Appendix 3-A. Data Gap Assessment

Note: This appendix will continue to be refined and it is only providing a preliminary list of new data to be collected.

INTRODUCTION

Multiple datasets were utilized during development of this GSP to characterize current and historical Basin conditions. Monitoring networks were designed to support the evaluation of Basin conditions throughout GSP implementation, particularly with respect to the six sustainability indicators. The representative monitoring points (RMPs) in these monitoring networks are sites at which quantitative values for minimum or maximum thresholds, measurable objectives, and interim milestones are defined. New RMPs will be considered for the 5-years update based on the suggested expanded monitoring network. Data gaps that were identified throughout the GSP development process can be categorized into:

I. Data gaps in information used to characterize current and historical basin conditions.
II. Data gaps in monitoring networks developed to evaluate future Basin conditions which will be used in reporting and tracking Basin sustainability.
III. Additional data or information valuable for measuring progress towards the Basin's sustainability goal. This information has been identified as information that may be useful but has not been confirmed as a data gap,

These data gaps were identified based on spatial coverage of data, period for which data are available, frequency of data collection and representativeness of Basin conditions. An overview of data gaps in the first category is provided in Chapter 2, as part of the characterization of past and current Basin conditions, and the data gaps in the second and third categories are in Chapter 3 as part of descriptions of the monitoring networks. This appendix details the identification of data gaps and uncertainties in each of the categories and the associated strategies for addressing them. The process of data gap identification, and development of strategies to fill data gaps is illustrated in Figure 1 below, sourced from the Monitoring Networks and Identification of Data Gaps Best Management Practice (BMP), provided by DWR (2016).

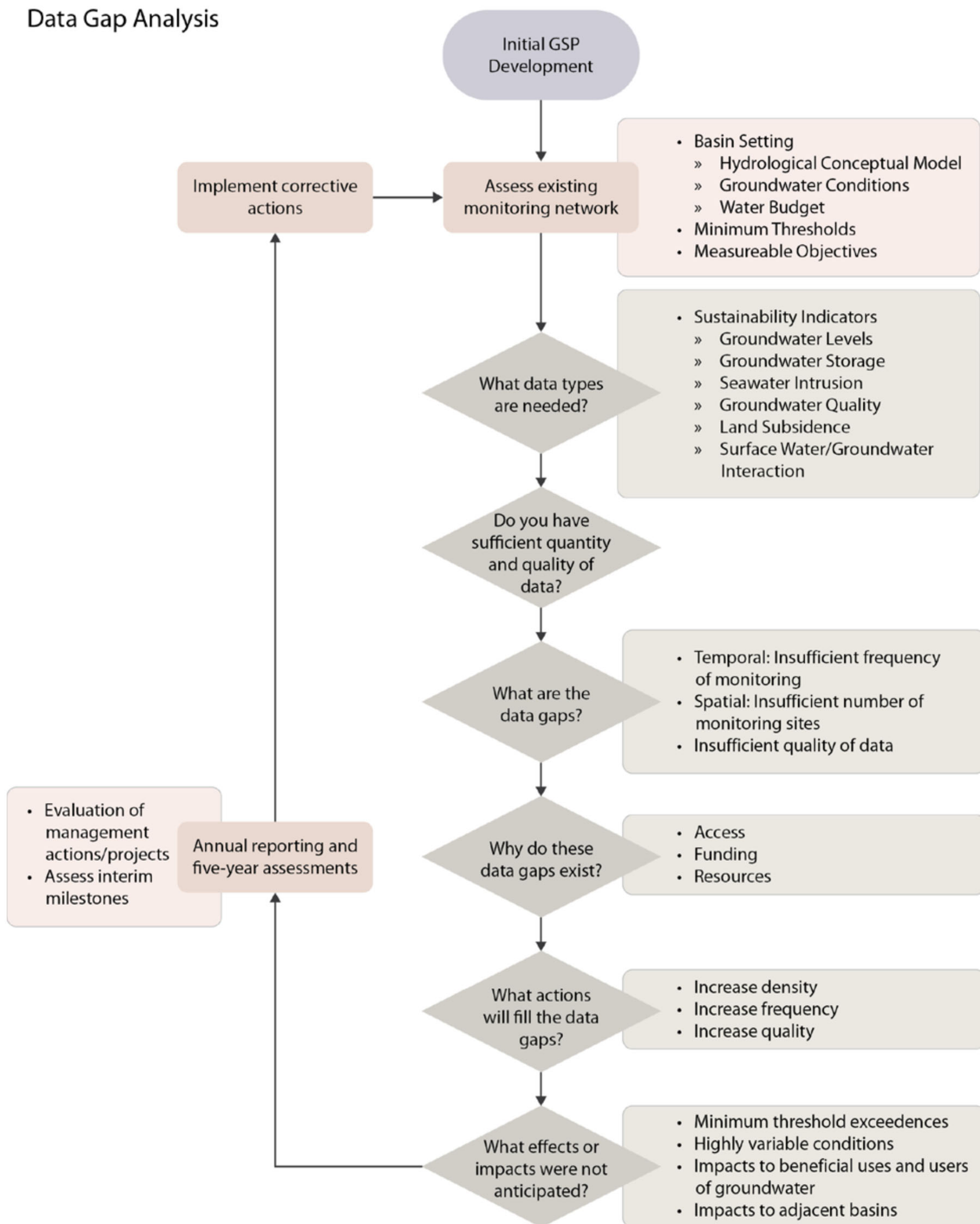

Figure 1: Data Gap Analysis Flowchart (DWR 2016)

I. DATA GAPS IN EXISTING INFORMATION USED FOR BASIN CHARACTERIZATION

Definition of the hydrogeological conceptual model (HCM) is a key requirement for understanding the Basin setting and characterizing existing and historical Basin conditions. An accurate assessment of the physical setting and processes that control groundwater occurrence in the Basin and is foundational to development of the sustainable management criteria and monitoring networks in Chapter 3 and identification of projects and management actions in Chapter 4.

Identification of data gaps and uncertainty within the HCM is a requirement per 23 CCR 354.14 (b)(5) and is important to inform locations and types of additional monitoring to reduce these gaps and uncertainties.

Identification of Data Gaps

The HCM is detailed in Chapter 2 of this GSP. Data gaps and uncertainties were identified throughout development of the HCM and are briefly discussed in Chapter 2 under applicable subsections. A discussion of the components of the HCM for which key datasets were used, associated data gaps, and uncertainties is provided below.

Climate

Long-term records are available from National Oceanic and Atmospheric Administration (NOAA) weather stations in and around Shasta Valley. A list of the applicable NOAA weather stations used in development of the climate component of the HCM can be found in Section 2.2.1.2. Data from these stations were used to evaluate historical and current precipitation (including snow pack measurements) and evaluate spatial and temporal (seasonal and long-term) trends in precipitation. The new HyDAS station installed through contribution of the SVRCD will provide the missing information about snow pack on the Shasta mountain.

Current and historical climate data is readily available for the Shasta watershed (Watershed) and has sufficient spatial coverage, frequency of measurement and length of record to evaluate current and historical conditions and identify trends. Based on an initial assessment of the data, a rainfall gradient is suspected but not confirmed in the Watershed.

Geology

Gaps in geological information are the largest component of the data gap for the HCM. As fully described in Chapter 2, geology of the Shasta valley is extremely complex and more data are critical to fully understand flow path in the aquifer. Through an effort by DWR, AEM surveys are expected to be conducted in fall 2021 and will complement the geophysical study presented in Appendix 2-G.

Aquifer tests and isotopes data collection will further support the refinement of the geological understanding of the basin.

Soils

A 1983 soil survey of central Siskiyou County (USDA 1983) was the primary source used for development of this component of the HCM. Additionally, soil properties as they relate to groundwater recharge were characterized through the Soil Agricultural Banking Index (SAGBI) ratings for the soil series in the Shasta Valley area can be viewed on a web application (app), developed by the California Soil Resource Lab at the University of California at Davis and University of California Agriculture and Natural Resources (UC Davis Soil Resource Lab and University of California Agriculture and Natural Resources 2019).

No data gaps were identified in the development of this section.

Hydrology

Significant data gaps have been identified regarding the hydrology of the Valley and new stream gages in the tributaries and along the mainstem of the Shasta river will be installed to support the definition of the SMC for ISW discussed in Chapter 3.

Note: Map with suggested locations of new stream gages to be added.

Identification of Interconnected Surface Water Systems

While interconnected surface water systems were identified in Section 2.1.1.7, there are uncertainties in this identification. A continuous saturated zone between the stream and aquifer is assumed for all locations that were identified as interconnected surface waters, as no locations are known to be separated from the water table by thick unsaturated zones, but this has not been physically confirmed.

New stream gages and new monitoring wells with continuous data collection, combined with seepage runs will provide stronger support to the conclusion presented in this GSP.

Identification of Groundwater Dependent Ecosystems

Data from the National Wetlands Inventory, The Nature Conservancy, and other sources (as detailed in Section 2.2.1.8) was used to identify groundwater dependent ecosystems (GDEs) in the Basin. While the results of the initial GDE inventory were evaluated by the Surface Water Ad Hoc Committee, physical verification has not been completed. There is therefore some uncertainty between riparian and non-riparian GDEs that were mapped and the existence and extent of these GDEs on the ground.

Satellite images evaluated twice per year would provide information on the health of GDEs over time and would be critical to fully understand their seasonal cycles.

Current and Historical Groundwater Conditions

Groundwater Elevation Data

Groundwater elevation data is sourced primarily from the California Statewide Groundwater Elevation Monitoring Program (CASGEM), and from DWR. Well data is available dating back to the 1960s and wells have adequate spatial coverage of the Basin, measurement frequency and period of record. The wells are measured at a frequency of bi-annually, with the exception of a few wells in the area of the former Nature Conservancy property. These frequencies are sufficient to enable determination of seasonal, short-term, and long-term trends, but they do not provide insights on high and low values and on the response of the system to precipitation or to the start of the irrigation season. A summary of the wells with groundwater elevation data is under development and will be used to complete **Error! Reference source not found.**.

Table 1: Wells with groundwater elevation data in the Shasta Valley

Wells	Groundwater Basin
Wells with coordinates (including data from WCRs referenced to nearest PLSS section)	***
Wells with screen depth information	***
Wells with coordinates and recent[1] water level data	***
Wells with pumping data	None

[1] Recent is here used to refer to data from the past ten years.

Note: To be added

- Map of wells that have continuous data
- Suggested locations for groundwater level and temperature measurement monitoring

Estimate of Groundwater Storage

Groundwater storage data is available from the foundational geological report (Mack 1958) and specific yield and storativity were estimated using the Shasta Watershed Hydrological Model (SWHM).

Groundwater Extraction Data

No pumping monitoring program currently exists in the Basin and this data is not available for any of the wells with groundwater elevation data. This has been identified as a data gap.

Groundwater Quality

Groundwater quality data was obtained from several sources including the California Groundwater Ambient Monitoring and Assessment (GAMA) Program Database, the USEP Storage and Retrieval Data Warehouse (STORET), GeoTracker GAMA. As detailed in Appendix 2-B, available water quality data were compared to regulatory standards and mapped. Constituents of concern were identified through visual analysis of recent data (within the past 30 years) of the generated maps and timeseries for each constituent (available in appendix 2-B). As seen on these maps, and noted in Section 2.2.2.3, there are multiple data gaps in the groundwater quality information used to develop the HCM. Spatially, groundwater quality data is not equally distributed throughout the Basin, with a general lack of data in the eastern side of the valley. Additionally, most of the groundwater quality data used in the assessment did not have a long record with consistent measurements, or measurements with a frequency that would be sufficient for determination of historical trends in groundwater quality. Further data gap discussion and the strategy for filling these data gaps is discussed under the groundwater quality monitoring network associated with Chapter 3, below.

Note: Information to be added regarding the NCRWQCB groundwater quality 2021 efforts in Shasta Valley.

Land Subsidence Conditions

Land subsidence data is entirely sourced from the TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) dataset which provides estimates of vertical displacement from January 2015 to June 2015. No data gaps were noted in this section.

Water Budget

The water budget is dependent on monitoring data inputs. For data gaps in the water budget see previous sections on climate and hydrology (i.e., tributary) data gaps.

DATA GAPS MONITORING NETWORKS

Requirements

Multiple data gap requirements are relevant to the definition of monitoring networks for sustainability indicators. Per 23 CCR 354.38 ("Assessment and Improvement of Monitoring Network"):

(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.
(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency
(c) If the monitoring network contains data gaps, the plan shall include a description of the following:
    a. The location and reason for data gaps in the monitoring network
    b. Local issues and circumstances that prevent monitoring
(d) Each Agency shall describe steps that will be taken to fill the data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

The following discussion summarized the identified data gaps, description, and strategy to fill the identified data gaps.

Groundwater Level and Storage Monitoring Network

Data gaps have been explicitly identified, and additional measurement of continuous groundwater levels and temperature have been included to support the evaluation of changes in storage and with model calibration.

Through the partnership with the SVRCD and through a Water Smart grant obtained from the Bureau of Reclamation, 14 wells have been already instrumented with continuous data and telemetry throughout the valley. These data will be used to refine the SWHM and to further improve the SMC definition.

Groundwater Quality Monitoring Network

Requirements

Requirements for the monitoring network for the degraded water quality sustainability indicator are outlined in 23 CCR 354.34 (c)(4): Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

Data Gaps

Data gaps in the groundwater quality monitoring network were identified due to inadequate spatial coverage, monitoring frequency, and/or lack of representativeness of Basin conditions and activities. The sites with existing and ongoing groundwater quality monitoring are public supply wells and are therefore concentrated near population, or seasonal population, centers, leaving much of the Basin without representative monitoring data. The location of these data gaps is shown on the map of the existing groundwater quality monitoring locations (see Figure 2 in Chapter 3). These data gaps are due to the limited number of wells that conduct current and ongoing monitoring for the identified constituents of concern, all public supply wells. The wells in the existing groundwater quality network also have a temporal data gap with a frequency of measurement annually or greater, corresponding to the public water supply system sampling frequency. A higher frequency of sampling, at minimum biannually, is necessary to enable determination of trends in groundwater quality on an intra-annual scale. No local issues or circumstances are expected to prevent monitoring. As discussed in Section 3.3.3, the groundwater quality monitoring network will be expanded with a minimum addition of five wells within the first five years of plan implementation to address this data gap. Candidate wells have been identified for inclusion in this expansion including wells used by dairy operators to report groundwater data to NCRWQCB, domestic wells, and wells included in the monitoring network for groundwater levels.

Depletions of Interconnected Surface Water Monitoring Network

Requirements

The requirements for the depletion of interconnected surface water monitoring network, as part of § 354.34. Monitoring Network, are detailed below:

(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.

(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.

(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.

(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

(E) Changes in gradient between river and groundwater system

Data Gaps

While the Scott Valley Integrated Hydrologic Model (SWHM) will be the primary tool for estimating depletions of interconnected surface water once we obtained a better calibrated model over the next 5 years, monitoring is necessary not only for inputs and calibration of the model, but mostly to demonstrate the sustainability through the SMC defined for ISW. As a result, data gaps in the hydrology and climate sections of the Basin setting are also relevant here. Data gaps were identified for physical monitoring to be used in combination with the SWHM. Wells near the mainstem of Shasta River, to be used in observation of long-term trends in the hydraulic gradient between the aquifer and stream were identified as a data gap for the monitoring network associated with the depletions of interconnected surface water sustainability indicator. Two transects of shallow piezometers instrumented with continuous pressure transducers across the Shasta River, and one on the little Shasta have already been installed and will provide critical information to fully understand the relationship between the river and the aquifer. More transects may be considered in the next 5 years pending some more data gaps that will be identified and pending funding availability.

ADDITIONAL DATA OR INFORMATION VALUABLE FOR MEASURING PROGRESS TOWARDS THE BASINS SUSTAINABILITY GOAL

Additional data has been identified that may be valuable to evaluations of progress towards the Basin's sustainability goal. This is primarily additional monitoring information that may be useful to identify adverse impacts on biological uses of surface water, in addition to existing biological monitoring in the Basin.

These include evaluation of streamflow depletion impacts on juvenile salmonids and use of satellite imagery for monitoring riparian and non-riparian vegetation. The GSA may consult other entities or specialists, as feasible, to determine the value of this data.

DATA GAP PRIORITIZATION

The identified data gaps are prioritized for actions to be taken to resolve them. Data gaps are categorized into "high", "medium", and "low" prioritization statuses based on the value to understanding basin setting or in comparison to the defined SMCs to evaluate Basin sustainability. Filling data gaps can be achieved through increasing monitoring frequency, addition of monitoring sites to increase spatial distribution and density of the monitoring network or adding or developing new monitoring programs or tools. Summaries of the data gaps discussed in this appendix, associated prioritizations, and strategies to fill the data gap are shown in Table 2.

Table 2: Data gap prioritization

Priority	Data Gap Summary	Strategy to Fill Data Gap
High	Groundwater quality monitoring network	Planned expansion of groundwater quality monitoring network in the first five years. Additional expansion will be evaluated at the five-year update.
High	Depletions of interconnected surface water monitoring network	Planned addition of continuous groundwater level and temperature measurement near the river to determine the gradient between the aquifer and stream and for use in

		calibration of SWHM, and to evaluate the baseflow SMC defined in Chapter 3 for ISW.
Medium	Groundwater extraction data	No strategy has been defined yet to fill this data gap. Only voluntary measures are being considered to gathered extraction data.
High	Identification and evaluation of Groundwater-Dependent Ecosystems	Using satellite imagery to confirm location and extent of GDEs and evaluate twice per year to assess GDE health over time.
Low	Additional precipitation data to confirm presence of rainfall gradient.	No strategy has been defined yet to fill this data gap.

Note: Prioritization to be refined and discussion of added monitoring for continuous groundwater and temperature, isotopes, and soil moisture after preliminary evaluation of the new data that have been collected since 2021. Expansion expected in 2022.

REFERENCES

California Department of Water Resources (2016). BMP 2: Best Management Practices for the Sustainable Management of Groundwater Monitoring Networks and Identification of Data Gaps, December 2016. https://water.ca.gov/-/media/DWR-Website/WebPages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/BestManagement-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-andIdentification-of-Data-Gaps_ay_19.pdf

Charles W. Jennings, with modifications by Carlos Gutierrez, William Bryant, George Saucedo, and Chris Wills. 2010. “Geologic Map of California (2010).” Department of Conservation; California Geological Survey. https://www.conservation.ca.gov/cgs/publications/geologic-map-of-california.

Mack, Seymour. 1960. “Geology and Groundwater Features of Shasta Valley, Siskiyou County California.” Geological Survey Water-Supply Paper 1484.

United States Department of Agriculture (USDA). 1983. “Soil Survey of Siskiyou County California Central Part.”