. GSP Groundwater Level Monitoring Network

The following provides a summary of these 2 main types of wells in the GSP groundwater level monitoring network:

- There are 41 observation wells installed in 11 clusters in the Subbasin. 6 clusters are in Glenn County, and 5 are in Tehama County. Each of the well clusters consists of 2 to 5 wells installed in close proximity with screens at different discrete depths of the aquifer. The purpose of this configuration is to allow for the assessment of variations in groundwater trends at various depths over time. This data can be used to make inferences about hydrogeologic connection and water use at various depths of the aquifer. Cluster wells can also be used to calculate the vertical groundwater head gradients, which indicate the upward or downward direction of groundwater flow over time in that location. The 11 clusters were installed under the direction of DWR between 2003 and 2011. The observation well depths range from 68 to 1,204 feet and were constructed with screen intervals ranging from 10 to 276 feet in length. About half of the observation well screen intervals are 20 feet or less.

- The remaining 57 wells in the GSP monitoring network were installed for water supply purposes but also provide access for groundwater level measurement. These wells were or are currently used as production wells for agricultural (irrigation and stock watering), domestic, or industrial purposes. Well owners have voluntarily provided DWR and/or County representatives access to measure groundwater levels in these wells. Since production wells are installed for groundwater extraction, their well design is different than that of typical dedicated observation wells. In general, production well screens cover greater intervals of the aquifer than do observation wells. Production wells also typically contain dedicated pumps that may impede groundwater level measurement access or may be in use when the GSAs intend to gauge or sample the wells.

5.2.3 Additional Monitoring Well Locations

Several new monitoring wells were in the process of being added to the groundwater level monitoring network during preparation of this GSP. Glenn County received a Technical Support Services (TSS) Grant from DWR to install a new cluster of observation wells at the border of Glenn and Tehama Counties west of Interstate 5 and north of Stony Creek. This cluster of 4 observation wells was installed in February 2021 with discrete screen intervals at depths ranging from 40 to 700 feet below ground surface (bgs).

[Note: additional TSS wells may be included in the Tehama County portion of the Subbasin – we will include more detail here as it becomes available]

5.2.4 Representative Monitoring Network for Groundwater Levels

According to §354.36 of the GSP regulations and DWR BMP for Monitoring Networks and Identification of Data Gaps (DWR, 2016b), Representative Monitoring Points [RMP(s)] may be selected to consolidate reporting of quantitative observations of the sustainability indicators as long as the RMP reflects general conditions in the area. A total of 56 RMP wells representative of general conditions in the Subbasin were identified for establishing SMC. These wells and SMCs will be used during the GSP implementation phase to evaluate sustainability.

The RMP wells were divided into subsets of shallow zone wells and deep zone wells to check the representativeness of the network at various depths of the aquifer. A depth of 450 feet bgs was selected as the distinction between shallow and deep RMP wells, based on historical convention of the Northern Sacramento Valley groundwater elevation mapping, and the depth of most domestic wells in the Subbasin. Of domestic wells in the subbasin, 99% have well depths that are 450 feet or less below ground surface. Of production wells in the subbasin, 81% have well depths that are 450 feet or less below ground surface, while 19% have well depths that are greater than 450 feet below ground surface. The deepest production well in the subbasin has a well depth of 1,320 feet below ground surface.

The shallow zone RMP well network includes 36 wells with screening intervals that are entirely less than 450 feet bgs, and the deep zone includes 20 wells with screening intervals that include depths greater than 450 feet bgs. Seven of these deep zone wells have a top of screen interval less than 450 feet bgs, and 2 have a well depth greater than 450 feet but an unknown screening interval.

The RMP well network is a subset of the CASGEM wells that are currently monitored by DWR and were identified as the initial GSP monitoring network during GSP implementation. The RMP network was refined using the following rationale:

- Two locations were added to the RMP network that were recently installed or added to the GSP monitoring network as discussed in Section 5.2.3.
- Twelve GSP monitoring wells did not have well screen information. Six of these wells were installed near other representative wells that had similar groundwater level trends so were removed from the RMP well network. Six wells without screen interval information were retained in the RMP well network, as they were installed in locations that did not have enough lateral coverage within the rest of the network to justify exclusion. Obtaining the well screen information for these 6 locations is considered a data gap to be addressed during GSP implementation as discussed in Section 5.2.6.
- Twelve additional voluntary GSP monitoring network wells were installed in a similar location and depth as another representative well; therefore, these wells were removed from the RMP well network.

- Nineteen of the 41 GSP observation cluster wells were not included in the RMP well network as the groundwater level trends matched closely with other wells in the cluster. As such, 22 total wells were selected for the shallow and deep RMP networks from the 11 observation well clusters in the Subbasin.

Table 5-2 summarizes the well location data for the RMP monitoring wells. Figure 5-2 shows the locations of wells in the shallow RMP network, and Figure 5-3 shows the location of wells in the deep RMP network. Hydrographs showing groundwater elevations over time, well locations, surveyed elevations, and well screen information are included for each well in Appendix 5B (well information) and Appendix 5C (hydrographs). The RMP well network will be reviewed during each future 5-year update to fill data gaps, assess well conditions, and add or remove wells based on GSP monitoring needs. New wells can also be added during annual reports if they become available and deemed appropriate for GSP monitoring.

Table 5-2. Groundwater Level RMP Well Summary Data

RMP Network	State Well Number	Well Type	Total Well Depth (feet bgs)	Perforated Interval (feet bgs)	Latitude (NAD 83)	Longitude (NAD 83)	Reference Point Elevation (feet AMSL)
Shallow	21N01W04N001M	Domestic	100	--	39.69710	-121.98930	137.68
Shallow	22N01W19E003M	Irrigation	500	80 - 400	39.75002	-122.02669	157.79
Shallow	22N01W29N003M	Observation	400	189 - 380	39.72627	-122.01052	149.99
Shallow	22N02W01N003M	Observation	440	210 - 370	39.78356	-122.04614	161.50
Shallow	22N02W15C004M	Observation	258	210 - 220	39.76344	-122.07716	192.25
Shallow	22N02W18C003M	Observation	188	165 - 175	39.76820	-122.13645	225.54
Shallow	22N03W01R002M	Observation	314	270 - 280	39.78662	-122.14552	228.53
Shallow	22N03W05F002M	Irrigation	218	188 - 218	39.79560	-122.22780	298.89
Shallow	22N03W06B001M	Domestic	210	195 - 210	39.79527	-122.24339	309.90
Shallow	22N03W12Q003M	Domestic	124	112 - 123	39.77050	-122.14910	232.94
Shallow	23N02W16B001M	Irrigation	120	100 - 120	39.85339	-122.09629	186.53
Shallow	23N02W28N004M	Observation	205	100 - 170	39.81167	-122.10200	204.43
Shallow	23N02W34A003M	Irrigation	125	104 - 124	39.81079	-122.07105	171.01
Shallow	23N02W34N001M	Industrial	100	70 - 100	39.79930	-122.08500	185.92
Shallow	23N03W04H001M	Irrigation	270	200 - 270	39.88039	-122.19808	261.90
Shallow	23N03W13C006M	Observation	182	95 - 135	39.85430	-122.15350	215.59
Shallow	23N03W16H001M	Domestic	150	144 - 150	39.84932	-122.20168	278.08
Shallow	23N03W22Q001M	Irrigation	380	--	39.82597	-122.18757	235.97
Shallow	23N03W24A003M	Domestic	199	180 - 199	39.83915	-122.14301	207.44
Shallow	23N03W25M004M	Observation	155	120 - 130	39.81925	-122.15900	237.40
Shallow	24N02W17A001M	Domestic	140	120 - 140	39.94124	-122.10400	212.20
Shallow	24N02W20B001M	Domestic	120	100 - 120	39.92745	-122.11234	223.43
Shallow	24N02W29N003M	Observation	388	200 - 290	39.89962	-122.12275	213.76
Shallow	24N03W02R001M	Domestic	270	--	39.96665	-122.16465	257.95
Shallow	24N03W03R002M	Domestic	132	112 - 132	39.95860	-122.18120	279.46
Shallow	24N03W14B001M	Industrial	140	130 - 140	39.94214	-122.16762	294.05

RMP Network	State Well Number	Well Type	Total Well Depth (feet bgs)	Perforated Interval (feet bgs)	Latitude (NAD 83)	Longitude (NAD 83)	Reference Point Elevation (feet AMSL)
Shallow	24N03W16A001M	Irrigation	195	85 - 195	39.93760	-122.20210	290.97
Shallow	24N03W17M001M	Domestic	108	100 - 108	39.93460	-122.23490	316.48
Shallow	24N03W24E001M	Domestic	224	212 - 220	39.92147	-122.15879	298.45
Shallow	24N03W26K001M	Irrigation	245	103 - 175	39.90609	-122.16893	283.46
Shallow	24N03W29Q001M	Observation	372	130 - 360	39.90305	-122.22456	316.18
Shallow	24N03W35P005M	Domestic	120	100 - 120	39.88510	-122.17370	251.46
Shallow	24N04W14N002M	Domestic	180	--	39.92972	-122.28761	375.52
Shallow	25N02W31G002M	Irrigation	115	93 - 113	39.98198	-122.12937	223.80
Shallow	24N05W23L001M	Stock	235	TBD	39.91976	-122.397837	TBD
Shallow	Glenn TSS Well	Observation	TBD	TBD	39.79549	-122.25500	TBD
Deep	22N01W29N002M	Observation	670	549 - 641	39.72627	-122.01052	150.68
Deep	22N02W01N002M	Observation	730	700 - 710	39.78356	-122.04614	161.31
Deep	22N02W15C002M	Observation	825	760 - 781	39.76342	-122.07717	192.37
Deep	22N02W18C001M	Observation	1062	841 - 1029	39.76820	-122.13645	224.64
Deep	22N03W01R001M	Observation	515	470 - 480	39.78662	-122.14550	228.17
Deep	23N02W28N002M	Observation	580	550 - 570	39.81170	-122.10200	204.37
Deep	23N03W07F001M	Irrigation	790	240 - 790	39.86618	-122.24796	314.40
Deep	23N03W13C004M	Observation	835	815 - 825	39.85430	-122.15350	215.88
Deep	23N03W17R001M	Irrigation	720	360 - 720	39.84559	-122.21995	302.50
Deep	23N03W25M002M	Observation	513	470 - 500	39.81925	-122.15900	237.68
Deep	23N04W13G001M	Irrigation	560	--	39.85270	-122.26100	360.71
Deep	24N02W29N004M	Observation	741	590 - 710	39.89960	-122.12270	213.45
Deep	24N03W17M002M	Irrigation	505	315 - 495	39.93458	-122.23443	316.80
Deep	24N03W29Q002M	Observation	575	490 - 550	39.90305	-122.22456	315.76
Deep	24N04W33P001M	Irrigation	780	250 - 780	39.88760	-122.32070	424.56
Deep	24N04W34K001M	Irrigation	750	310 - 750	39.88933	-122.29434	421.50
Deep	24N04W34P001M	Irrigation	535	290 - 475	39.88578	-122.30107	440.10
Deep	24N04W36G001M	Irrigation	750	320 - 750	39.89290	-122.25731	362.20
Deep	25N03W36H001M	Irrigation	524	--	39.97888	-122.14458	241.00
Deep	Glenn TSS Well	Observation	TBD	TBD	39.79549	-122.25500	TBD

TBD = to be determined

-- = not available

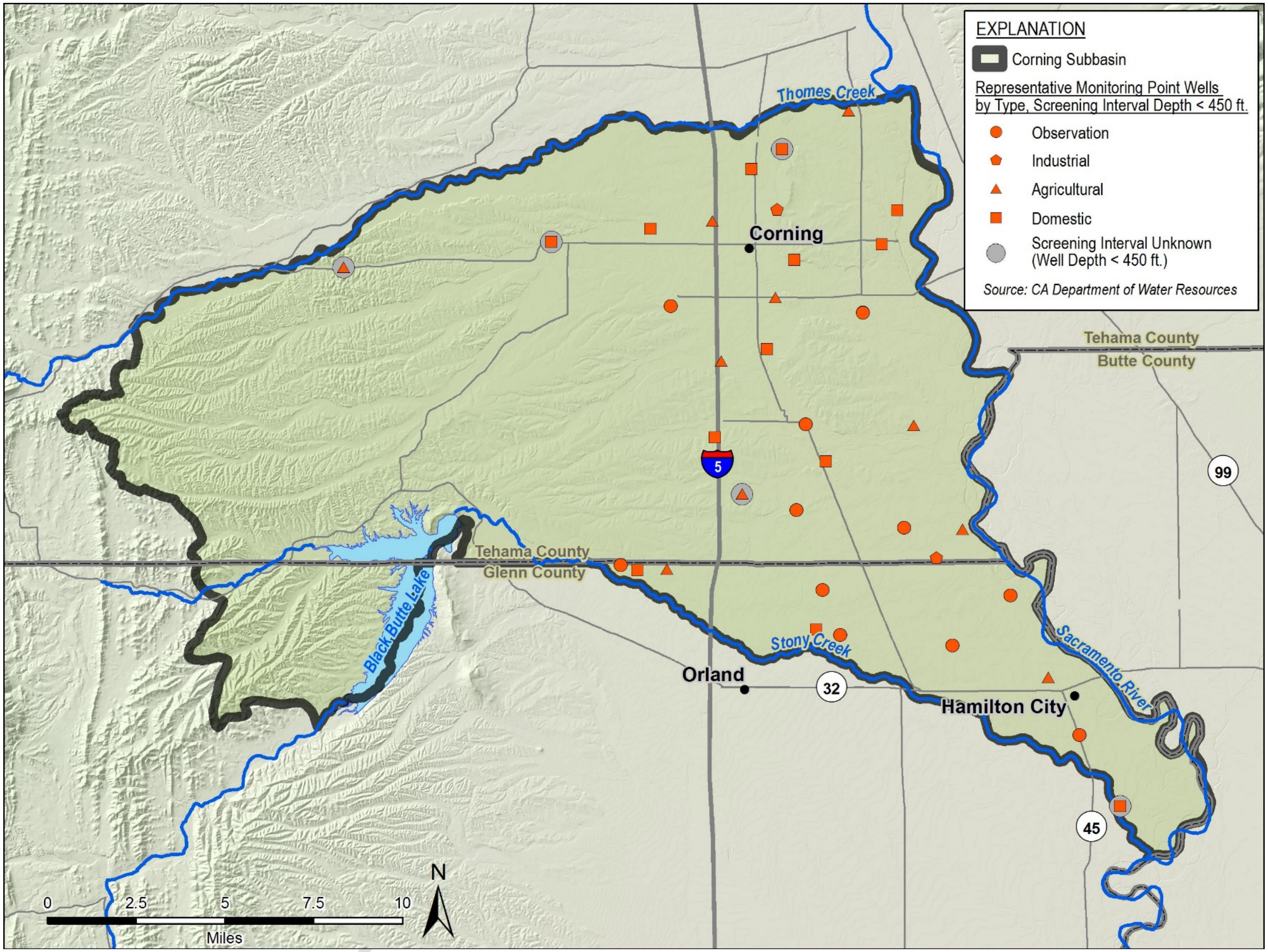

Figure 5-2. Shallow Groundwater RMP Well Locations (less than 450 feet deep)

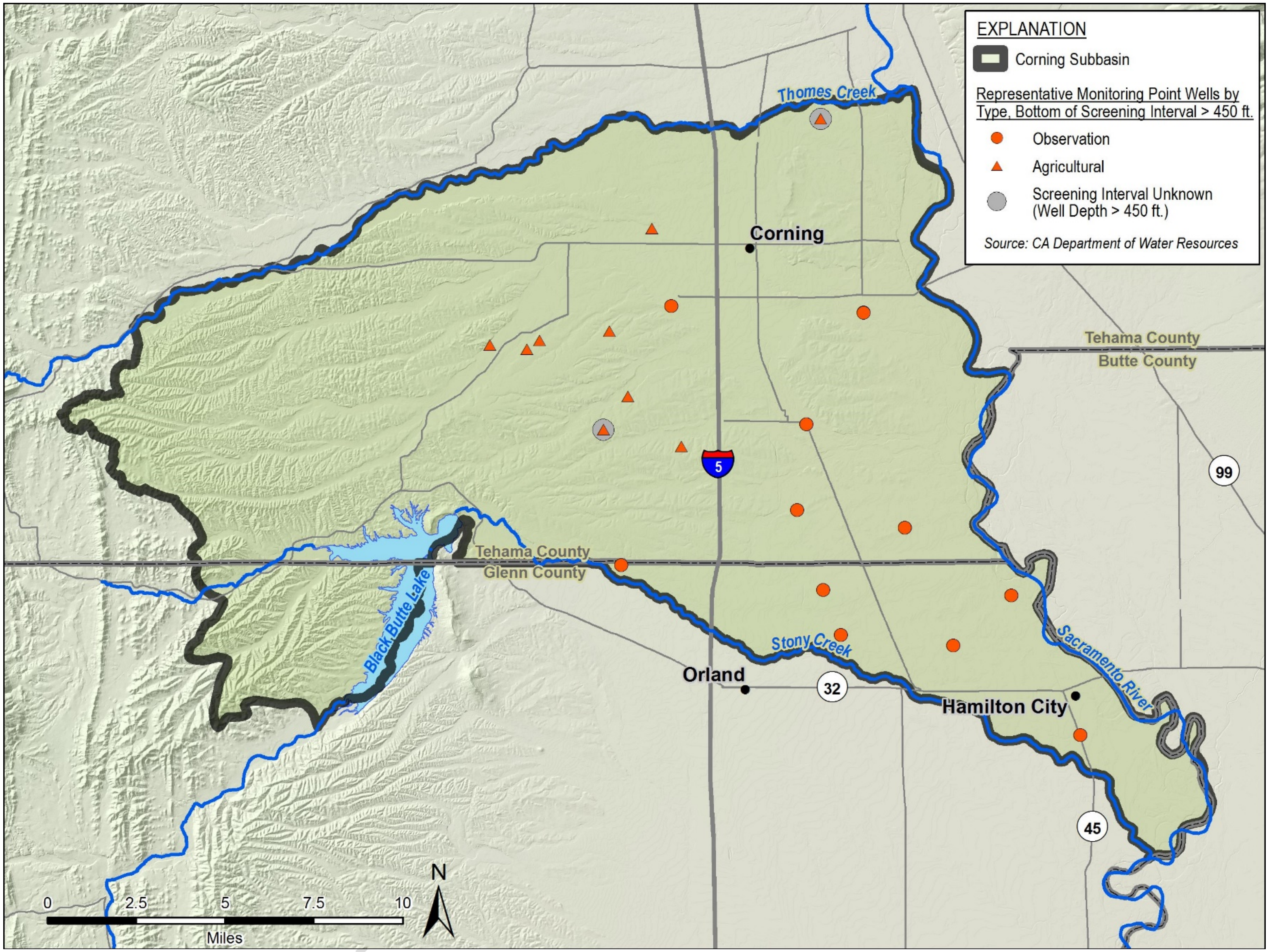

Figure 5-3. Deep Groundwater RMP Well Locations (greater than 450 feet deep)

5.2.5 Groundwater Level Monitoring Protocols

Groundwater level monitoring will be conducted by the GSAs or their designated entities as described in the Implementation Section 8. Manual groundwater level measurements will be collected periodically in each well using an electronic sounder or steel tape. Electronic sounders consist of a graduated wire equipped with a weighted electric sensor. When the sensor is lowered into water, a circuit is completed and an audible beep is produced, at which point the sampler will record the depth to groundwater. This is the preferred method for monitoring water levels in the Subbasin, but other methods may be used. For instance, some production wells may have lubricating oil floating on top of the water column; oil and groundwater levels in these well will be gauged with an oil water interface probe or steel tape with oil and water indicator paste.

All manual groundwater level measurements in the Subbasin wells will abide by the following protocols:

- Equipment usage will follow manufacturer specifications for procedure and maintenance.
- In wells that have been subjected to recent pumping (within a few days of measurement), a measurement will be taken after pumping has ceased and the groundwater level has recovered to a stable level. If a well pump cannot be turned off during the scheduled monitoring event, then a measurement will be collected if possible, and accompanied by an explanatory note.
- For each well, multiple measurements will be collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.
- Equipment will be thoroughly cleaned after measurements at each well location in order to prevent cross-contamination among wells.
- The groundwater level measurement will be collected from a permanent reference mark. If a well is found to not have a permanent reference mark, one will be made on the north side of the casing to ensure subsequent measurements reference the same point.

The observation wells in the Subbasin are equipped with pressure transducers capable of collecting more frequent data than is collected using manual measurements. It is the intention of the GSAs or cooperating agencies to continue to equip the observation wells with pressure transducers; however, in the event of device failure, or lack of funding, at a minimum, seasonal manual measurements will be taken. Installation and use of pressure transducers for groundwater level measurements will follow the protocol below:

- In order to calibrate the transducer data a groundwater level measurement device such as an electronic sounder or steel tape will be used to measure the current groundwater level prior to installation of the probe. The groundwater level will be measured following the protocols listed above.

- All transducer installations will follow manufacturer specifications for installation and calibration. The time on the transducer internal clock will be synchronized with the computer satellite time.
- The well identification (or ID), transducer identification, transducer range, transducer accuracy, and cable serial number will be recorded in any log or datasheet used to document measurements.
- The type of pressure transducer (vented or non-vented) will be noted for barometric compensation needs. If non-vented units are used, data will be corrected for natural barometric pressure changes using a barometric pressure logger or if unavailable, weather station data.
- All transducer cables will be secured to the well head with a well dock or another reliable method. This cable will be marked at the elevation of the reference point to allow estimates of future cable slippage (as needed).
- Transducer data will be periodically checked against hand measured groundwater levels to monitor electronic drift, highlight cable movement, and ensure the transducer is operating correctly. These checks will occur at least annually, typically during routine site visits.
- Transducer data will be downloaded when water levels are measured, on a semi-annual basis. Transducer data will be entered into the data management system (DMS) as soon as possible. Once the transducer data has been successfully downloaded and stored, the data will be deleted or overwritten to ensure adequate data logger memory.
- Desiccant for vented transducers will be replaced as needed, or at least annually, in order to prevent failure of the transducers. Non-vented transducers do not require routine maintenance.

5.2.6 Groundwater Level Monitoring Data Gaps

The GSP regulations allow the GSP to use existing monitoring sites for the monitoring network. Wells used for monitoring, however, are limited by restrictions in §352.4(c) of the GSP regulations which requires GSAs to provide specific information for any well used as a monitoring well, including construction information, such as well perforation intervals. According to §352.4(c)(2), if an Agency relies on wells that lack information on casing perforations, borehole depth, or total well depth to monitor groundwater conditions for the GSP, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information or demonstrate to DWR that such information is not necessary to understand and manage groundwater in the basin. The well depth is known for each well used in the monitoring network; however, for 14 of the 98 total wells, well screen intervals are unknown, as shown in Table 5-1. Since there is only one principal aquifer in the Subbasin, the lack of well screen data for some groundwater level monitoring wells does not preclude these wells from being used to understand and manage groundwater in the basin. The lack of well screen data for some of the monitoring wells is a data gap of lesser importance for understanding groundwater conditions and will be addressed through video logging of wells with unknown screen intervals, as described in the Plan Implementation section of the GSP.

A visual analysis of data gaps in the existing groundwater level monitoring network was performed using the Monitoring Network and Identification of Data Gaps BMP (DWR, 2016a). While there is no definitive requirement regarding monitoring well density, the BMP cites several studies that recommend 0.2 to 10 wells per 100 square miles (Heath, 1976; Sophocleous, 1983; Hopkins, 1984). The BMP notes that professional judgement should be used to design a monitoring network that accounts for high-pumping areas, proposed projects, and other subbasin-specific factors.

The Corning Subbasin encompasses approximately 323 square miles. Applying the BMP guidance to the Subbasin as a whole, the well network for groundwater level measurement should consist of up to 30 wells at approximately even spatial distribution. The GSP groundwater level monitoring network consists of 98 wells in 67 unique locations, as some wells are installed in clusters at different depths. The RMP network consists of 56 wells, 36 of which are in the shallow portion of the aquifer and 20 of which are in the deep portion of the aquifer. The wells are spatially distributed relatively evenly throughout the eastern two-thirds of the Subbasin, where groundwater use is the highest in the Subbasin, both on the horizontal and vertical plane, as shown on Figure 5-1. In summary, there is adequate spatial coverage with the current monitoring well network to measure groundwater level fluctuations in the vast majority of the Subbasin.

There are a few localized spatial data gaps shown on Figure 5-4 and Figure 5-5, where monitoring wells at one or more depths could be used to help further refine the understanding of groundwater conditions in areas of high groundwater use. These data gaps are noted along the Sacramento River to the southeast of Corning, near Thomes Creek to the northeast of Corning, and in the western one-third of the Subbasin in the limited areas where land is used for agriculture. The generalized locations for new wells were selected to provide adequate data for the following objectives listed in the Monitoring Network BMP:

- Produce seasonal water elevation maps
- Map groundwater depressions and recharge areas
- Estimate change in groundwater storage
- Demonstrate conditions at Subbasin boundaries

The proposed wells could also be used to aid in the evaluation of groundwater and surface water interaction as discussed in Section 4.6.3. The data gap areas shown on Figure 5-4 and Figure 5-5 will be addressed in the future for each area by either identifying an existing well that meets the criteria for a valid monitoring well or drilling a new well, as further described in the Plan Implementation summary. As noted in Section 2.3 and 2.4 of the Plan Area, and shown on Figure 5-4 and Figure 5-5, large portions of the western one-third of the Subbasin are open grassland or shrubland with very minimal groundwater pumping; therefore, measuring groundwater levels in some of these areas is not considered a data gap for the GSP. If land use changes in the future, the monitoring network will be re-assessed to add more wells in this area as needed.

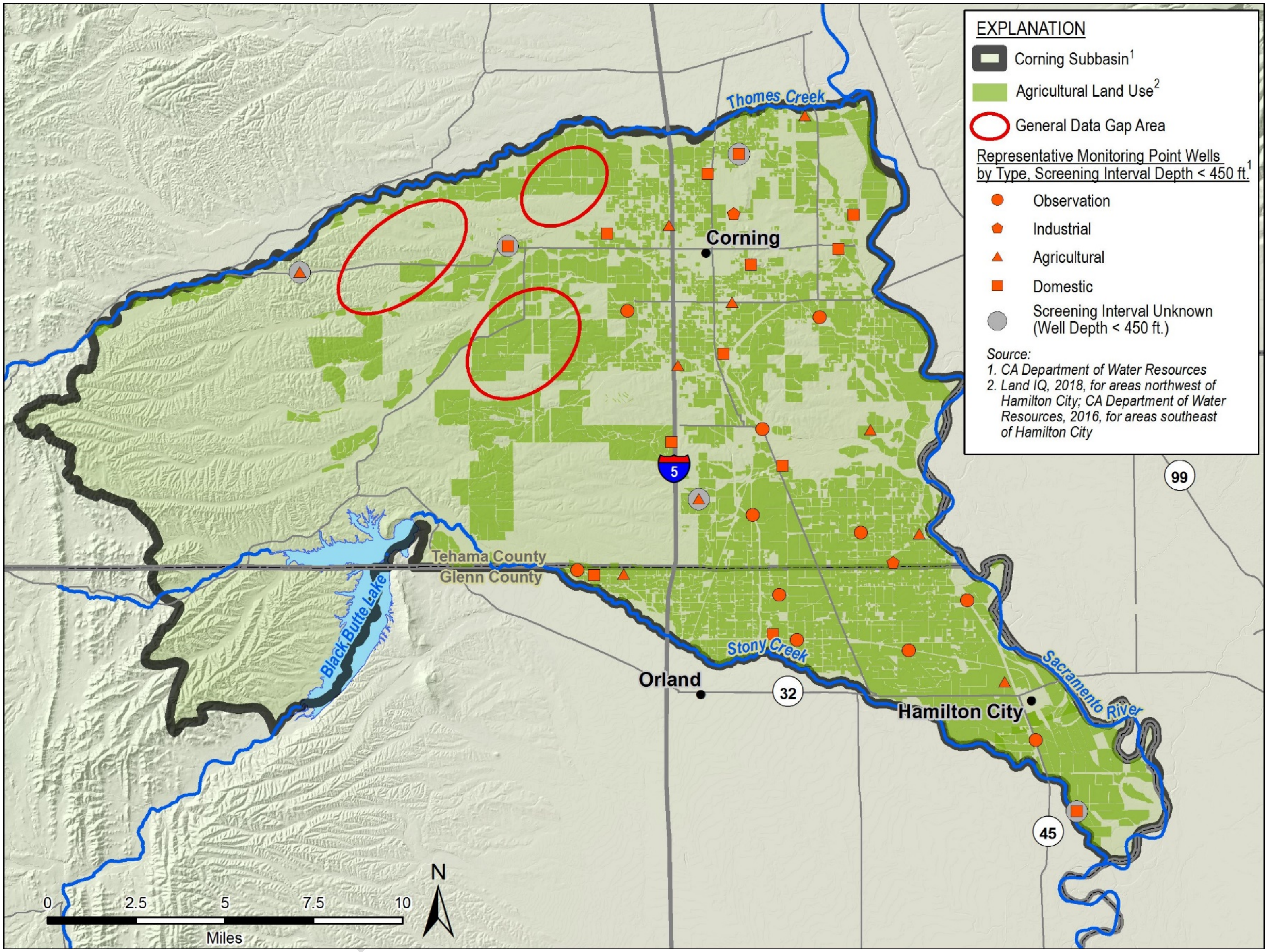

Figure 5-4. Potential Shallow Groundwater RMP Data Gaps

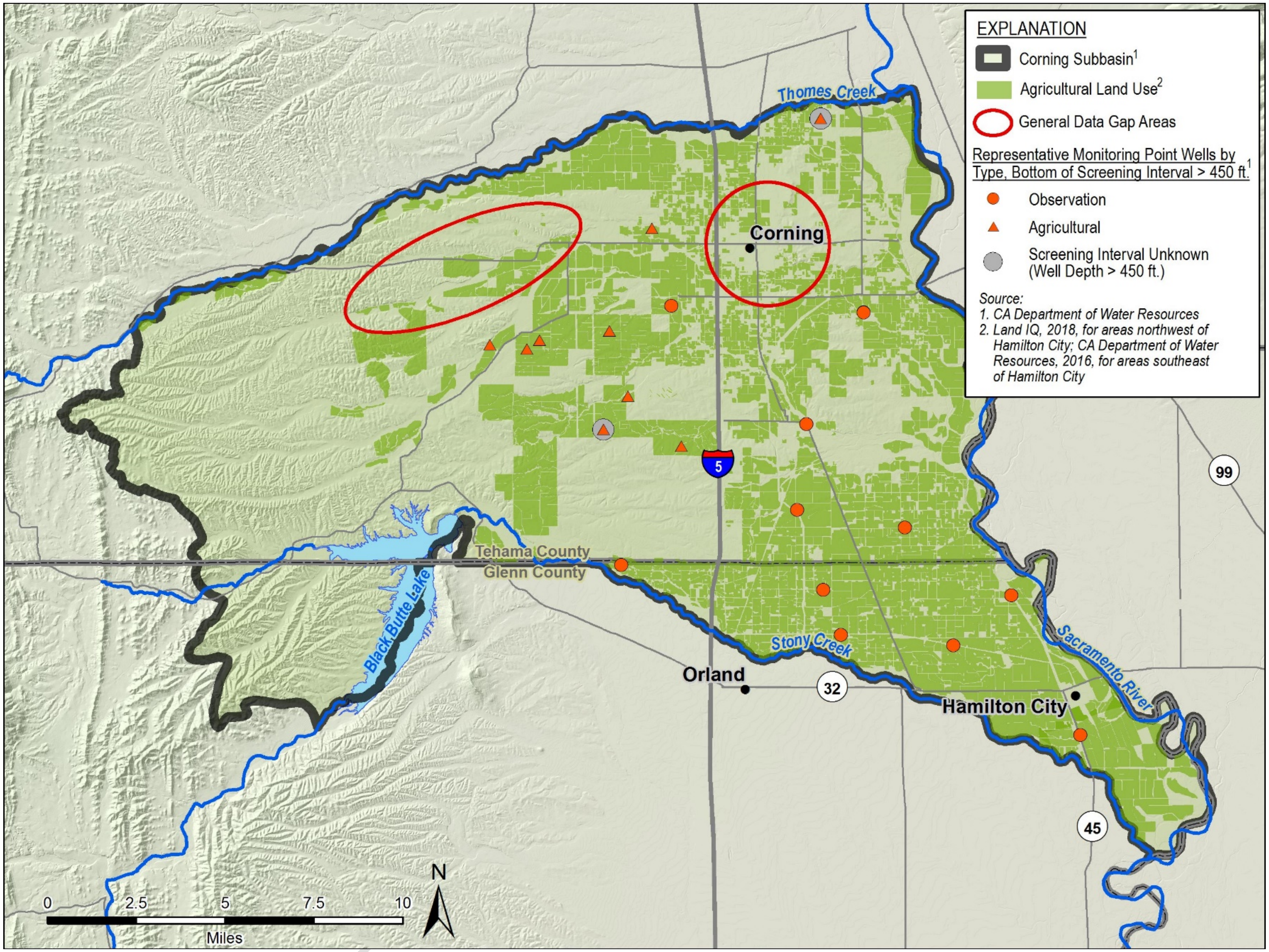

Figure 5-5. Potential Deep Groundwater RMP Data Gaps

5.3 Groundwater Storage Monitoring Network

Per the GSP Regulations, the quantitative metric for reduction of groundwater in storage is the amount of total annual groundwater pumping that can be withdrawn. However, there are different ways to establish and calculate the appropriate metric:

1) Calculating the annual change in storage directly:

   For example: Using groundwater elevation data from the monitoring network, then developing contour maps to calculate the annual change in storage by assuming a storage coefficient and aquifer thickness.

2) Calculating the annual pumped water and comparing it to the sustainable yield:

   This method has a high degree of uncertainty, as only public water supplier is currently reporting metered usage. The GSAs would need to estimate an approximate amount of pumping for agricultural wells based on estimated demand by crop, and domestic wells based on per capita use.

Since change in storage is directly correlated to the change in annual groundwater levels in the Subbasin, using groundwater elevation data from the monitoring network as a proxy allows the GSAs to estimate changes in groundwater in storage. If groundwater levels decline, groundwater in storage decreases, and if groundwater levels increase, storage increases. This method for estimating storage change using groundwater levels as a proxy allows the GSAs to estimate the necessary data to meet GSP Regulations without having to develop a metering program at this time.

5.3.1 Groundwater Storage Monitoring Locations

Groundwater storage changes in the Subbasin will be measured or estimated using the same groundwater elevation RMP network described in Section 5.2.4. Annual data will be reviewed, and contour maps of equal groundwater elevation will be developed as described in Section 6. The density of monitoring sites and frequency of measurements required from these sources will enable the GSAs to demonstrate short-term, seasonal, and long-term trends.

5.3.2 Groundwater Storage Monitoring Protocols

Monitoring change in groundwater storage due to groundwater pumping will be accomplished using existing monitoring protocols for the groundwater level monitoring network.

5.3.3 Groundwater Storage Monitoring Data Gaps

The same data gaps identified for the groundwater level monitoring network apply for the groundwater storage monitoring network.

5.4 Land Subsidence Monitoring Network

The sustainability indicator for land subsidence is evaluated by monitoring land deformation using survey monuments, extensometers, or InSAR data. As described in Section 3.2.5, land subsidence in the Subbasin has been measured historically by each of these 3 methods. Available data indicate that little to no inelastic subsidence has occurred in the Subbasin during the past 2 decades.

5.4.1 Land Subsidence Monitoring Locations

There are 3 different land subsidence monitoring networks available for use in the Subbasin:

- InSAR land surface elevation data used to measure subsidence is collected monthly by satellite for the entire State. The dataset is currently compiled and provided by DWR on their publicly available SGMA Data Viewer web map[1] approximately on an annual basis.
- Twenty land surface elevation survey monuments in the Subbasin were installed and surveyed for the Sacramento Valley Height-Modernization Project, through a collaborative effort by DWR, USBR, and county and local agency representatives. The subsidence monuments were surveyed throughout the Northern Sacramento Valley in 2008 and 2017, providing a baseline and single value for land surface elevation change (DWR, 2018). Measurements were also collected at the Glenn County locations in 2004 and at a subset of the Glenn County locations in 2015 as discussed in Section 3.2.5.1. Survey monuments are planned to be surveyed by DWR every 5 years moving forward. Since the last survey event was in 2017, the next planned event is in 2022. This will allow for a five-year comparison of land surface deformations at these monuments. Data will be made available by DWR for public download.
- Subsidence and water levels have been measured and downloaded by DWR for one extensometer in the Subbasin on an approximately quarterly schedule from 2004 to 2019. This extensometer well (22N02W15C002M) was installed with a screen from 759 to 780 feet bgs; therefore, the extensometer measures expansion and compression of the Quaternary alluvium and Tehama/Tuscan Formation aquifer systems above this depth at this location (Davids Engineering, 2018). Downloaded data is uploaded to the DWR Water Data Library approximately on a quarterly schedule.

[1] https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub

During GSP implementation, the GSAs will continue to assess subsidence using each of these 3 available data sources. The InSAR surveys are done by satellite and are made available by DWR at no cost. There is no local monitoring needed for this network; however, data may need to be analyzed at a local level. Locations of the subsidence monuments and extensometer installed in the Subbasin are summarized in Table 5-3 and shown on Figure 5-6. For recent subsidence monument surveys, local agencies supply staff (in-kind) to conduct the monitoring and DWR provides supplies and leads the project. DWR has been responsible for monitoring the extensometer in the Subbasin.

Table 5-3. Subsidence Monitoring Network Locations

Monument ID	Monument Type	Latitude (NAD 83)	Longitude (NAD 83)
K276	Survey benchmark	39.85597	-122.35743
CORN	Survey benchmark	39.92219	-122.35569
BUTG	Survey benchmark	39.81924	-122.32766
EUCA	Survey benchmark	39.89180	-122.30629
Q106	Survey benchmark	39.93041	-122.29194
LBRL	Survey benchmark	39.88271	-122.22991
02CJ	Survey benchmark	39.90712	-122.21400
BRHM	Survey benchmark	39.95738	-122.20616
MICH	Survey benchmark	39.90685	-122.11628
SRGS	Survey benchmark	39.83735	-122.19917
N852	Survey benchmark	39.81094	-122.17439
2966	Survey benchmark	39.79196	-122.22757
ORLA	Survey benchmark	39.76937	-122.19439
CAPA	Survey benchmark	39.78291	-122.10560
VIOL	Survey benchmark	39.76765	-122.07905
271F	Survey benchmark	39.83481	-122.08764
PMPR	Survey benchmark	39.78589	-122.04759
HAMI	Survey benchmark	39.74611	-122.02140
WILD	Survey benchmark	39.71467	-121.96672
CREE	Survey benchmark	39.73198	-122.41428
22N02W15C002M	Extensometer	39.76351	-122.07728

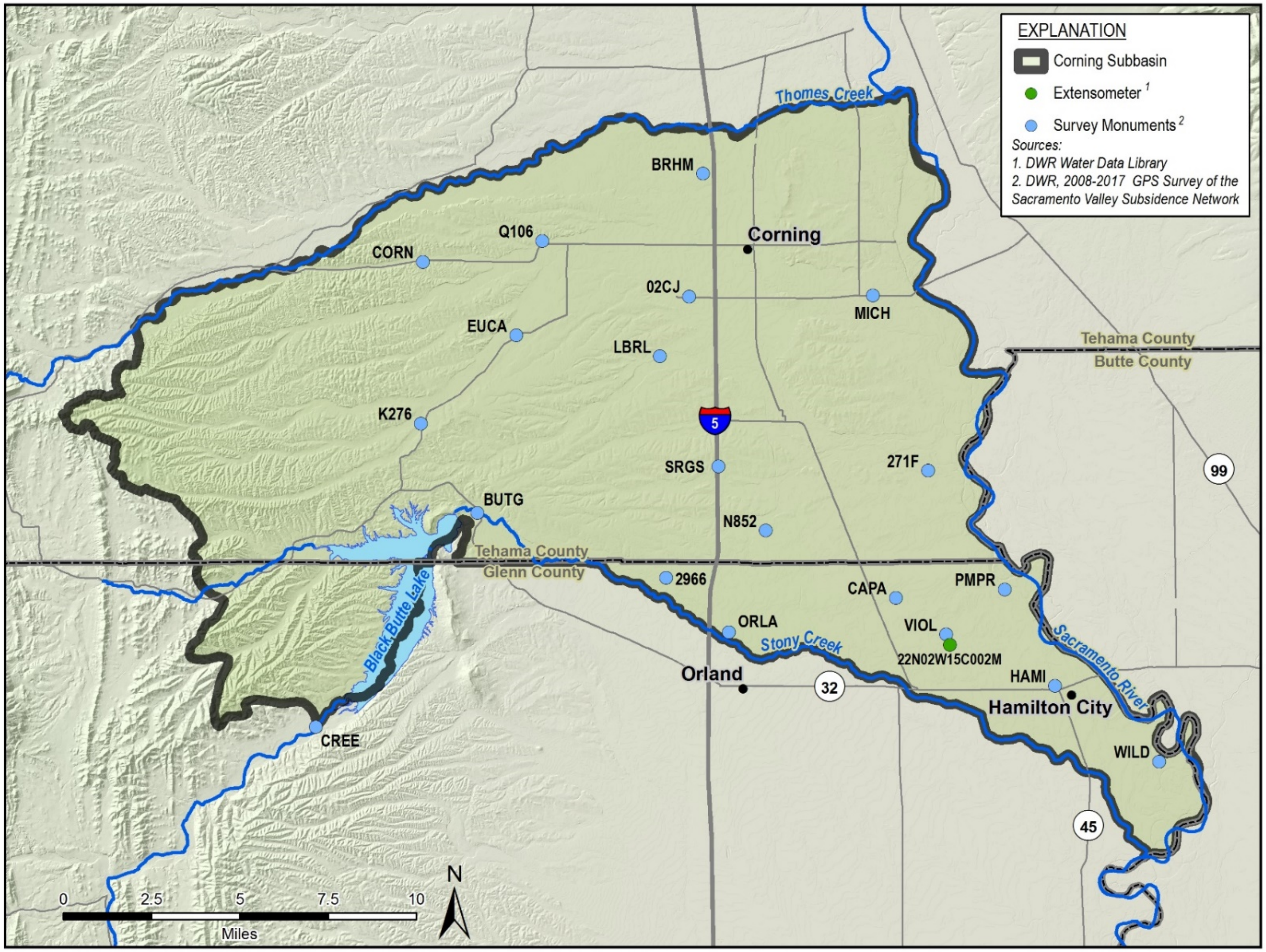

Figure 5-6. Subsidence Monitoring Network

5.4.2 Land Subsidence Monitoring Protocols

The GSAs will rely on the DWR to continue updating the 3 publicly available subsidence datasets that were used to develop this GSP. The GSAs assume that the DWR will follow the protocols available on SGMA Data Viewer and in the 2018 DWR subsidence survey report (DWR, 2018), provided in Appendix 5D.

5.4.3 Land Subsidence Monitoring Data Gaps

There are no spatial data gaps in the subsidence monitoring network. InSAR measurements are collected across the entire Subbasin. The permanent subsidence monument network is dispersed relatively evenly throughout the portions of the Subbasin used for groundwater pumping and most prone to inelastic subsidence. These survey monuments will be used to ground truth InSAR subsidence measurements should the InSAR surveys indicate that land subsidence is occurring in the Subbasin. The most recent DWR subsidence survey report recommended that the monument be surveyed every 5 years; the next DWR survey is expected to occur in 2022 (DWR, 2018). The extensometer will continue to be monitored by DWR as a physical line of evidence for elastic or inelastic ground surface deformation in response to groundwater level changes in the aquifer.

There are no data gaps identified for the land subsidence sustainability indicator at this time, since existing data sources provide sufficient information at a scale that is appropriate for the GSP implementation.

5.5 Groundwater Quality Monitoring Network

The sustainability indicator for degraded groundwater quality is evaluated by collecting and analyzing samples from a network of groundwater quality monitoring wells. The GSP Regulations require sufficient spatial and temporal data to determine groundwater quality trends and to address known groundwater quality issues. Existing groundwater quality monitoring programs in the Subbasin are described in Section 2 - Plan Area, and groundwater quality distribution and trends are described in the Section 3.2 - Groundwater Conditions. Constituents of concern were identified in Section 3 based on an evaluation of constituents in the Subbasin relative to drinking water standards. There are no regionally extensive point-source contaminant plumes in the GSP area. As such, the selected monitoring network is intended to monitor non-point source pollution and naturally occurring groundwater quality concerns.

5.5.1 Groundwater Quality Monitoring Locations

The existing active groundwater quality monitoring networks in the Subbasin used for the GSP monitoring network include the following:

- Drinking water quality is monitored in water supply wells per Title 22 of the California Code of Regulations (CCR). The State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) oversees monitoring of public water supply systems that serve more than 200 service connections. Smaller systems are overseen by the Tehama County Environmental Health Department and Glenn County Environmental Health Department.
- Sporadic ambient groundwater quality data have been collected by DWR in the observation well clusters in the Subbasin since 2005. The data, which are publicly available through the SWRCB Geotracker/GAMA database, were not collected as part of a specific regulatory program. Currently, DWR halted this groundwater quality monitoring program and is re-assessing the need for additional monitoring in the future.
- The Central Valley Regional Water Quality Control Board (CVRWQCB) Irrigated Lands Regulatory Program (ILRP) includes sampling and analysis of one domestic well in the Subbasin. This Groundwater Quality Trend Monitoring Network has been sampled by the Sacramento Valley Water Quality Coalition (SVWQC) on an annual basis since 2018.
- Glenn County has conducted annual testing of 4 irrigation supply wells in the Subbasin since 2003.
- The Central Valley Dairy Representative Monitoring program includes sampling and analysis of 5 wells at one site in the Subbasin.

For each of these networks, the GSAs will be able to download the data directly from the program websites for their annual review and report submittal. The following sections provide additional details on each of these programs and sites included in the GSP monitoring network.

5.5.1.1 Public Drinking Water Supply Monitoring Locations

Public drinking water supply wells are included in the groundwater quality monitoring network, as they are routinely sampled to meet California Code of Regulations (CCR) Title 22 water quality reporting requirements as regulated by the SWRCB DDW and the Glenn and Tehama County Departments of Environmental Health. There are 28 active public drinking water supply wells used in the Subbasin. The municipal wells in Corning and Hamilton City are required to collect samples for a wide array of analysis to meet Title 22 groundwater quality requirements. Smaller systems are only required to report results to the County and are not required to routinely test for all Title 22 analytes. Locations of the public drinking water supply wells in the Subbasin are shown on Figure 5-7 and summarized in Table 5-4.

Table 5-4. Groundwater Quality Monitoring Network – Public Drinking Water Supply Wells

Water System	DDW Well ID	Local Well ID	Well Screen Interval (ft bgs)	Latitude (NAD 83)	Longitude (NAD 83)
Bartels Giant Burger	5201083-001	WELL 01	180-260	39.92794	-122.20275
Black Butte Lake, Buckhorn Group, USCOE	5200670-001	WELL 01	--	39.81224	-122.37418
Black Butte Lake, Buckhorn RA, USCOE	5200672-001	WELL 01	--	39.81061	-122.36676
Black Butte Lake, Headquarters, USCOE	5201142-002	WELL 02 - NEW WELL	136 - 196	39.81384	-122.32873
Cal-Water Service Co. - Hamilton City	1110002-001	WELL 01-01	60 - 312	39.73898	-122.00993
	1110002-002	WELL 02-01	70 - 130	39.74412	-122.01423
	1110002-003	WELL 02-02	71 - 122	39.74400	-122.01417
Capay Joint Union Elementary School	1100527-001	WELL 01	--	39.79773	-122.08427
City of Corning	5210001-001	6TH ST. WELL	123 - 260	39.93101	-122.18367
	5210001-002	BLACKBURN AVE. WELL	195 - 205	39.93525	-122.16973
	5210001-003	BUTTE ST. WELL	130 - 230	39.93017	-122.17953
	5210001-005	PEACH ST. WELL	150 - 500	39.92502	-122.17414
	5210001-008	WELL 06 - EDITH AVE.	160 - 262	39.93415	-122.19724
	5210001-009	FRIPP STREET WELL	200 - 260	39.92948	-122.16488
	5210001-010	HIGHWAY 99W WELL	120 - 300	39.91625	-122.19534
	5210001-019	CLARK PARK WELL	--	39.92042	-122.16678
Corning RV Park	5200255-001	WELL 01	--	39.93436	-122.20217
E Headstart	5200541-001	WELL 01	--	39.97890	-122.16485
Irvine Finch River Access	1110300-001	WELL 01	--	39.75027	-121.99764
Jehovah's Witnesses - Corning	5200338-001	WELL 01	--	39.92836	-122.15456
Kirkwood Elementary School	5200520-001	WELL 01	--	39.85710	-122.16315
Lake Elementary School	1100440-001	WELL 01	--	39.76932	-122.15948
Lazy Corral Mobile Home Park	5200516-001	WELL 01	--	39.92106	-122.19675
Maywood Farms	5200865-001	WELL 01	--	39.90502	-122.22567
Maywood Mobile Home Park	5200556-001	WELL 01	--	39.93689	-122.20201
Richfield Elementary School	5200565-001	WELL 01	--	39.97455	-122.14360
Sierra Pacific Industries - Richfield	5201055-001	WELL 01 - RICHFIELD	--	39.98038	-122.17052
Woodson Bridge Mobile Home Park	5200551-001	WELL 01	100 - 140	39.90942	-122.09708

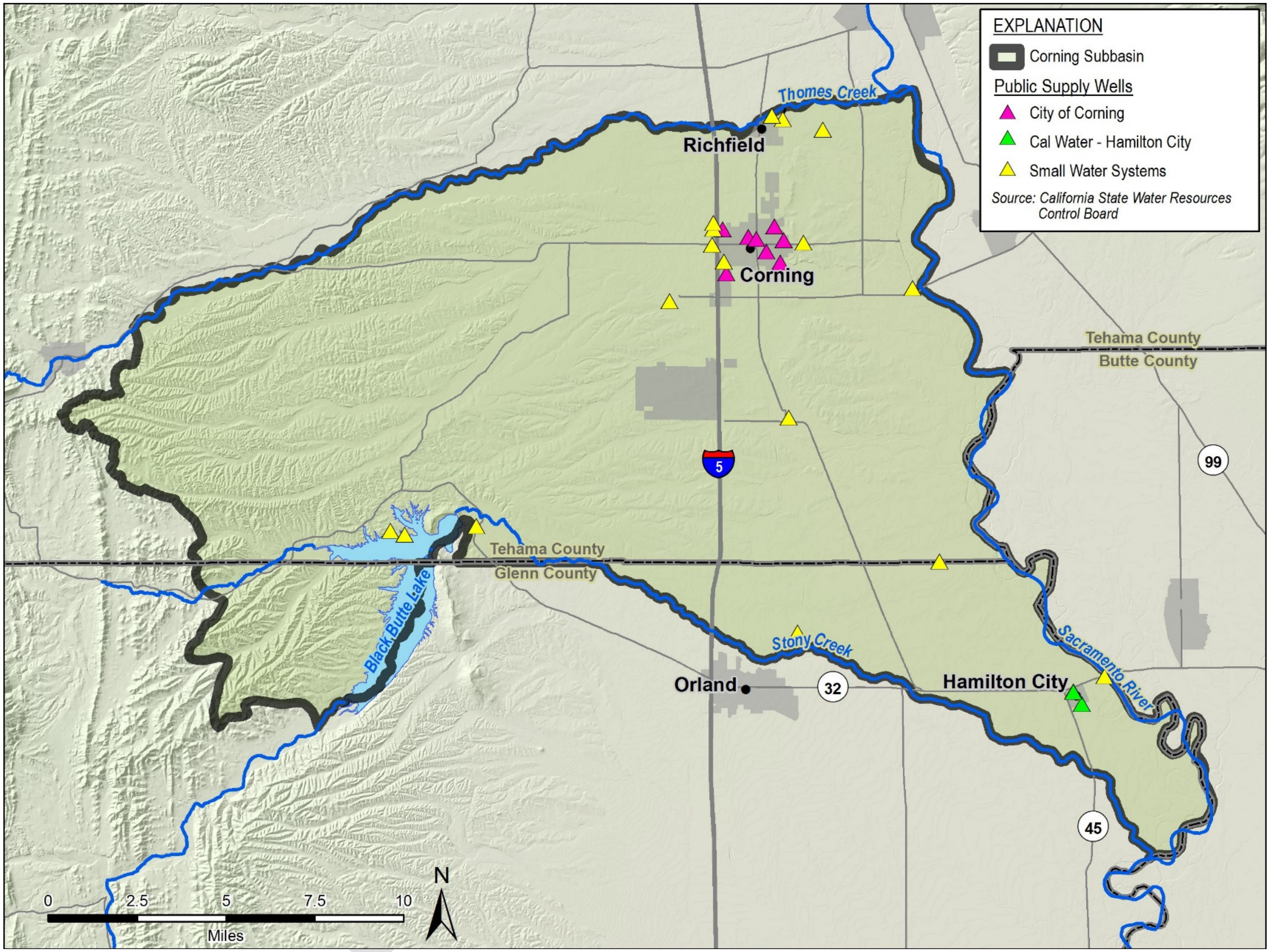

Figure 5-7. Groundwater Quality Monitoring Network - Public Drinking Water Supply Wells

5.5.1.2 DWR Groundwater Quality Monitoring

Water quality testing has been conducted sporadically since the early 2000s by DWR at 22 of the 37 observation well clusters in the Subbasin. Samples from these wells have been analyzed for a wide variety of water quality constituents, including nitrate, arsenic, and TDS. Results of these monitoring events are uploaded to the GAMA GeoTracker database. The DWR groundwater quality monitoring well network in the Subbasin is shown on Figure 5-8 and summarized in Table 5-5. Seven of the 10 observation well clusters in the Subbasin were sampled by DWR 2 or 3 times between 2005 and 2017. A total of 18 individual observation wells in 5 clusters were sampled in the Glenn County portion of the Subbasin, and 4 individual observation wells in 2 clusters were sampled in the Tehama County portion of the Subbasin.

5.5.1.3 ILRP Groundwater Quality Trend Monitoring Program

One domestic well in the Subbasin was included in the ILRP monitoring network sampled by the Sacramento Valley Water Quality Coalition. The well (ILRP number SVWQC00020) was sampled and analyzed annually under the direction of the SVWQC in 2018 and 2019. The GSAs intend to utilize the ILRP well data for GSP updates, but will not have a role in data collection, analysis, or reporting. The ILRP well is not part of the CASGEM or GSP groundwater level monitoring networks. Starting in 2022, as part of the ILRP, all domestic wells that are located on agricultural parcels will need to be monitored for nitrate and report it directly to the Regional Board; those values could be used to identify potential groundwater quality impacts to domestic well users, as needed.

5.5.1.4 Dairy Program

The Central Valley Dairy Representative Monitoring program includes sampling and analysis of 5 observation wells at one site in the Subbasin (LSCE, 2020). The Site, Brentwood Farms, is between the City of Corning and Hamilton City in Tehama County. One well couplet BRE-MW-1S/D is installed upgradient of the property, one well couplet BRE-MW-2S/D is installed cross-gradient of a pasture, and one well couplet BRE-MW-3S/D is installed adjacent to an animal housing. Each of the wells is sampled quarterly except for BRE-MW-3D. BRE-MW-2S has been periodically dry in the recent sampling events. In 2019, the wells were sampled quarterly for TDS, nitrate, and ammonia/ammonium and annually for common cations and anions. Sample results are summarized in annual reports provided to the CVRWQCB. Data will soon be made available on the GAMA website for public download and could then be used for the GSP monitoring network. The location of the wells is shown on Figure 5-8 and summarized in Table 5-5.

5.5.1.5 Glenn County Groundwater Quality Monitoring Program

Glenn County conducts annual groundwater quality monitoring at 4 irrigation wells in the Subbasin. Measurements are taken for temperature, conductivity, and pH using field water quality meters.

Table 5-5. Groundwater Quality Monitoring Network

Well ID	Type	Monitoring Program	Well Screen Interval (ft bgs)	Latitude (NAD 83)	Longitude (NAD 83)	Last Sample
22N01W29N001M	Observation	DWR	859 - 1135	39.72627	-122.01052	2017
22N01W29N002M	Observation	DWR	549 - 641	39.72627	-122.01052	2017
22N01W29N003M	Observation	DWR	189 - 380	39.72627	-122.01052	2017
22N01W29N004M	Observation	DWR	89 - 99	39.72627	-122.01052	2017
22N02W01N001M	Observation	DWR	810 - 1050	39.78356	-122.04614	2017
22N02W01N002M	Observation	DWR	700 - 710	39.78356	-122.04614	2017
22N02W01N003M	Observation	DWR	210 - 370	39.78356	-122.04614	2017
22N02W01N004M	Observation	DWR	70 - 80	39.78356	-122.04614	2017
22N02W15C003M	Observation	DWR	370 - 380	39.76344	-122.07716	2017
22N02W15C004M	Observation	DWR	210 - 220	39.76344	-122.07716	2017
22N02W15C005M	Observation	DWR	60 - 70	39.76344	-122.07716	2017
22N02W18C001M	Observation	DWR	841 - 1029	39.76820	-122.13645	2017
22N02W18C002M	Observation	DWR	414 - 434	39.76820	-122.13645	2017
22N02W18C003M	Observation	DWR	165 - 175	39.76820	-122.13645	2017
22N02W18C004M	Observation	DWR	55 - 65	39.76820	-122.13640	2017
22N03W01R001M	Observation	DWR	470 - 480	39.78662	-122.14550	2017
22N03W01R002M	Observation	DWR	270 - 280	39.78662	-122.14552	2017
22N03W01R003M	Observation	DWR	60 - 70	39.78662	-122.14552	2017
24N02W29N003M	Observation	DWR	200 - 290	39.89962	-122.12275	2017
24N03W29Q001M	Observation	DWR	130 - 360	39.90305	-122.22456	2017
24N03W29Q002M	Observation	DWR	490 - 550	39.90305	-122.22456	2017
24N03W29Q003M	Observation	DWR	650 - 710	39.90305	-122.22456	2017
SVWQC00020	Domestic	ILRP	134 - 161	39.94540	-122.22980	2019
BRE-MW1S	Observation	Dairy	15 - 30	39.83378	-122.133	2019
BRE-MW1D	Observation	Dairy	85 – 100	39.83378	-122.133	2019
BRE-MW2S	Observation	Dairy	95 - 105	39.82874	-122.133	2019
BRE-MW2D	Observation	Dairy	116 - 126	39.82871	-122.132	2019
BRE-MW3S	Observation	Dairy	88 - 98	39.83096	-122.125	2019
Red 5	Irrigation	Glenn County	140 - 350	39.7834	-122.14048	2021
Red 11	Irrigation	Glenn County	100 - 320	39.73185	-122.0094	2021
Red 12	Irrigation	Glenn County	--	39.68637	-121.97684	2021
Red 13	Irrigation	Glenn County	80 - 430	39.75342	-122.076373	2021

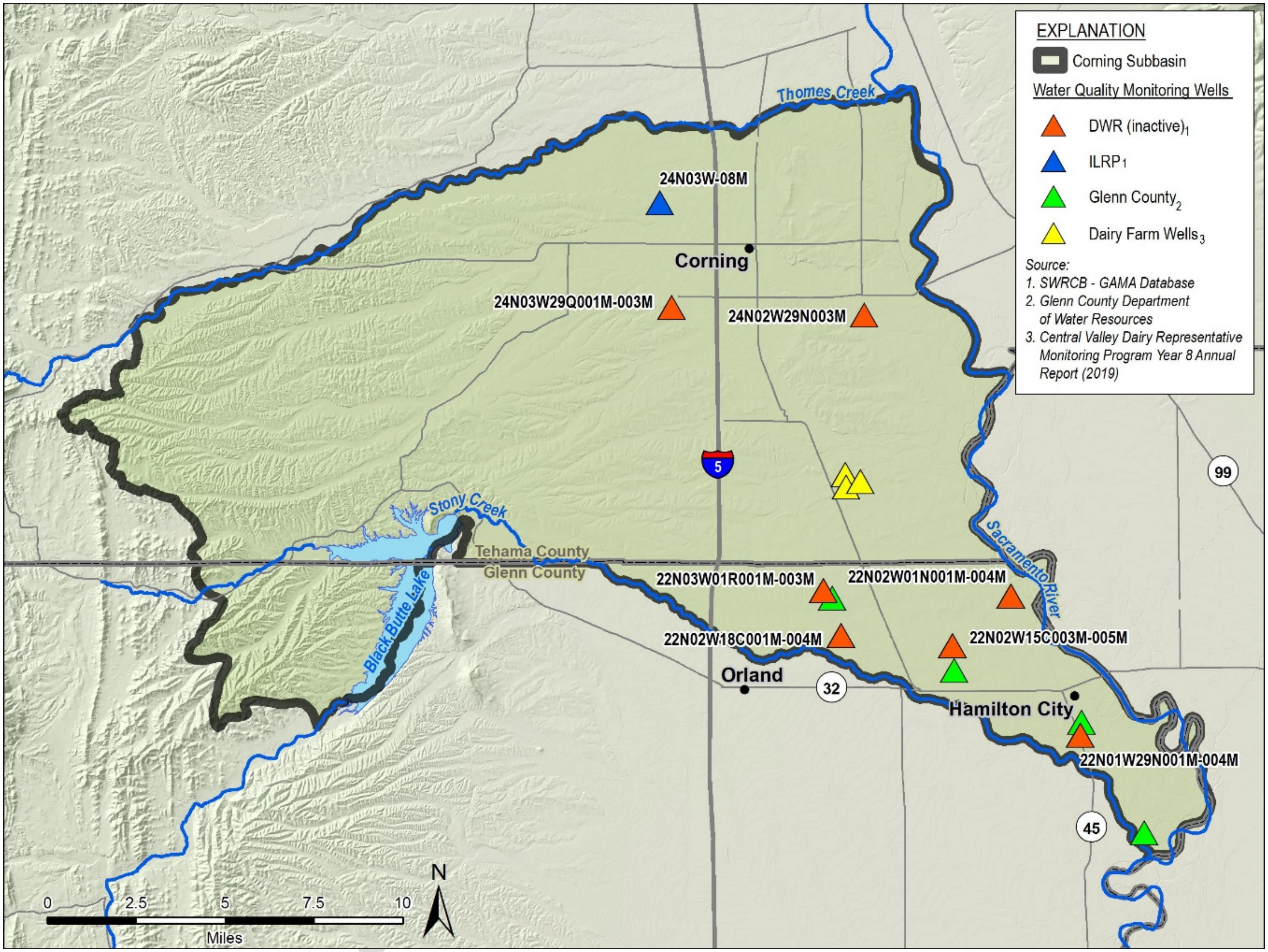

Figure 5-8. Groundwater Quality Monitoring Well Network

5.5.1.6 Groundwater Quality RMP Network

Since the groundwater quality SMC uses TDS as a metric, the groundwater quality RMP network only includes wells that are used to actively monitor TDS. The groundwater quality RMP network consists of the following wells:

- Eleven municipal supply wells for the City of Corning and Hamilton City
- Four small water system supply wells

The wells in the groundwater quality RMP network for salinity shown on Figure 5-9 will be sampled periodically for TDS. TDS results will need to be reported annually to DWR during GSP annual updates. The GSAs will collaborate with the public supply well agencies for monitoring and reporting purposes. In addition, DWR observation well sample results may be included during GSP implementation, if that network is revived. The GSAs will collaborate with DWR, as needed.

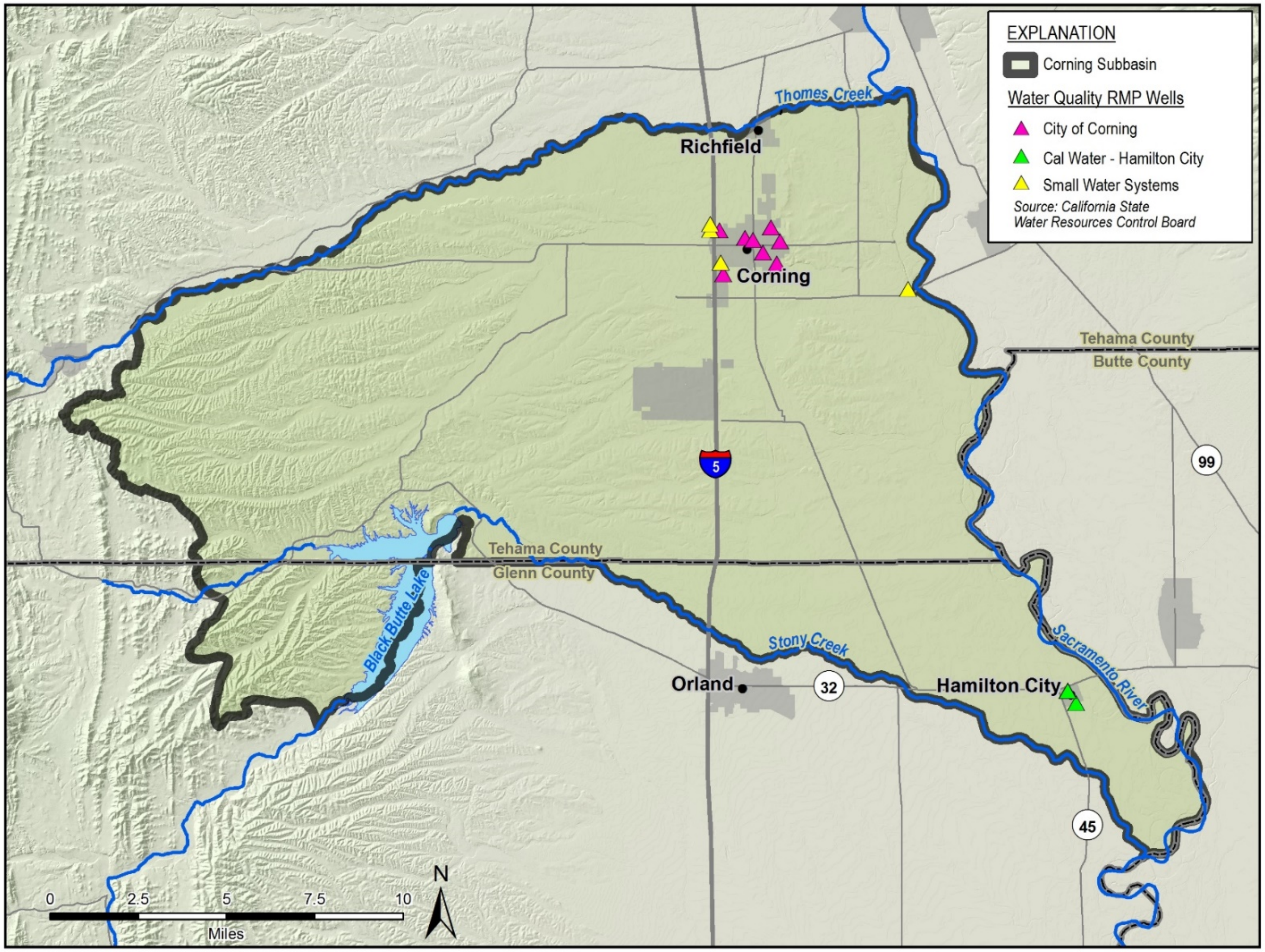

Figure 5-9. Groundwater Quality RMP Well Locations

5.5.2 Groundwater Quality Monitoring Protocols

The GSAs will rely on groundwater quality monitoring data from existing programs where available. Monitoring of drinking water supply wells is the responsibility of the entity that provides the water to the public. Drinking water quality data from public systems are collected, analyzed, and reported in accordance with state and federal regulations. For the drinking water wells in the Subbasin, the monitoring protocols are reviewed and approved by either the DDW, Glenn, or Tehama County Environmental Health Department and may vary by agency.

5.5.3 Groundwater Quality Monitoring Data Gaps

DWR's Monitoring Networks and Identification of Data Gaps BMP (DWR, 2016b) states, "The spatial distribution must be adequate to map or supplement mapping of known contaminants." There are currently some spatial data gaps in the groundwater quality monitoring network in the western portion of the Subbasin. However, water use is limited in that area. Several groundwater quality monitoring programs exist in the basin to monitor both point source and non-point source groundwater contaminants. Analytical results from these monitoring programs show that groundwater is of good quality for the beneficial use of groundwater throughout the Subbasin. The GSAs will continue to rely on these existing groundwater quality monitoring programs to collect and report data during GSP implementation.

The GSP groundwater quality monitoring network will be re-evaluated every 5 years to assess if additional groundwater quality monitoring wells should be included. The GSAs recommend that the DWR continue to monitor ambient groundwater quality in the network of observation well clusters in the Subbasin in the future. With the continued monitoring of these wells, there is adequate spatial coverage to assess the constituents of concern, particularly because groundwater quality in the portions of the Subbasin used for groundwater pumping is generally suitable for drinking and agricultural purposes.

A secondary data gap that should be filled as funding is available is that well construction information, including well screen intervals, is not known for some of the public supply wells and one of the Glenn County groundwater quality monitoring program wells. Confirmation of well construction details for these wells will be included in the Implementation Plan of this GSP.

5.6 Interconnected Surface Water Monitoring Network

Interconnected surface water and groundwater will be assessed in areas of the Subbasin where streams are connected to groundwater and groundwater pumping occurs in the vicinity of streams. In addition, the location of potential GDEs will be taken into consideration for the monitoring network. The interconnected surface water monitoring network will provide the necessary data to characterize spatial and temporal exchanges between surface water and groundwater. The monitoring data will be used to further calibrate the groundwater model for estimating locations and quantities of groundwater and surface water interaction during GSP implementation.

5.6.1 Interconnected Surface Water Monitoring Locations

The interconnected surface water monitoring network incorporates surface water monitoring and groundwater level monitoring. The current surface water monitoring network consists of 5 active stream gauges that measure river stage and/or discharge, summarized in Table 5-6 and shown on Figure 5-10. The interconnected surface water network also includes a subset of the shallow RMP groundwater monitoring network identified in Section 5.2.4. The interconnected surface water groundwater monitoring network consists of the observation wells that are close to interconnected reaches of the Sacramento River and Stony Creek. The network only includes observation wells as these wells were constructed specifically to monitor groundwater levels, in contrast to supply wells which are designed for groundwater extraction but are also used to monitor groundwater levels as a secondary purpose. Deeper observation wells and wells that are further away from the interconnected streams were excluded from this network as they are less likely to be influenced by surface water interconnection. The groundwater level monitoring network component of the interconnected surface water monitoring network is described in detail in Section 5.2.4 and summarized in Table 5-7.

Table 5-6. Interconnected Surface Water Monitoring Locations – Active Stream Gauges

Gauge ID	Gauge Name	Monitoring Agency	Data Source	River Stage (feet msl)	River Discharge (cfs)
				Start Date	Start Date
BBQ	STONEY CK BLW BLACK BUTTE DAM	USACE	CDEC	1/20/2010	NA*
SCG	STONY CK NR GRIZZLY FLAT (CO RD 200A)	USBR	CDEC	12/9/2014	12/9/2014
THO	THOMES CREEK AT PASKENTA	DWR	DWR Water Data Library / CDEC	1/1/2002	12/18/1997**
VIN	SACRAMENTO RIVER AT VINA BRIDGE-MAIN CH	DWR	DWR Water Data Library	10/1/1975	4/13/1945
HMC	SACRAMENTO R NR HAMILTON CITY CA	DWR	DWR Water Data Library	10/1/1975	4/21/1945

* = not available
** = stopped monitoring river discharge at THO in 2013
feet msl = feet above mean sea level
cfs = cubic feet per second

Table 5-7. Interconnected Surface Water Monitoring Locations – Shallow Groundwater Monitoring Wells

State Well Number	Well Type	Total Well Depth (feet bgs)	Perforated Interval (feet bgs)	Latitude (NAD 83)	Longitude (NAD 83)	Reference Point Elevation (feet msl)
22N01W29N003M	Observation	400	189 - 380	39.72627	-122.01052	149.99
22N02W01N003M	Observation	440	210 - 370	39.78356	-122.04614	161.50
22N02W15C004M	Observation	258	210 - 220	39.76344	-122.07716	192.25
22N02W18C003M	Observation	188	165 - 175	39.76820	-122.13645	225.54
22N03W01R002M	Observation	314	270 - 280	39.78662	-122.14552	228.53
23N02W28N004M	Observation	205	100 - 170	39.81167	-122.10200	204.43
24N02W29N003M	Observation	388	200 - 290	39.89962	-122.12275	213.76
Glenn TSS Well (Planned)	Observation	TBD	TBD	39.79549	-122.25500	TBD

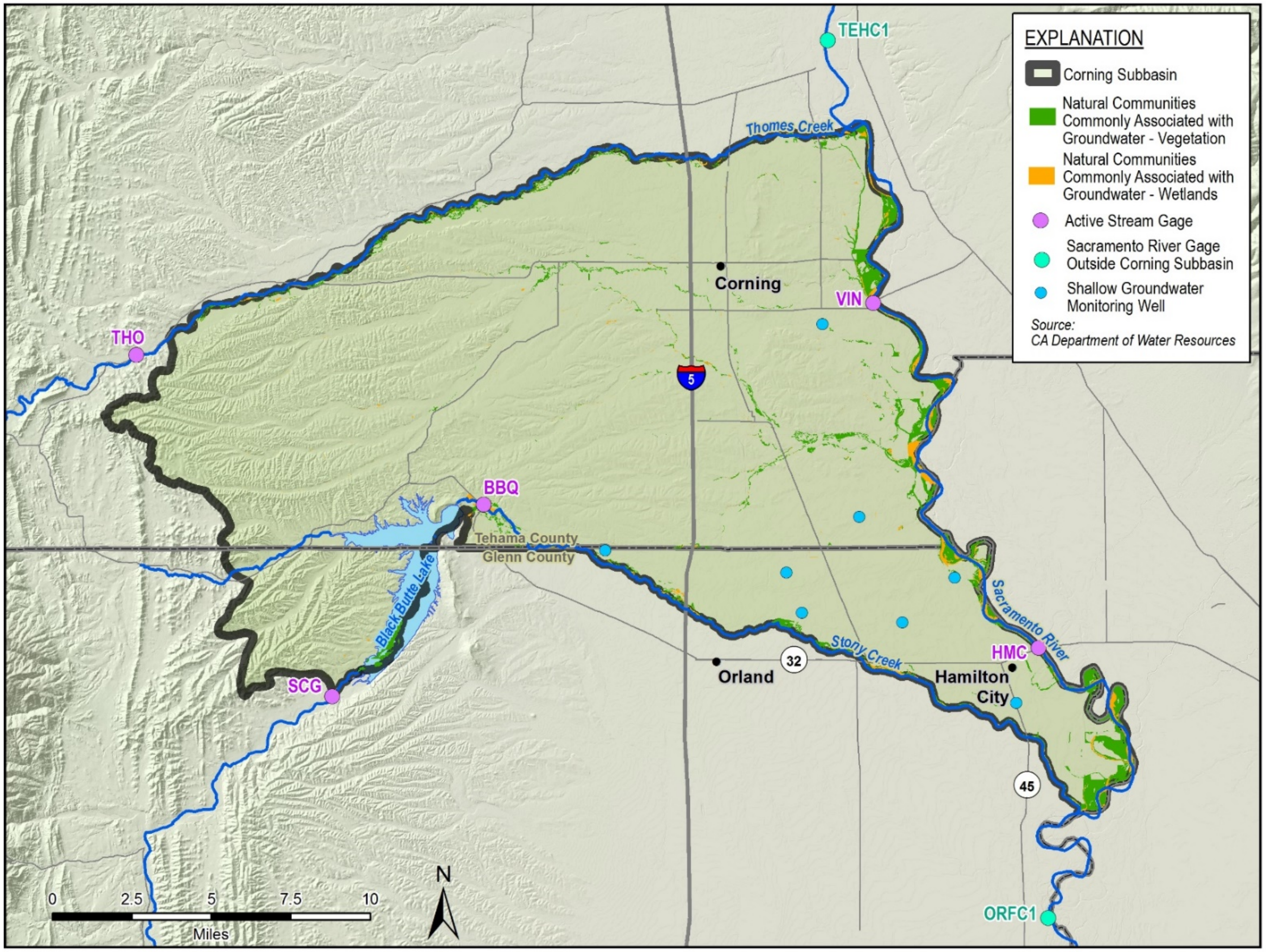

Figure 5-10. Interconnected Surface Water Monitoring Network

5.6.2 Interconnected Surface Water Monitoring Protocol

Monitoring protocols for collecting groundwater levels were described in Section 5.2.5.

Streamflow data are currently collected in the Subbasin by the USACE, USBR, and DWR. Raw daily stream stage and discharge are reported by the USACE, USBR, and DWR through CDEC. DWR also provides data in their Water Data Library database. The GSAs will coordinate with these entities to obtain routine data transmittals as discussed in the Implementation Plan in Section 8 of this GSP.

5.6.3 Interconnected Surface Water Monitoring Data Gaps

The interconnected surface water monitoring network includes data gaps that need to be addressed to characterize groundwater level fluctuation and its impact on stream stage and discharge for implementation of the GSP. For example, there is a lack of shallow observation wells currently available near connected streams to effectively monitor streamflow depletion in all portions of the Subbasin. This is a common data gap in the Sacramento Valley. For this initial GSP, a subset of the groundwater level shallow RMP observation wells will be used as a proxy. Two specific shallow monitoring well data gaps were identified in Section 5.2.5 that would help characterize groundwater and surface water interaction adjacent to Thomes Creek and the northern boundary of the Subbasin as shown on Figure 5-4.

Another monitoring location data gap is that many of the formerly active stream gauges in the Subbasin are no longer available for monitoring. Replacing or reviving the inactive stream gauge stations would provide adequate spatial coverage for streamflow monitoring in the Subbasin. The Nature Conservancy (TNC) developed the Gage Gap mapping tool[2] to identify streams that they believe have adequate or inadequate streamflow gaging information (TNC, 2019). The following description was paraphrased from their report:

The gauge gap analysis relies on stream segment, gauge station, and drainage area datasets from a variety of sources. A well-gauged stream segment has a gauge that reports data in real-time on a state or federally managed data portal. Almost well gauged streams are streams where a gauge is present that only reports height or stage (not flow) and/or data reporting is delayed up to 18 months. These gauges are considered to be good targets for rehabilitation or retrofitting. Poorly gauged streams are stream segments that have no active stream gauge for stage or flow OR a stream gauge is present, but the data is not reported in a state or federally managed data portal. Segments without an active gauge, but with a gauge in upstream or downstream segments were characterized as one of the 3 categories described above using a simple analysis of drainage area. It was determined that a drainage area upstream of a gauge was sufficiently monitored until the drainage area of that upstream segment falls below 50% of the drainage area at the gauged

[2] https://gagegap.codefornature.org/

location. If the stream segment downstream of the gauged segment exceeds 150% of the drainage area of the gauged location, the segment is considered to be poorly gauged.

Figure 5-11 shows the result of the stream gauge analysis in the Corning Subbasin. This figure shows that Thomes Creek is a poorly gauged stream that could benefit from additional stream gaging for more adequate data. The other major stream reaches in the Subbasin are adequately gauged.

By addressing these data gaps, the GSAs will establish a sufficient monitoring network of wells and stream gauges along each major creek and river in the Subbasin. This will allow for analysis of stream stage and discharge fluctuation in response to changing water levels and groundwater gradients (both vertically in cluster wells and horizontally in other wells).

The following less critical data gaps exist and will be addressed in Section 8 of this report:

- A discharge rating curve will be developed for the existing BBQ station so that stream stage can be correlated with stream discharge. Several measurements of discharge at a variety of stream stages are taken to develop an accurate ratings curve.

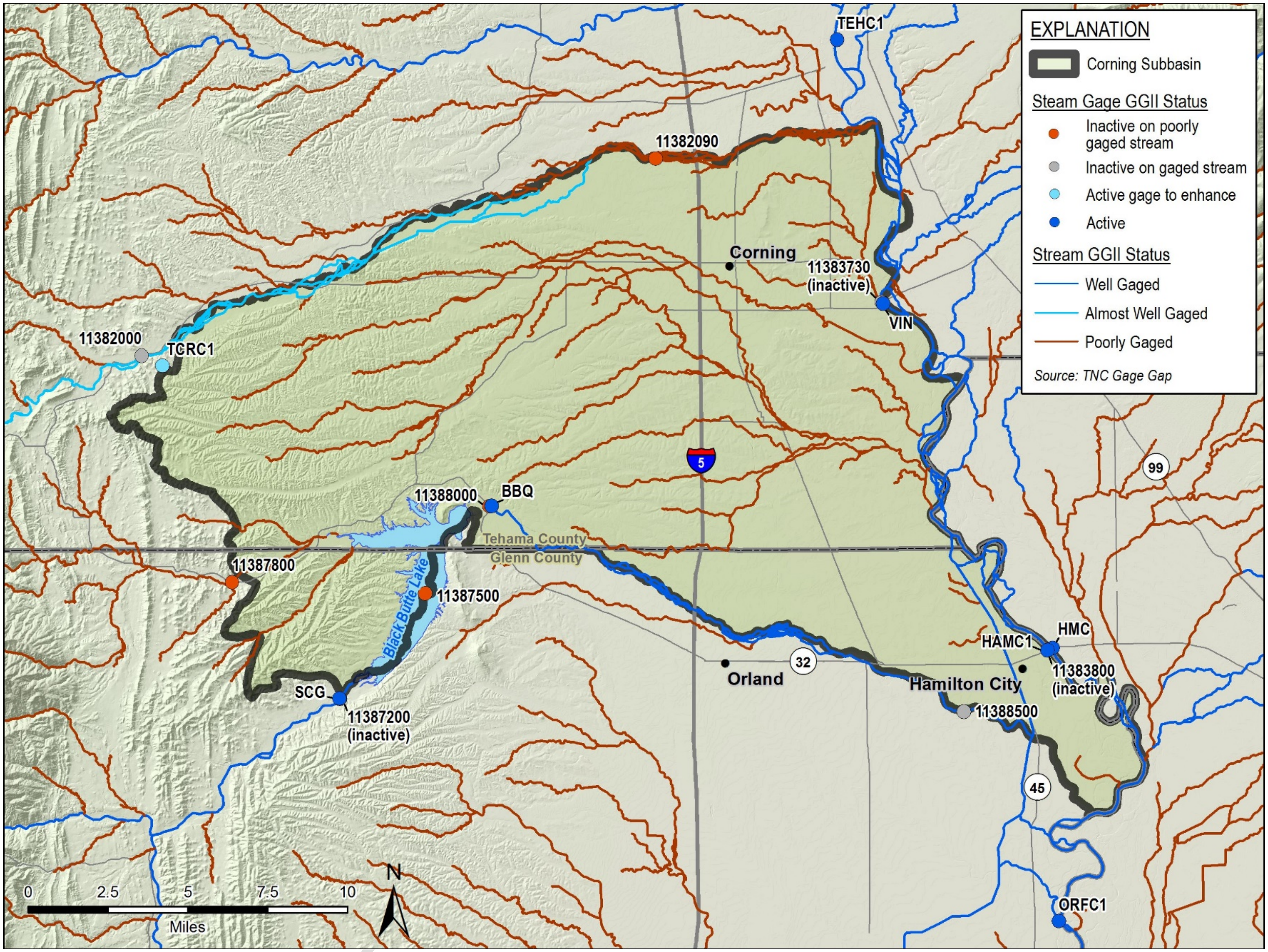

Figure 5-11. Stream Gauge Evaluation Map (data from TNC)

5.7 Data Management System and Data Reporting

The GSAs developed a Data Management System (DMS) that is used to store, review, and upload data collected as part of the GSP development and implementation. The DMS adheres to the following GSP regulations:

- Article 3, Section 352.6: Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the Subbasin.
- Article 5, Section 354.40: Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

5.7.1 DMS Design and Organization

The Corning Subbasin DMS consists of a Microsoft Access database that includes stations and related time-series data for wells and other monitoring sites used in the development of the GSP. These include wells in the monitoring networks, including RMP wells, and other sites. The data are organized in stations tables for groundwater monitoring wells, groundwater quality monitoring wells, subsidence monitoring sites, and surface water monitoring sites and in time-series data tables for groundwater level, groundwater quality, subsidence, and surface water stage and discharge, respectively.

These data tables were designed based on GSP data upload templates provided by DWR. The groundwater monitoring wells table includes, among other attributes, the following information for each well:

- State and Local Well Names
- Subbasin
- County
- Monitoring Network
- Latitude/Longitude
- Reference Point and Land Surface Elevations
- Well Completion Type
- Well Depth
- Screened Interval Top and Bottom Depths
- Well Status
- Sustainable Management Criteria, if applicable

The subsidence monitoring sites table includes similar attributes for extensometers and monuments that measure subsidence. With the exception of 4 wells monitored by Glenn County for electrical conductivity, the groundwater quality and surface water monitoring sites are monitored through existing programs; therefore, these tables have fewer attribute fields but include a field with URLs linking to the existing program sites. The 4 Glenn County electrical conductivity wells are included in the groundwater monitoring wells table.

Related tables for groundwater level and subsidence time-series data were also designed based on GSP data upload templates provided by DWR and include, among other fields, the following information for each time-series data record:

- Local Well Name
- Measurement Date and Time
- Measurement Reading
- Measurement Method and Accuracy
- Collecting Agency
- Comments

Time-series data tables for USGS streamflow data and GAMA groundwater quality data are also included in the DMS and include data provided through those existing program sites. A diagram outlining the organization of the DMS Access database is shown on Figure 5-12.

In addition to the Access database, the Corning Subbasin DMS also includes an ArcGIS Online web mapping application that allows GSP stakeholders and GSA staff to visualize key GIS layers, including monitoring network well locations, groundwater level contours, and other data related to the GSP development process. Figure 5-13 outlines how this web mapping application is integrated with the DMS.

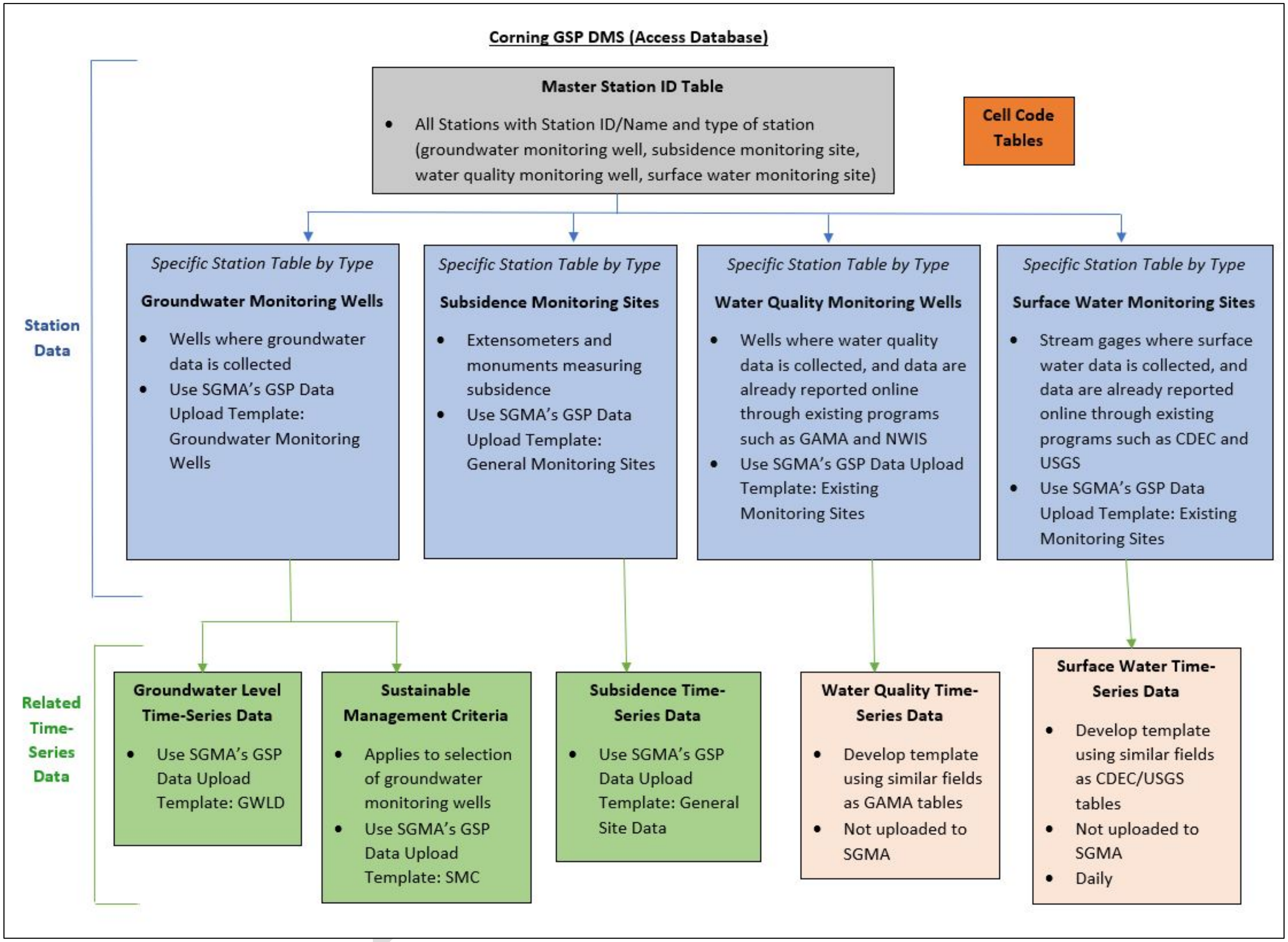

Figure 5-12. Organizational Diagram of DMS

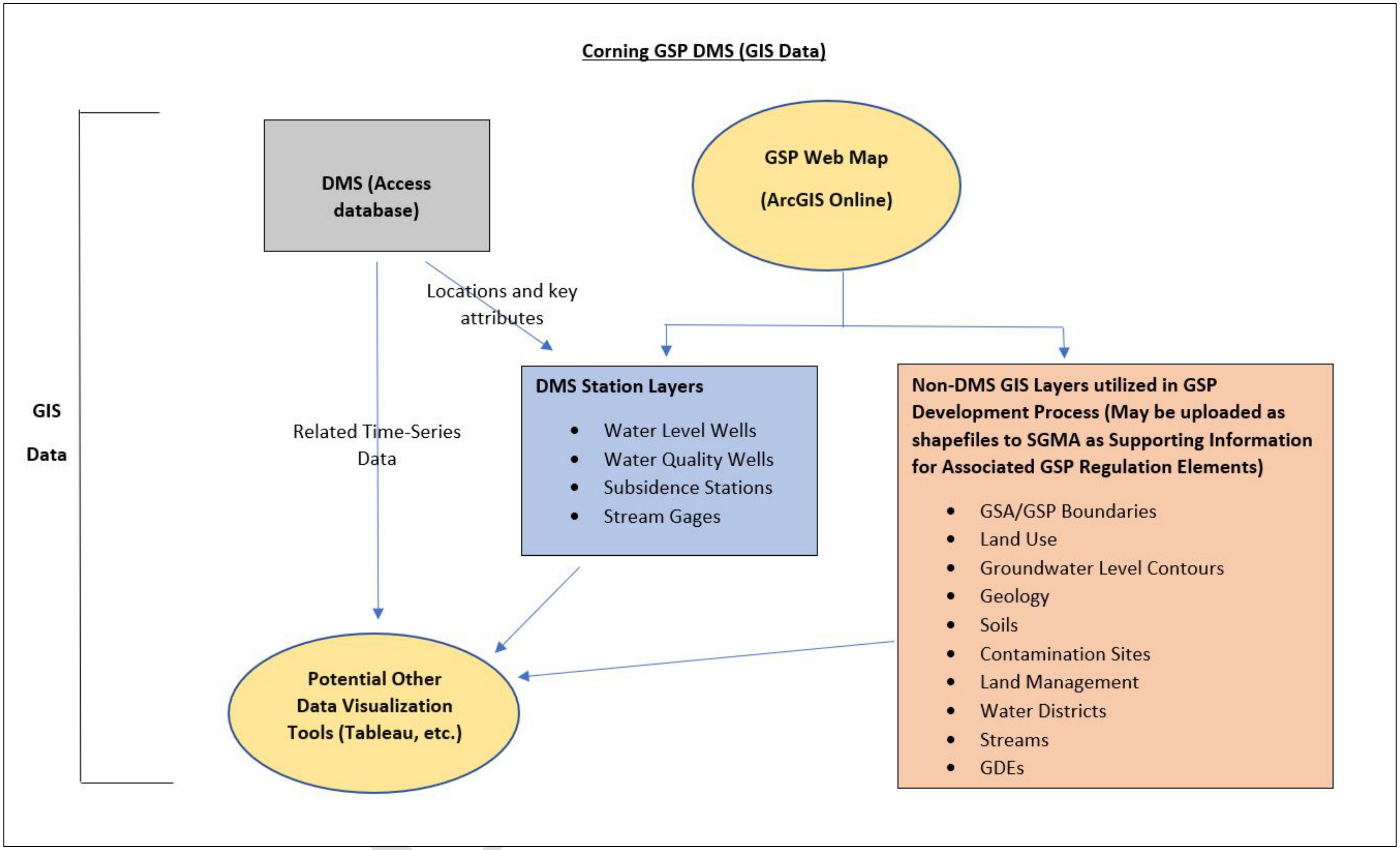

Figure 5-13. Organizational Diagram of Web Mapping Application

5.7.2 Data Management Process

The GSAs collaborated with Tehama County and Glenn County on the design of the DMS and on the data upload process. The data used to populate the Corning Subbasin DMS are listed in Table 5-8. Categories marked with an 'X' indicate datasets that are publicly accessible or available from Glenn or Tehama County and other sources that were used in populating the DMS.

Table 5-7. Datasets Used in Populating the DMS

Data Sets	Data Category					
	Well and Site Information	Well Construction	Water Level	Streamflow	Subsidence	Water Quality
DWR (CASGEM)	X	X	X			
Glenn DMS	X	X	X			X
GeoTracker GAMA	X					X
USGS Gauge Stations	X			X		
USGS/DWR/InSAR	X				X	

During the initial populating of the DMS, data were first compiled in Excel tables modeled closely on the GSP data upload templates provided by DWR. Then, data were imported to the Access DMS and were reviewed to comply with quality objectives. The review included the following checks:

- Identifying outliers that may have been introduced during the original data entry process by others.
- Removing or flagging questionable data being uploaded in the DMS. This applies to both historical and new groundwater level and quality data.

After the initial data upload and GSP submission, updated data are compiled in the input Excel tables and imported annually to the Access DMS. GIS data in the web mapping application is also updated annually. Figure 5-14 describes this process.

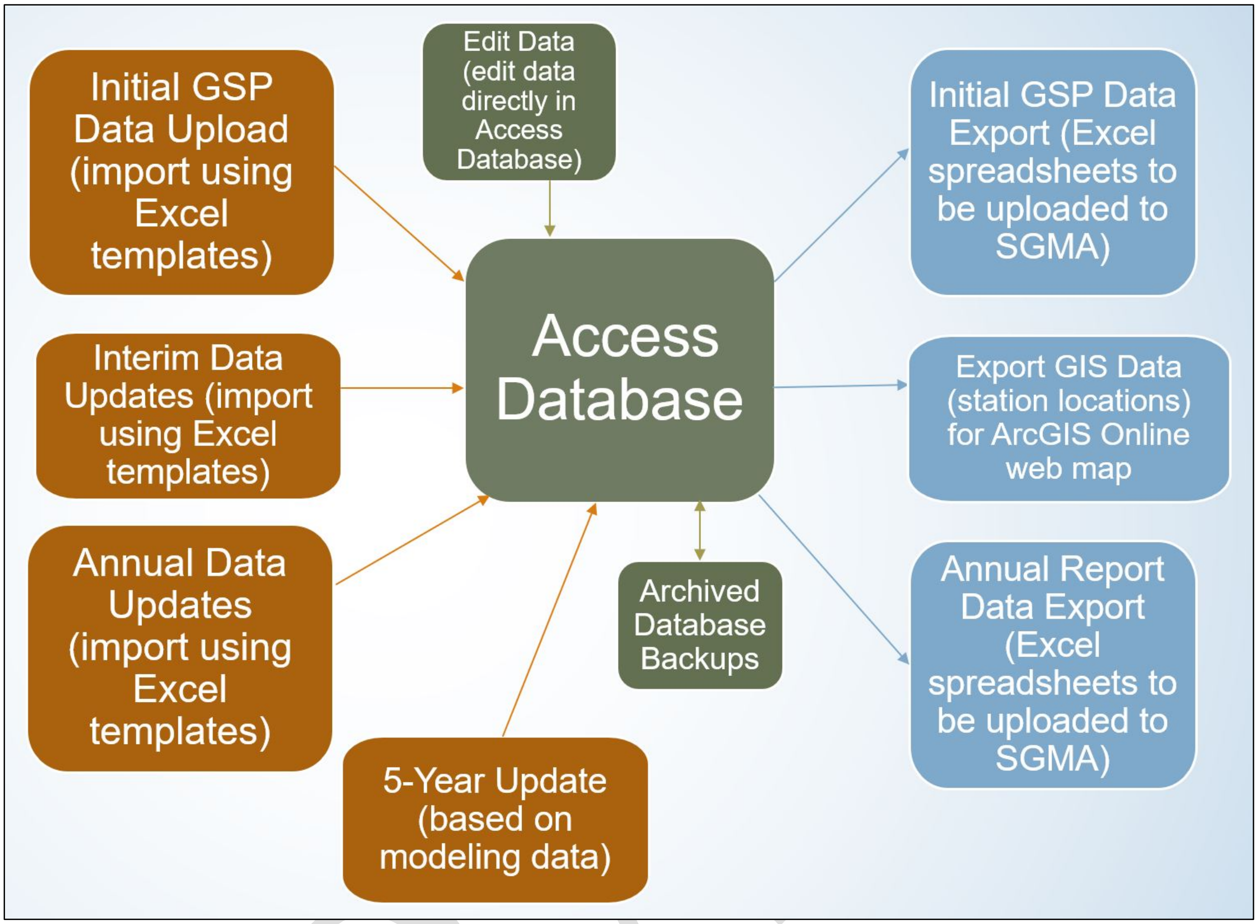

Figure 5-14. DMS Data Management Process Diagram

5.8 References

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